TRANSACTIONS

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ROYAL SOCIETY OF VICTORIA.

VOL. I. PART I.

[PLATES, 1, 2, 3, 4, 5, 6.]

THE ANATOMY

OF

MEGASCOLIDES AUSTRALIS

(THE GIANT EARTH-WORM OF GIPPSLAND.)

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IT HAS been decided that the Society shall, in future, issue two separate publications, of which one shall be called the "Transactions," the other the "Proceedings of the Royal Society of Victoria."

This forms the first part of the first volume of the "Transactions."

August, 1888.

I. *On the Anatomy of Megascolides australis, the Giant Earth-worm of Gippsland.*

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[PLATES 1, 2, 3, 4, 5, 6.]

HISTORICAL.

THE first figure and description of this, which is probably the largest earth-worm yet known, were those given by Professor MCCOY,* to whom it had been sent from Gippsland. This description is unfortunately incorrect, the worm being placed in a wrong family, and the first correct one is that given by Mr. FLETCHER, in his "Notes on Australian Earth-worms."† To this author we are indebted for a large series of careful studies, so far as their macroscopic anatomy is concerned, of Australian Earth-worms.

In November 1887, this paper, on the anatomy of *Megascolides australis*, was read in abstract before the Royal Society of Victoria; I was unaware at that time that Mr. FLETCHER had in September, two months previously, described its macroscopic anatomy, and our work was carried on quite independently.

Before this Mr. FLETCHER had described two species of Earth-worms, which he placed in a new genus, *Notoscolex*, and in the paper which contains his description of the worm with which we are now dealing, the latter is described as *Notoscolex gippslandicus;* at the same time Mr. FLETCHER described two other new species belonging to the same genus, viz., *N. tasmanicus* and *N. tuberculatus.*‡

It is unfortunate, inasmuch as we owe our knowledge of this very interesting genus almost entirely to Mr. FLETCHER, that from reasons of priority his name of *Notoscolex* must give way to that of *Megascolides*, the name first given to the type of the genus which now includes five species.

The characters of the genus, as given by Mr. FLETCHER, are as follows:—

Megascolides MCCOY (*Notoscolex* FLETCHER).

Intra-clitellian worms, with clitellum, comprising some or all of segments XIII.—XXIII.; male pores two, on segment XVIII., on papillæ, in a line with

* Prodromus to the Zoology of Victoria. Dec. 1, pl. 7.

† Proc. Linn. Soc. N.S.W., 28th Sept., 1887. See also the same author's series of "Notes on Australian Earth-worms" in the same journal.

‡ *N. camdenensis* and *N. grandis.* See Proc. Linn. Soc., N.S.W., 30th June, 1886, pl. VIII, pages 1–6.

the intervals between the inner couples of setæ; oviducal pores on XIV.; setæ in eight longitudinal rows.

Habitat.

In September 1887, and at subsequent periods, I procured many specimens of *Megascolides australis* in the neighbourhood of Warragul and Brandy Creek, and my thanks for valuable assistance are due to Messrs. Hugh and Henry Copeland, and to Messrs. C. A. Topp and A. H. S. Lucas; without their kindly aid it would not have been possible for me to have secured entire specimens of the worm. I have also to thank the Rev. W. Mantell for the gift of the first specimen of the worm which reached me, and upon the examination of which my preliminary account, presented to the Royal Society in October 1887, was based.

The worm, which is known as the "Giant Earth-worm of Gippsland," appears to be confined to the latter districts. The other species of the genus are found, one in Tasmania, two in Camden, N.S.W., and one in Gippsland. None is as yet reported from the Western or Northern parts of Australia, though probably species of the genus will be found in all portions of the continent when carefully searched for.

Of all the species yet known, this one seems to be the largest, and is apparently confined to Gippsland; it is, when found at all, somewhat abundant, and lives principally on the sloping sides of creeks. At times it is found beneath fallen logs, and may be turned out of the ground by the plough.

When first seeking it, we were somewhat puzzled by some of those who were evidently well acquainted with the worm assuring us that the entrance to its burrow was indicated by a distinct "casting;" whilst others, evidently equally well acquainted with the animal, were quite as positive in asserting that it never produced any "casting." Whilst searching, we found what I believe to be the explanation of these contradictory statements, and soon discovered that the surest test of the presence of the worm underground was a very distinct gurgling sound, made by the animal retreating in its burrow when the ground was stamped upon by the foot. When once heard this gurgling sound is unmistakeable, and we at once learnt to regard it as a sure sign of the worm's presence.

The worm very frequently lives in ground riddled by the holes of the land-crab, as it is popularly called; this animal has a small circular burrow leading down to a chamber hollowed out underneath containing a pool of water, and through these chambers the worms' burrows frequently pass. The "crab" almost invariably has a large conical "casting" at the entrance to its hole, and may raise this to a height of even a foot and more; but the true worm burrow never, so far as yet observed, has any "casting" at its entrance, and all trace of this is wanting where the crab-holes are absent. The very frequent association of the "crab" and worm leads to the idea that the latter forms a cast; but one of the most noticeable features of the ground, which is at times riddled with worm burrows only, is the entire absence of "castings." What the worm does with the immense quantity of earth which it passes through its body I cannot at present say, and it must also be noticed that, only on very rare occasions, can any trace be detected of leaves dragged down into the burrows.

It is no easy matter to extract the worm without injury, owing to its length, the coiling of the burrow, the rapidity of movement which it possesses when underground, and its power of distending either the anterior or posterior ends of the body, or both.

Directly the burrow is laid bare, the worm is seen gliding rapidly away, often producing the curious gurgling sound as it passes through the slimy fluid, always present in a burrow containing the living animal. Sooner than allow itself to be drawn out, it fixes, if held in the middle, both ends of its body, by swelling them out till they are tightly jammed against the sides of the burrow ; under these circumstances pulling merely results in tearing the body. The worm has been described as brittle, but this term is most inapplicable, as its body is very soft, and capable of a great amount of extension before tearing. Its curious smell, when living, resembling somewhat that of creosote, has been already observed by Professor McCoy, and when dead it is worse than ever, and very strong and characteristic ; the body in decaying passes into an oily fluid which, we were assured by one or two old natives of the district, is very good for rheumatism. Fowls refuse to touch the worm living or dead.

When held in the hand, the worm in contracting its body throws out jets of a milky fluid from its dorsal pores to a height of several inches ; if the burrow be examined carefully its sides are seen to be very smooth, and coated over with a fluid exactly similar to that ejected from the pores. Whatever be the primary function of the fluid when within the body cavity, there can be no doubt that it has the important and perhaps secondary function when it has passed out of the body of making the burrow walls smooth, moist and slippery, and of thus enabling the animal to glide along with ease and speed.

The worm in its burrow moves rapidly by swelling up its anterior or posterior end as the case may be, and then using this as a fixed point, in doing which the setæ perhaps help, though to a minor extent, it strongly contracts the rest of its body. In the next movement, the end free in the first instance will be swollen out and used as a fixed point from which expansion forwards can take place. These changes of motion follow each other so rapidly that in the burrows the appearance of continuous gliding is given. Outside the burrow when the whole body surface is not in contact with the earth, the worm makes no attempt whatever to move, lying passively on the ground. Anyone who merely sees the beast removed from its burrow imagines it to be of a very sluggish temperament, and can form no idea of its active and rapid movements when underground.

So far as locomotion is concerned, its setæ seems to be of little or no use to it. The perichæte worms, on the contrary, when taken from the burrow, move along on the ground with remarkable speed, certainly using their setæ as aids to progression.

The burrows of the large worm measure $\frac{3}{4}$-1 in. in diameter, and in disused ones are often found (1) casts of the worms, or rather, what are probably the earthy contents of the alimentary canal, with clear indications marked upon them of the segments of the body, and (2) more rarely cocoons. The latter measure $1\frac{1}{2}$-2 in. in length, vary from light yellow to dark brown in colour according to their age, and contain only one embryo each, which I have at present only been able to obtain in a somewhat highly developed state.

The cocoon itself is somewhat thin, and made of a tough leathery material, with a very distinct stalk-like process at each end; it contains a milky fluid closely similar to that found in the body cavity of the worm.

I hope soon to be able to increase the number of my stock of worm embryos, and to be able to work out in detail its development.

It is interesting to note the fact that at the present time we know of three especially large kinds of earth-worms; that of these, one comes from South Africa, another from the southern parts of India and Ceylon, and the third from the South of Australia. We know as yet little about the distribution of earth-worms, but the same laws which governed the distribution of other animals must also have governed theirs, and it is just possible that these great earth-worms may be the lingering relics of a once widely-spread race of larger earth-worms, whose representatives at the present day are only found, as occurs with other forms of life, in the southern parts of the large land masses of the earth's surface. Possibly careful search will reveal the existence of a large earth-worm in the southern parts of South America.

Anatomy.

1.—*External Anatomy.* The worm certainly deserves its name of the "Giant Earth-worm." Large earth-worms have been described by Benham, from South Africa, and Beddard from Ceylon, but this one from Gippsland seems to be the largest yet described. When dead the body is capable of great extension; but the largest living one (measured by Professor McCoy) had a length of 6 feet. I have taken numerous worms direct from the burrow, and the longest one measured 56 in when alive; the average length being 44–48 in. and the breadth $\frac{3}{4}$ in.

The following description of the external anatomy agrees in all important points with that already given by Mr. Fletcher.*

The segments in the sexually mature worm vary from 300–500, or perhaps even more in number. When fully expanded, the anterior end of a large worm has the size and form represented in Figure 1, plate 1, seen from the ventral surface. The body tapers somewhat towards the first segment, broadening out till the eighth, then becoming narrower to the twelfth, then broadening again till the nineteenth, and then

* Proc. Linn. Soc., N.S.W., 1887, p. 603. The worm is described under the name of *Notoscolex gippslandicus.*

diminishing in size till the twenty-fourth or twenty-fifth, after which the same size is maintained till the very posterior end, where the segments again become enlarged. The prostomium overhanging the mouth is ribbed by longitudinal folds, and the first or buccal segment is divided into two by a groove; the second and third segments are of nearly the same width as the first, and each is similarly divided into two annuli by a median groove; the fourth segment is broader and has its groove nearer to the anterior than the posterior end. After the fourth segment, and as far back as the thirteenth, the grooves dividing the segments into annuli are somewhat irregular and frequently incomplete; the figure represents them in the worm taken for description, though slight variations in the grooves are to be found in different specimens. Posterior to segment thirteen, the segments are faintly triannulate.

There is no difficulty, especially in an expanded worm, in counting the segments, as the grooves marking them off are much more definite than those marking off the annuli. The setæ vary in distinctness in various parts of the body and in different examples, and I have not been able to detect them anteriorly in front of the eleventh segment, though Mr. FLETCHER appears to have done so. There is not the slightest difficulty in all specimens, at all events in certain parts of the body, in seeing them, or rather, the little papillæ from the tops of which they protrude. There are, as described by Professor McCOY and Mr. FLETCHER, eight longitudinal rows forming four series of pairs, but, as stated by the latter, the setæ of the outer pairs of each segment are further apart than those of the inner pairs. The setæ also agree well in shape with the description given by Mr. FLETCHER, they have a slight sigmoid flexure and a distinct swelling, about one-third of the way from the free pointed tip. Each has also a slightly swollen rounded extremity at the internal end where the protractor muscles are attached, which can be well seen when sections of the body wall containing the setæ are cut. (Plate 3, fig. 13.)

The setæ only project very slightly beyond the surface of the body and are probably of but very little service to the animal in progression. None are specially modified in connection with the male genital aperture, and those which should occupy the position of the latter—that is the ventral pair on either side of the body in the eighteenth segment—cannot be seen either macroscopically or by means of sections.

The dorsal pores which are very evident oval openings in the mid dorsal line, commence about the fifteenth segment, that is immediately behind the remarkably strong septa in the anterior part of the body. Each pore is very clearly situated exactly in the line of the groove separating two segments from one another. (Fig. 2, *dp.*) The pores can be traced back to the very last segment. The general body surface has a dirty pinkish flesh colour, and is quite intransparent. In segments 13–21 inclusive, however, the skin is dark purple in colour, and distinct from that elsewhere in the possession of a large glandular development immediately beneath the epidermis and external to the muscle-layers. (Plate 2, fig. 6.) The whole of this part may, with

Mr. Fletcher, be called the clitellar region, as its curious glandular development corresponds with that characteristic of the same part in other earth worms. In addition to this, there are present usually three and rarely four light-coloured and very prominent bands* (Plate 1, fig 1, *clt.*) on the ventral surface in the clitellar region. The first of these lies, as in the figure, partly on segment 17 and partly on segment 18, the second in a similar manner on segments 18 and 19, the third on segments 19 and 20, and the fourth, when present, on segments 20 and 21.†

The openings connected with the genital organs are not difficult to see in specimens in anything like a good state of preservation.

1.—*Spermathecal Pores* (Fig. 1 rs^1 *o.*, rs^2 *o.*) on the ventral surface very slightly in front of the grooves separating segments 7 and 8 and segments 8 and 9 respectively. Each pair is surrounded, as in the figure, by a slight line-marking on the surface of the skin, though these are too strongly indicated in the figure.

2.—*Oviduct Pores* (Fig. 1, *fo.*), just in front of but nearer to the mid ventral line than the innermost setæ in segment 14.

3.—*Vas Deferens Openings* (Fig. 1, *mo.*) These are always evident and are placed on two slight papillæ within the second ridge in the clitellar region, one in the position of each of the two most ventral pairs of setæ. As above said, the setæ corresponding to this position cannot be found.

No nephridiopores are visible.

2.—*Septa.* Immediately on opening the body cavity, one of the most striking features presented is the enormous development of the anterior septa.‡ (Fig. 2, *sept.*) For the first fourteen segments they form, as it were, deep cups, with their concavities facing forwards (Figs. 2, 3, and 4), each cup fitting into the one lying posteriorly to it. The septa are connected with each other and with the body wall by strong muscular slips. (*m.*) Passing backwards, the septa become gradually

* This happened in the case of two out of some three or four dozen specimens examined by myself. Both these worms were found in March, but, save in this particular respect, agreed with all other specimens procured at other times of the year.

† In Professor McCoy's description, these ridges are said to represent an imperfect clitellum or cingulum. In view of the fact stated above, that the whole region from segments 13–21 has the skin modified in the manner which is so characteristic of a clitellum in other earth worms, it is perhaps preferable to call this portion of the body the clitellar regions, and to regard these ridges as special developments of the same part. In Professor McCoy's description, these ridges are stated to occur between the 32nd, 33rd, and 34th rings (the word "ring" in his description is evidently, from its relationship to the setæ, &c., used as the equivalent of segment), a mistake which must be attributed to the counting of the annuli as segments. The position of the structures on the segments named by Mr. Fletcher and myself can easily be verified by counting the septa internally.

‡ Cf. Benham. *Microchæta rappi.* Q.J.M.S. Feb. 1886. Plate 15.

thinner in segments 14–19 (Fig. 2), the long muscular slips running from segment to segment, until after the twentieth segment the septa assume the usual membraneous appearance, and retain this nature until the posterior end of the body is reached (Plate 4, fig. 20), where they again become strongly muscular. In this part, comprising some twenty segments, they form flat plates encircling and standing at right angles to the alimentary canal. There are very well-developed muscular slips, passing (Fig. 20) radially from the walls of the alimentary canal to the posterior face of each septum. The first complete septum bounds anteriorly, as may be seen from the external indications of the segments, the fifth segment. In front of this the body is filled with a dense mass of muscle fibres surrounding the pharynx, all the spaces between being filled with the modified nephridia forming the salivary glands.

Throughout the body the septa are incomplete only, as usual, on the ventral surface, where in the mid line is an arched space through which passes the ventral blood-vessel and the nerve cord. (Plate 5, fig. 21, *sept, o.*) Special supporting muscles run to the body wall from each side of the arch.

It is curious to note that all through the body, and especially in the middle and hinder regions, the insertions of the septa do not correspond with the grooves separating the segments; each septum is very distinctly joined to the body wall posteriorly to the groove which externally forms the anterior limit of the segment of which it forms internally the anterior boundary. (Plate 3, fig. 14.) Each septum (Plate 5, fig. 22, and plate 3, fig. 14) has, as it were, a slight pouch extending forwards in the mid dorsal line, and into which opens the dorsal pore, the latter therefore lying slightly in front of the segmental chamber with which it is thus connected by a short canal: in transverse section, this actually appears as a canal. At the pores the epidermic layer of cells dips down and lines the pore as far as the level of the inner side of the circular muscle-fibre layer. The longitudinal fibres run up towards the body surface around each pore with which they may happen to be in contact, and are inserted into the connective tissue immediately beneath the epidermis at its lowest position in the pore. The septa, as usual, are composed of radially arranged muscle fibres, of which only a thin layer is present, save in the very strong and thick septa anteriorly; on either side is a thin epithelium of distinctly nucleated flattened cells, directly continuous with the epithelium lining the body wall internally.

3.—*Body Wall.* This may structurally be divided into two parts—(1.) That over the whole surface except the clitellar region; (2.) That in the clitellar region.

In the first of these two regions the structure is, on the whole, that which is characteristic of most earth-worms, though in minor points it shows variations from that of *Lumbricus.* The epidermis is represented in fig. 7, the whole body wall in fig. 18. Most externally is the cuticle (*cut.*) The cells of the epidermis have the usual elongate columnar form, with very distinct oval nuclei; amongst them lie numerous goblet cells (*gob.*) much larger than the others, and distinguishable also by containing clear spaces surrounded by a granular non-staining material; towards the base of each can usually be detected a nucleus pushed to one side. These goblet cells push aside the others, only parts of which are hence sometimes cut in section. The internal ends of the columnar cells cannot generally be clearly made out, as they appear to run into a kind of thick basement membrane, in which nuclei (*n.*) are often seen. Into this membrane, and thus amongst the bases of the columnar and goblet cells penetrate numerous branches of blood-vessels (*bv.*) These vessels actually penetrate between the epidermis cells, and, though unfortunately not shown in the figure, form small coils amongst the cells reaching nearly to the surface. Internally to the epidermis is the usual layer of circular muscle fibres (Plate 2, fig. 6, and plate 4, fig. 18.) On its external aspect, the fibres are thinner and more loosely arranged than internally, as they are also in sections of *Lumbricus*; they are also thrown into much more strongly marked folds than is the case with the internal fibres, which are thicker and somewhat closely packed together. Great numbers of blood-vessels branch amongst the fibres.

The layer of longitudinal muscles is, seen in transverse section, much deeper than that of the circular ones, and is again much more strongly developed ventrally than dorsally. The fibres differ considerably from those of *Lumbricus*, not presenting that definite arrangement of the strands resembling branches on each side of a series of radially placed stems of connecting tissue, which is so characteristic of *Lumbricus*. In *Microchæta rappi** there is apparently no gathering of the longitudinal fibres into groups, whilst in *Megascolides* we meet with a form intermediate between the two extremes seen in *Microchæta* and *Lumbricus*. The strands (*musc., long.*) are first of all gathered into smaller groups of 3–12, surrounded by connective tissue (*ct.*), and these smaller groups are again gathered into much larger and irregular ones, separated from each other by radial strands of connective tissue passing from the circular muscles, inwards to the body cavity. Along these breaks, between the muscles, pass blood-vessels and the ducts of the numerous nephridia to be described later on.

The strands are also, as in *Lumbricus*, angular and not rounded in section. Internally again to the muscle layers is a distinct layer of connective tissue, from which strands of tissue of a homogeneous appearance may be seen radiating into the body wall amongst the muscles (*ct.*), and within this is the epithelium, the irregularly shaped cells of which line the body cavity, becoming modified in various parts.

In the second—the *clitellar region*—the skin is much modified as usual, but differs in structure from that in *Lumbricus* or in *Microchæta* † as recently figured by Benham.

* Benham. Q.J.M.S. (Plate 16, bis., fig. 39.)

† Op. Cit.—For the description of that in *Lumbricus* I have not been able to consult the original paper of Claparede, and so have taken advantage of the description quoted by Mr. Benham.

Within the cuticle (Plate 2, fig. 6) lies the epidermis (*epi.*), the cells of which are, as in *Lumbricus*, somewhat shorter than those elsewhere; their oval nuclei are very distinct, and their inner ends seem to merge into the thick basement membrane mentioned above. A few goblet cells can be seen, but not nearly so many as in the extra-clitellar region. There cannot be detected the narrow elongated cells containing granules similar to those found in the goblet cells, and remarkable for being some three times the length of the epidermic cells, such as are described in *Lumbricus* and *Microchæta*.

Within the epidermis in *Megascolides* lies a great development of glandular cells (*gl.*) packed more or less closely together, and of very varying sizes. Some are almost globular, others almost, save for their rounded bases, columnar. All are filled with a granular material arranged in a meshwork in which lies a very distinct oval nucleus. These cells have long ducts leading towards the exterior and swollen internal ends, and are many times longer than the epidermic cells.

Possibly some of the more elongate external lying ones may correspond to those mentioned above as present in *Lumbricus* and *Microchæta*, but they, at all events, differ from these in not having branched bases, a condition which does not seem to obtain in any cells in the clitellum of *Megascolides*.

Benham in *Microchæta* describes special strands of connective tissue as running down amongst the gland cells, and continuous with the network at the base of the epidermic cells; this is doubtless equivalent to a curious development seen in *Megascolides*, which consists of radial, somewhat wavy-looking, strands of a perfectly homogeneous material, which pass down amongst the gland cells from the basement membrane beneath the epidermis, till the circular muscles are reached, upon which the strands branch and lie flat (*ct*, fig. 6). This same material forms a surrounding to the openings of the nephrial tubes as they pass through the clitellum (Fig. 28, *ct.*) This glandular portion is very rich in blood-vessels, and the latter have a very definite arrangement, usually forming distinct coils (Fig. 6 and 28, *bv.*) One of these coils always accompanies each nephridial tube, and all have a definite radial arrangement.

Beddard figures in *Acanthodrilus* a blood-vessel, accompanying the nephridial tube, and forming a very distinct loop around the latter, just beneath the epidermis; this loop enclosing the nephridial tube seems to be absent in *Megascolides*, but the two forms agree in having a special vessel running with the tube apart from, and in addition to the copious supply of blood-vessels on the nephridium itself.

Numerous more irregularly arranged blood-vessels are present, and pass up close to the bases of the epidermic cells, between which they may penetrate. The clitellar region has a very marked development of pigment. The dark red-brown colouring matter is distributed principally in irregularly arranged stellate masses, close beneath the epidermis, and also along the paths of the blood-vessels. To this pigment, and the great development of blood-vessels, the clitellar region owes its dark colour.

The nephridial tubes of this part, which are quite distinct from those of the rest of the body, will be described later.

4.—*Alimentary Canal.*—On opening the body cavity by a median dorsal incision, the alimentary tract with its very thin brown coloured walls, and its lumen full of earth, is seen to occupy almost the whole of the body cavity in the middle and posterior part of the animal, save the last twelve to twenty segments, where the septa, as above described, are strongly developed, and there is consequently a very distinct space maintained between the body wall and the intestine. Anteriorly however, the canal is quite concealed from view by the immensely strong cup-shaped septa (Fig. 2). A median longitudinal section gives very much the appearance, as far as the alimentary tract is concerned, which is represented diagramatically in Fig. 3. The short buccal chamber is distinguishable by the possession of very thin walls, which can be protruded. This opens immediately into the pharynx, the walls of which are as usual very thick and muscular, with special strands passing from them to the body wall. The pharynx extends through four somites, that is as far back as the first septum which bounds anteriorly the fifth segment.

The space between the pharynx and the body wall is occupied partly by muscle strands, but principally by a large mass of minute tubules resembling exactly, in appearance, the numerous small nephridia present in the other parts of the body. Examined with a lense *in situ*, these structures, which there is little doubt are salivary glands, are seen to be a mass of minute coiled tubules, with a very strong development of blood-vessels upon them. Somewhat similar structures are described by Benham as occurring in *Trigaster lankesteri*; * in this worm "there are three pairs of grape-like glands" around the pharynx and œsophagus in the somites, IV., V. and VI. In *Megascolides*, on the other hand, they are much more irregularly arranged, and are confined to the pharynx. Transverse sections show them to have precisely the same structure as nephridia, and after a careful search I was enabled to trace their openings into the pharynx. (Plate 3, fig. 10.) The glands are composed of an immense number of small tubules embedded in connective tissue. Each contains an intra-cellular duct. The structure of these is exactly similar to that of the nephridia from which the salivary glands, anatomically, are indistinguishable. There is present also the great development of blood-vessels forming a network upon the tubules. The latter are massed together in great numbers, and the ducts seem at intervals to join together into a common duct, which pierces the muscular walls of the pharynx, and opens into the alimentary canal. Where the opening takes place, the columnar cells lining the pharynx are, just as in the case of the epidermis where the nephridia open, modified so as to form what, at first sight, resembles somewhat a taste bulb. (Fig. 10.) The cells are arranged, as it were, along what would correspond to the lines of longitude on the surface of a sphere, being swollen out medianly where is the nucleus and tapering

* Benham. Q.J.M.S., August 1886, page 96, plate 9, fig. 35.

towards both ends, and the duct passes right through the axis of the sphere (cf. for nephridia, plate 2, fig. 6, and plate 6, fig. 28.)

From their relation to the alimentary canal, there is no doubt that they are of the nature of salivary glands, and their structure even to minute details shows them to be modified nephridia. The only difference observable between the salivary glands and the nephridia, is the absence in the former of the inter-cellular duct. The whole duct is intra-cellular until the epidermic lining of the pharynx is reached.

This modification of nephridia agrees with that observed in *Peripatus* and almost certainly in *Acanthodrilus multiporus* and *Trigaster lankesteri.** It will doubtless be found to exist in many other worms.

Segment five is occupied by the very short œsophagus, and the gizzard. The intestine commences in segment six, and runs hence to the extremity of the body.

There is no trace whatever either of œsophageal glands or of typhlosole. The only modification in the intestine consists of very distinct dilatations in segments 12–18 inclusive. (Figs. 3 and 4.) In these parts the walls are highly vascular, and devoid of any strong muscular development. Sections (Plate 5, fig. 24) show that the hypoblastic lining is thrown into a series of longitudinal folds. Each fold is made up of thin columnar cells with very distinct oval nuclei, the cells of each side of a fold being very close to each other, and separated by a network of blood-vessels (*bv.*) which are in connection with another network running round the intestine beneath the circular muscle fibres. This great supply of blood-vessels gives the dilatations of the intestines a reddish colour. Outside the blood-vessels lie (1) the layer of circular, and (2) the layer of longitudinal muscle fibres, both of which are comparatively feebly developed. In and amongst the latter is a small amount of connective tissue, and outside is the layer of flattened peritoneal epithelium cells.

Posteriorly to segment 18 the intestine forms a simple tube, the walls of which are, as usual, brown coloured. In sections (Fig. 5) they are seen to have the usual structure. Most internally lies a layer of deep columnar cells with large spherical nuclei, each with a distinct aggregation of chromatin fragments in the centre. There are no cilia to be seen, and when the walls are uncontracted the columnar cells form a smooth coating to the tube, with an absence of folds such as are described and figured by Benham in *Microchæta rappi.*

External to the columnar epithelium are the circular muscle fibres, which are well developed, especially in the posterior segments of the body, from which part the section represented is cut. Here, owing to the strength of the fibres, the canal retains its tubular shape when taken from the body. Externally to the circular, lie the longitudinal fibres (*Long. M.*), which seem to be best developed in the median dorsal line beneath the blood-vessel. In the walls of the intestine are two networks of blood-vessels. From the dorsal blood-vessel (Figs. 5 and 8, *d. bv.*) pass off two branches on each side of every segment to the walls of the alimentary canal. (Plate 2, fig. 8, *al, bv.*) Each pierces the longitudinal fibres, and a network of vessels is formed immediately beneath these. From this network branches pass down, piercing the layer of circular fibres (Fig. 5), and another network is formed at the bases of the columnar cells, amongst which branches penetrate. The intestine is covered externally with an epithelium of cells, whose extremities, facing into the body cavity, are much larger than their internal ends, which run down between the longitudinal fibres. Still finer processes can at times be traced on from these cells, leading through the layer of muscular fibres till they reach the intestinal epithelium (these are represented too clearly in the figure). Each cell contains in its swollen end a great number of minute yellow-brown granules, which give the characteristic colour to the intestine in this part. The nucleus is very distinct, somewhat spherical in shape, and placed where the cell begins to narrow. In the very median dorsal line these cells are absent, and a tubular structure is present, connected with the wall of the alimentary canal, and surrounding the dorsal blood-vessel, to which reference will be made later on. The brown cells are merely special modifications of the peritoneal epithelium, with which they are directly continuous around the dorsal tube just mentioned. There is nothing corresponding to the typhlosole, nor to the intestinal glands present in certain earth-worms.

5.—*Vascular System.* The vascular system is, in comparison with most earth worms, somewhat simply developed. It consists of the following vessels :—(1) dorsal trunk; (2) ventral trunk; (3) transverse vessels; (4) lateral vessels. As in *Pleurochæta, Perichæta, Pontodrilus,* and *Microchæta, there is no sub-neural trunk.*

1.—*Dorsal Trunk.* This runs from the posterior to the anterior end of the body, in close connection with the dorsal wall of the alimentary canal. In the fifth segment it breaks up into numbers of small branches, which run forward and form a plexus in the walls of the gizzard and pharynx. (Plate 1, fig. 2; plate 2, figs. 8 and 9, *d, bv.*) In segments 14–6 inclusive, it is somewhat swollen and its walls more muscular, and hence firmer than in the posterior region.

In Plate 4, fig. 20, is a drawing representative of a structure confined to the hinder half, or even less, of the body. Such a structure does not appear to have been described in any other earth-worm as yet, and its exact nature is very doubtful. When the hinder part of the body is opened, the dorsal blood-vessel is seen to be surrounded by a white-coloured tubular structure, from which more or less solid diverticula are given off on each side. (Plate 4, fig. 20; plate 2, fig. 5, *x*, and *dv.*) In the section (Fig. 5), half of the tubular structure surrounding the dorsal blood-vessel is represented. It is lined throughout by the peritoneal epithelium (*ep.*), which in the median line, as mentioned above, is not modified into brown cells, though certain of the cells lying nearest to these become somewhat columnar. The walls of the tube are formed of connective tissue (*ct.*), in which lie a certain number of circularly disposed muscle fibres, which, where the tube rests upon the alimentary canal, pass both towards the central line, lying upon the longitudinal fibres, and outwards for a short distance amongst the bases of the brown cells. Into the tube open the diverticula, the walls of which are formed of connective tissue, lined externally by peritoneal epithelium. Each process has the form of a bag, more or less filled with a mass of polygonal-shaped cells (*y.*), with very distinct nuclei; between the masses of these cells, often stretching from one side of the diverticulum to the other run strands of connective tissue. Sometimes (*dv.*) the processes are full of these cells, at others (*dv.*[1]) they are comparatively empty. The main tube (*x*) opens into the cœlom in each segment anteriorly by a slit-like aperture on its ventral surface just where it becomes constricted to pass with the dorsal blood-vessel through the septum. In this part there is very little space between the wall of the blood-vessel and that of the tube in question. The cells from the diverticula, which in general appearance, save their white colour, much resemble those of the liver of higher forms, can pass into the main tube and thence into the cœlom, and may perhaps serve as stores from which are formed the numerous white corpuscles present in the cœlomic fluid. The structure has no direct connection with the vascular system, nor are any blood-vessels whatever to be found in or about the diverticula. In a worm of some 500 segments it could be traced anteriorly to about the 120th segment from the head end, where it ceased. As far as the 150th the tube could be seen, but very few diverticula, which were well developed from the 200th to the posterior extremity.

2.—*Ventral Trunk.* This runs, as the dorsal one, from the posterior to the anterior end, where, in the fifth segment, it breaks up into small branches, distributed principally to the walls of the gizzard and pharynx. It lies at some distance below the alimentary canal (Plate 2, figs. 8 and 9 ; *v. bv.*), from which it is suspended by a very definite longitudinal mesentery. It is placed just above the nerve cord, and passes, as usual, with this through a definite opening left in each septum in the median line ventrally. (Plate 5, fig. 21 ; *sept. o.*)

3.—*Transverse Vessels.* Branches are given off both from the dorsal and ventral trunks, and the nature and distribution of these branches differs very much in the regions behind and in front of the 14th segment. (A) In the segments behind the 14th (Plate 2, fig. 8), three branches are given off from the dorsal vessel on either side. Of these, one (*sept. bv.*) runs to the anterior face of the septum bounding the segment posteriorly, and gives branches to its upper half, the other two (*al. bv.*) run round the alimentary canal, and pierce the muscular coats, forming as already described, two vascular networks, one on either side of the circular muscle layer. These may be called the intestinal vessels. From the ventral vessel arises one main branch on either side, close to the septum, bounding each segment posteriorly. A short mesentery runs out laterally from the ventral blood-vessel to the body wall, and serves to support on either side one of the two branches into which this lateral vessel divides. The upper of the two branches (*sept. bv.*) supplies the lower half of the septum ; the lower runs across the mesentery to the body wall, and supplies the latter with blood-vessels, and also gives off the very numerous smaller branches, which form such a rich plexus around the nephridia. (B) In the 14th segment the dorsal blood-vessel becomes muscular and swollen out, and gives off the same three branches already described. From the ventral vessel arises a single one, as in the posterior sections, which supplies the septum and body wall. (This has inadvertently been omitted in the diagram Fig. 9, but should have been drawn as in Fig. 8, immediately above.) In addition to these there is also a lateral vessel present on either side of the alimentary canal, to which, as well as the septum, it gives branches. It is connected with the lateral vessels of the anterior segments, but appears to have no connection with any vessels in the 14th segment. (c) In the segments 13–6 inclusive, the blood-vessels are very differently developed. These are first the usual dorsal and ventral trunks, both somewhat muscular, and the former swollen out in each somite. From the dorsal arises on each side posteriorly a single large muscular vessel, the "heart," (*h.*) passing down to join the ventral vessel. Each transverse vessel, or heart, gives off a branch from its antero-internal surface. Each of these again divides into two, of which one runs to join its fellow of the other side, and these two uniting form a small median vessel lying immediately upon the dorsal surface of the alimentary canal ($al.^1$ *bv.*) The second branch runs downward, and this again divides, one branch running to join the lateral vessel (*lat. bv.*), the other, and larger, passing on to the face of the septum, and giving off one important branch ventrally to the body wall and nephridia. The lateral vessel on either side gives off branches to the alimentary canal.

In front of the sixth segment, the dorsal, ventral, and lateral branches all break up into small divisions, which supply the body wall and the alimentary canal and salivary glands.

There are no blood-vessels in connection with the nerve cord—neither sub. nor lateral-neural vessels.

The *Blood* itself has the usual red colour, due to the presence of hæmoglobin in the fluid, and contains (1) very numerous nucleated corpuscles of definite outline, which may be either oval or round in shape, and measure about ·0016 mm. in diameter (Plate 3, fig. 17, *a.*), (2) fewer more irregularly shaped nucleated corpuscles, from which few or many stiff pseudopodia-like processes may be extended (Fig. 17, *b.*) These are somewhat larger than the former, the body of the cell, exclusive of process, measuring about ·0025 mm. in diameter.

The *Cœlomic Fluid,* on the other hand, is of a milky-white colour, and opaque. Its numerous corpuscles are all of more or less irregular shape, and precisely similar in size and appearance to the second kind described in connection with the blood. (Fig. 17, *b.*) Possibly, as suggested above, the masses of cells present in the diverticula of the tube surrounding the dorsal blood-vessel posteriorly are merely special developments of the peritoneal layer lining the cœlom which serve as supplies of these corpuscles. The latter, passing into the cœlom, lose their regular shape, and put out processes—becoming, in fact, amœboid cells.

There is no doubt that the worm passes the cœlomic fluid out by its dorsal pores into the burrow, and with the fluid must pass the corpuscles, a constant fresh supply of which will hence be needed.

6.—*Nervous System.* This has, in the main, the form usual in earth-worms. It consists of a pair of cerebral ganglia, united by commissures to a ventral cord.

The cord cannot be clearly divided either by its external shape or by its structure into well-defined ganglia and commissures, and is of about the same width throughout its whole length.

Where the cerebral ganglia join the commissures on either side, a nerve arises which runs forward and sends branches to the body wall in the prostomial region. (Plate 3, fig. 16, *ln*[1].) A little lower down, a curiously flattened mass of nerve fibres arises from the postero-internal face of the commissure, and immediately breaking up into branches enters the muscular walls of the pharynx. (Fig. 16, *ph.*, *n.*) In section the branches are seen ramifying amongst the connective tissue and muscle fibres of the pharyngeal wall. (Plate 3, fig. 10, *nc.*) This constitutes the stomatogastric system. Still lower down the commissures arises on either side another nerve which runs forward, and breaking up into branches supplies the body wall ventrally in the region of the mouth.

The ventral cord gives off in each segment three pairs of branches. (Plate 5, fig. 21, n^1. n^2. n^3.) Of these three branches, two are placed somewhat close together in the posterior region of the segment, whilst one is situate slightly in front of the median line. Where the nerve cord passes (Fig. 21, *sept. o.*) through the septum it is supported by a definite mesentery, which arises from either side of it, and is inserted into the body wall ventrally. This structure runs for some little distance both anteriorly and posteriorly to the septum.

The histological structure is much the same as that described for other earthworms. The whole nervous system is covered by the cœlomic epithelium, which over the greater portion of the surface consists of nucleate flattened cells. On the ventral nerve cord, however, as the under surface is reached, these merge into cubical cells, and such also cover the supporting mesenteries. (Fig. 19, *ep.*) Within the epithelium is a definite development of connective tissue, forming a sheath for the whole nervous system. As in *Pontodrilus,* and certain species of *Microchæta* and *Pleurochæta,* neither sub-neural nor latero-neural blood-vessel is present.

With regard to the nervous tissue itself, the cerebral ganglia consists of (1) a sheath of ganglion cells on the anterior and ventral aspects, and (2) a mass of fibres dorsally and posteriorly, amongst which a strong commissural band, passing from side to side, is developed, such as is not met with elsewhere in the system. As previously noted, no nerves seem to be given off from the cerebral ganglia directly, though one arises on each side where the commissures begin. The commencement of these is indicated by the absence of ganglion cells, none of which are found in the commissures or, as far as could be ascertained, by means of a long series of consecutive sections, in the stomato-gastric system. The walls of the pharynx are well supplied with nerve fibres, which run backwards from the commissures. (Plate 3, fig. 10, *ne.*)

Where the two latter join the ventral cord ganglion cells again appear, and are developed along the whole length of the ventral cord.

Along the cord the connective tissue is arranged in a very definite manner. There is first of all the external coat immediately beneath the cœlomic epithelium. On either side this passes off in the region of a septum into a flat mesentery supporting the cord (Fig. 19), and as two strands of tissue are given off, one running from the upper and the other from the lower side of the cord, a somewhat triangular space is enclosed in which longitudinal muscle fibres are enclosed. Similar fibres are present in other worms, as figured by Benham in *Microchæta rappi.** Within the cord itself are definitely arranged strands of connective tissue, in addition to the still finer tissue penetrating in and amongst the nervous elements and serving for their support. The cord is clearly seen in sections to be composed of two lateral halves, and may be divided into (1) a central double division, consisting of two halves, lying closely side by side and separated from each other and surrounding structures by a thin, but distinct, layer of connective tissue. These two parts are each composed of a meshwork of nerve fibres, which, in very many cases, can be traced into connection with larger or smaller ganglion cells lying externally. The fibres, many of which are seen to curve in towards the middle line, very frequently have slight varicose swellings; and amongst them, more especially towards the ventral surface, and near the middle line, are a certain number of small nucleated ganglion cells. (Fig. 19.)

The central part of the nerve cord is noticeable by reason of its not staining nearly as deeply (with borax-carmine) as the outer layer, and from the very much looser way in which its fibres are arranged. (2) An outer part confined to the lateral and ventral aspects of the cord, composed of a much denser meshwork of fibres, containing ganglion cells of various sizes. These cells do not appear to be aggregated into definite ganglia, but are present in great abundance in the parts of the cord which lie between the points of origin of the three pairs of nerves which arise in each segment. The larger cells are distinctly pear-shaped (Fig. 17), and as a rule arranged so that their thin pointed end protrudes into the central part, and from it passes off a single fibre, curving round towards the centre of the cord. Some of the smaller cells appear to have a fibre passing off from each end, but the large ones never have more than the single one. Occasionally a cell may be so large as to stretch across the space between the outer and inner layer of connective tissue. This external layer takes stain more readily than the internal one, and containing numerous nerve cells, as well as a closer meshwork of fibres, appears in section much darker.

Where the lateral nerves enter, the fibres run right through to the central part, with which alone they appear to be in connection. In this region, ganglion cells are

* Q.J.M.S., Feb. 1886, Plate 16, bis., fig. 37.

much less frequent, and as the nerves curve upwards, so as to enter nearer the dorsal than the ventral side, the few which are present are almost confined to the under surface. In *Microchæta rappi*,* BENHAM figures the ganglion cells as present in greater numbers in the region of the lateral nerves, exactly the reverse of that which obtains in *Megascolides*. (3) An upper region where "giant fibres" are present. Each of these fibres is enclosed in a distinct encasement of connective tissue, continuous (see Fig. 19, *gf.*) with the external and internal layers of this already described. The numbers of the "giant fibres" seen in section, varies in different parts of the cord. Right in the very front of the body, in the region of the sub-pharyngeal ganglion, only one, the central upper one of the figure is present (cf. Fig. 10, *gf.*), a little further back two lateral ones are present in addition, and in very many sections, though not in all, a fourth median one is present, as in the figure. The great length of the worm precludes the cutting of continuous sections, so as to trace the exact relationship of the fibres, but they were traced, as in the figure, completely through one segment in the hinder region of the body. In another series of sections from the same region, the lower one of the four gave branches off to the two lateral ones and disappeared, the connective tissue septum then passing right up the median line through the space occupied in the figure by the "giant fibre." The three upper ones appear to be the main ones, and of these, the first seen in a series of sections passing backwards from the cerebral ganglia is the central one. (cf. Fig. 10, in which in the region of the pharynx, just posterior to the sub-pharyngeal ganglion, only the central fibre is seen). It commences in the very anterior region of the ventral cord, where it simply thins out and merges into the external connective tissue sheaths of the cord. The two lateral ones appear in a similar manner a little further down the cord, but no giant fibres appear, as in other earth-worms, to either (1) pass up the pharyngeal commissures, or (2) to have any connection with the nervous tissues.

As to the structure of the fibres, they are described† as being composed of a "doubly-contoured sheath, with clear contents," and as being "separated from the nerve cord by the inner neurilemma," and "embedded in a connective tissue-sheath, containing reticulate cells."

BENHAM‡ figures them with the double contour, and surrounded by a certain amount of connective tissue. In *Megascolides* (Fig. 19) each one is enclosed, as said above, in a very definite compartment of tissue (*ct.*), and each fibre itself has the nature of a rod, formed of a perfectly homogeneous material, which stains moderately with borax-carmine, and has, owing doubtless to the action of reagents, a somewhat irregular outline in section. At times a nucleus may, as in the figure, be

* Op. cit. Fig. 37.

† "Forms of Animal Life," ROLLESTON and JACKSON, 2nd Edit., p. 212.

‡ Op. cit., Fig. 38.

seen in the rod. Each rod is again surrounded by a very clearly-marked sheath of tissue, which in transverse section seems to consist of fine wavy fibres, arranged, as in the figure, in a circular manner, with nuclei here and there.

In longitudinal sections, the rods are very clearly seen to be formed of a homogeneous structure, perfectly continuous along apparently the whole body.

The "giant fibres" can in no way be called "neural canals," the name suggested by CUNNINGHAM* for what must be regarded as homologous structures in the *Polychætæ*. "Neural canal" is a term which already has a definite meaning, and the structure to which this is usually applied has, of course, no connection whatever with the structure now under consideration. The "giant fibres" of *Megascolides* are remarkable (1) for the very definite central rod of homogeneous gelatinous material, and (2) for the equally definite enclosing sheath of connective tissue. No connection exists between the fibres and any of the nervous elements, and it seems probable, more perhaps because it is difficult to suggest any other use for them, than because of any direct evidence in its favour, that the usually accepted idea of their possessing solely a supporting function is the correct one. They doubtless serve also, as suggested by CUNNINGHAM, "to prevent the nerve cords being bent at a sharp angle, causing them always to remain in curves, and so to escape injury during the wriggling and burrowing of the worm." Under these circumstances, the name of "neurochord," given to them by Vejdovsky, appears to be the most applicable.

I hope very shortly to be able to study their development in *Megascolides,* in which in its adult state they form striking features in sections of the nerve cord.

7.—*Nephridia.* The nephridia form, perhaps, the most interesting structures in *Megascolides.* During the last two or three years, our knowledge of the nephridia of various earth-worms has been very greatly enlarged, owing in large part to the descriptions of BENHAM and BEDDARD.

The arrangement of the nephridia in *Megascolides* has many points of agreement with that described by BEDDARD† as obtaining in *Perichæta aspergillum* and *Acanthodrilus multiporus,* and has already been shortly described.‡

The main features in connection with the system are (1) *the presence of numerous nephridia in each segment,* (2) *the modification of the nephridia in various parts of the body,* (3) *the connection of the ducts of the various nephridia.* PERRIER was the first apparently to draw attention to the presence of several nephridia in one segment, and in 1885, BEDDARD § described the same occurrence as taking place in a species of *Acanthodrilus,* from New Zealand, which, according to him, had eight nephridia in each segment. BENHAM || mentions the fact that in certain worms (a *Perichæta* from

* Q.J.M.S., Nov. 1887, p. 267.

† Q.J.M.S., Feb. 1888.

‡ Proc. R.S. Victoria. Oct. 1887.

§ Proc. R.S. May 1885, p. 459.

|| Q.J.M.S. Feb. 1886, p. 256.

the Phillipines) numerous small nephridia occurred in each segment; whilst FLETCHER * noted that in various species of Australian earth-worms there were numerous small vascular tufts in each segment attached to the body wall, and probably nephridial in nature. Such occur, according to him, in *Digaster armifera, Cryptodrilus saccarius, Perissogaster excavata, Perichæta tenax, P. gracilis, P. queenslandica, P. stirlingi.* He noted the same fact also in various species of his genus *Notoscolex.* (= *Megascolides* McCOY.)

BEDDARD, lastly, has described in two worms very numerous nephridia as being present in each segment, the whole system having a curiously close resemblance to that which obtains in *Megascolides.*

In respect of having these numerous nephridia in one segment, the *Oligochætæ* agree with certain *Polychætæ* (*Capitellidæ*), and the connection of successive nephridia has now been shown to be common to the two groups.†

As already described, when dealing with the salivary glands, these are to be regarded without doubt as modified nephridia. They are formed out of the organs belonging to the segments as far back as, and including the fourth. They are arranged with great irregularity, forming a mass of minute vascular tubules connected with the walls of the pharynx, and filling up all the spaces amongst the muscle bands passing from the alimentary canal to the body wall.

Similar structures have been already described and figured by BENHAM‡ in his account of *Trigaster lankesteri.* He does not, however, appear to have traced these modified nephridia into actual connection with the alimentary canal, and in *Trigaster* also, they are much more definitely grouped than in *Megascolides,* and are confined to segments 4, 5, and 6, but they possess the same intra-cellular duct, and the network of minute blood-vessels, so characteristic of nephridial tubules. In all the segments behind the first four, the nephridia are seen, when the worm's body is opened, to have the form of numerous minute vascular-looking tufts attached to the body wall. (Plate 1, fig. 2 ; plate 5, figs. 21 and 22.) Variations in the number, distribution, and structure of the nephridia are to be detected in various parts of the body, and the whole system is, in certain respects, more interesting than that of any earth-worm yet described. *There are two distinct kinds of nephridia present*—(1) An enormous number of small nephridia (cf. Plate 1, fig. 2 ; plate 5, fig. 22), which lies so close to one another that the shape of each separate one cannot be distinguished. Though they vary somewhat in form, each appears to be always composed of at least two divisions—(1) A small, somewhat straight, tube, and (2) a larger coiled part.

These small nephridia are present in every segment after the fourth. They are most largely developed in the clitellar region, where they form an almost complete

* Proc. Linn. Soc. N.S.W., various papers on Australian Earth-worms. 1886 and 1887.

† CUNNINGHAM. Q.J.M.S. Nov. 1887. *Nature,* June 16, 1887. BEDDARD, Op. cit. SPENCER, Proc. R.S. Victoria. Oct. 1887.

‡ Q.J.M.S. August 1886.

investment for the body walls. (Fig. 1 and fig. 22.) They are absent in the very median dorsal and ventral lines, though they extend very closely on to these. On the ventral surface, the nerve cord separates the nephridia of the two sides. In Fig. 22 is represented a portion of the dorsal body wall, cut away from the hinder clitellar region, where the septa are thinner than in front. Three segments are shown, and in the median line is seen a distinct groove, which separates the nephridia of the two sides, and out of the roof of which open the dorsal pores.

Passing backwards, the nephridia lessen in number, and after about the 25th segment, form simply a ring round the posterior region of the segment (Fig. 21) between the two posterior and the anterior pairs of nerve branches. They are more or less irregularly scattered in the ring, which in the middle and posterior parts of the body seem to be continuous across the mid-dorsal line, to be only broken ventrally where the nerve cord runs.

It is quite impossible to count the number of these small nephridia, of which certainly more than a hundred are present in each clitellar segment.

None of them have any trace whatever of an internal opening, though I have searched for such most carefully, both by means of examining numerous whole nephridia, and large series of sections.

2.—*A series of much larger nephridia, which are only present in the posterior region of the body, and occur in the same segments with the smaller nephridia* (Fig. 21), from which there is no difficulty in distinguishing them—(1) On account of their position; (2) on account of their size, and (3) on account of their possessing internal openings.

There is only one pair of these larger nephridia in each segment, and each lies close to the ventral nerve cord, occupying the anterior part of the segment, whereas the smaller nephridia are placed in the posterior. Each is attached to the body wall in front of the anterior nerve branch, and not very far behind the septum. There is no difficulty in recognising on the anterior wall of every septum, close to the median ventral line, a small ciliated funnel, which has the appearance during life of a minute white speck, attached by a short stalk to the septum. (Fig. 21, *neph. i. o.*) With care, it can be dissected away, and under the microscope is recognisable at once as a ciliated trumpet-shaped opening, the lower lip of the trumpet being somewhat shorter than the upper. (Fig. 26.) The opening leads back into a tubular duct, in which cilia may be seen working, and which is evidently continuous with the anterior prolongation of the large nephridium. The latter consists of two parts—(1) A smaller straight one (*i.*), and (2) a larger coiled portion, which seems to vary somewhat in shape and size, and to consist of a large number of smaller coiled tubules aggregated together, and enclosed in a common surrounding of connective tissue.

As above said, these large nephridia are only found in the posterior region of the body, and *are quite wanting anteriorly,* where the smaller ones are alone present.

There is, however, a very curious, and, at the same time, instructive series of gradations to be seen if the nephridia be carefully studied *in situ.* Thus in worms containing some 500 segments, the large nephridia, with internal openings, can be recognised through some 220 segments, counting from the posterior end. In front of this no internal openings can be detected, but for some 15-20 segments anteriorly, a nephridium larger than the rest, but gradually decreasing in size, can be recognised. It does not, however, stand alone, but forms one of a group of nephridia, the large individual one, on passing anteriorly, gradually decreasing in size and predominance as the group increases until, after twenty segments or thereabouts, the group remains, but no one nephridium is larger than the rest. This ventral group, as the anterior end is reached, tends to merge more and more into the general ring of small nephridia (though generally detectable by careful examination), which at the same time becomes more widely spread over the body wall, until, in the clitellar region, the whole body wall becomes covered with the smaller nephridia.

THE SPECIALIZATION IN NEPHRIDIA APPEARS THUS TO COMMENCE AT THE POSTERIOR END, AND TO PASS GRADUALLY FORWARDS, THE ANTERIOR BEING IN A MUCH MORE PRIMITIVE CONDITION THAN THE POSTERIOR END OF THE BODY.

Structure of the Nephridia.

1.—*Small nephridia.*—These, when cut in section, are seen to have the structure typical of the nephridia of earth-worms. Each consists of a coiled tube with an intra-cellular duct (Fig. 18). The tube is surrounded with an investment of a large number of connective tissue cells, the boundaries of which cannot be detected, though their nuclei are clearly seen scattered about irregularly. The effect is produced of a somewhat homogeneous mass surrounding the tubules and continuous with the body wall. This agrees closely with the structure, described by BENHAM as existing in the part of the nephridia of *Microchæta rappi*, farthest away from the vesicular end. There is also a thin definite layer of tissue surrounding closely the tubules, consisting of fibres with nuceli (*ct. neph.*) In the connective tissue, ramify and branch a great number of minute blood-vessels (*bv.*), which, as usual in earth-worms, are seen when the nephridium is viewed as a whole, to form an investing network over the nephridial tubules.

The latter have the usual form of a series of large cells, placed end on, and pierced by an intra-cellular duct. Their nature makes them at once easily distinguishable from other structures in the body. The cell consists of a homogeneous ground work, in which are scattered minute granules, so set as to produce in section the effect of lines radially arranged with regard to the duct. The bounding line of the latter is very clear and distinct. This structure again resembles exactly that figured by BENHAM in *Microchæta rappi* and others, and by BEDDARD in *Perichæta aspergillum* and *Acanthodrilus multiporus.* Where the nephridium joins the body wall the duct passes into the latter (Fig. 18) sometimes directly, sometimes after running along for some distance parellel to the length or circumference of the body, and giving off or joining another similar duct from some other nephridium (*neph.*) The nature of the duct opening to the exterior varies in the clitellar and non-clitellar regions, and will be dealt with after the structure of the larger nephridia has been described.

2.—*Larger nephridia.*—Their structure agrees in the main with that of the small ones, so far as the body of the nephridium is concerned. In both cases the ducts are so complicated, that as remarked by BEDDARD in connection with *Acanthodrilus multiporus,* it is simply impossible to map out the course of the duct.

The differences between the large and small nephridia are, (1) the greater size of the larger, (2) the consequent greater number of the ducts cut in section. Of these some are thicker walled than others, and correspond exactly to those present in the smaller ones. The thinner walled ones, which are otherwise similar, are probably equivalent to the secondary ducts of other forms (such as *Microchæta,* &c.) and are absent in the part nearest to the attachment to the body wall.

The supply of minute blood-vessels forming a complete network around the ducts is even more strongly marked than in the smaller ones. The blood-vessels to the large nephridia arise from a pair of vessels given off one on either side of the body from the ventral blood-vessel. The lateral vessels thus given off divide into two parts, of which one (Fig. 8, *sept. bv.*) runs to the septum, the other to the body wall ventrally and the nephridia.

In Fig. 26 (Plate 6) is drawn a longitudinal section through the internal opening (Fig. 21, *neph. io.*) of a large nephridium. The duct leads through the septum and swells out on the anterior face of this into the funnel-shaped opening. It is encased in connective tissue, amongst which are a certain number of muscle fibres (*m.*), circularly and obliquely arranged. External to the connective tissue and muscles is the layer of pavement cœlomic epithelium (*c. ep.*) The duct, almost up to the opening, is merely a continuation of the intra-cellular duct of the nephridium, and is ciliated. It is exceedingly difficult to determine exactly where the intra-cellular duct ends, and the inter-cellular begins. The cells lining the whole of the funnel have the curious homogeneous appearance characteristic of the nephridium, and the granules present in the cells in the body of the latter are here not so distinctly marked or radially arranged. It appears in many sections as if the duct right to the opening were intra-cellular, but after examining with high powers several series of sections, both transverse and longitudinal, I think that the drawing represents the real state of the case, and that the funnel has at its open extremity some three rows of cells serving to form the mouth of the funnel, and the internal opening of the nephridial duct into the body cavity. The cilia at the mouth are long, and at the entrance turned with their free ends towards the body cavity.

External Openings of the Nephridia.—BEDDARD has recently published a description of the relationships of the various nephridia and their external openings in *Perichæta* and *Acanthodrilus,* which has a most curious resemblance in many points to that present in *Megascolides.* The work upon the latter was done quite independently of BEDDARD's, and the fact of the existence of a connection between the nephridia stated in a preliminary paper read to the Royal Society of Victoria in October, 1887.

BOURNE,* in *Pontobdella,* described a complete nephridial network with a pair of internal and external openings in each segment of the body. BEDDARD has described a continuous network in *Perichæta aspergillum,* and a network not continuous from segment to segment, or on both sides of the body in *Acanthodrilus multiporus.* In the former, the external openings are arranged in a row round the body; in the latter, they are very numerous and irregularly arranged in the anterior part of the body, less numerous, more grouped together, and having somewhat definite relationships to the setæ in the posterior part of the body.

In the anterior region of *Megascolides* the nephridial ducts are connected together, and branches pass in the body wall from the ducts of the nephridia on one side to those of nephridia on the other side of the dividing septa, forming a nephridial network.

In the posterior region of the body, all the small nephridia in the ring are united by a network of ducts, and on the ventral surface on either side of the mid line runs a clearly marked single duct (*d.* Fig. 27), which opens into (1) *the small nephridia on the ventral side in the posterior part of the segment,* which are also connected with the nephridial network, uniting the ring of small nephridia, and (2) *the large single nephridium anteriorly.* This duct passes forwards and through the body wall immediately beneath the insertion of the septum appears to send forward a small prolongation into the next segment to the region of the small nephridia. From these the duct (*d.*) passes on again to the next large nephridium, and so on. The longitudinal duct in transverse sections is seen to lie internally to the ventralmost setæ on either side. There is no doubt whatever as to the presence of the network uniting the smaller nephridia and the longitudinal duct on either side, into which the network opens, and which runs forwards to the large nephridium. The duct passing beneath the septum is finer and more difficult to trace, but Fig. 27 represents in diagrammatic longitudinal section what I believe to be the relationship of the nephridia on either side of the body. There is no connection ventrally between the nephridia of the two sides of the body, but the ring of small nephridia is continuous across the middle dorsal line.

In the anterior segments there is thus present a communication between the external ducts of the nephridia at a number of points in the circumference of the body wall, whilst in the posterior segments this communication is limited to the ventral surface, and we then find that there is here in each segment a longitudinal duct connecting together (1) a ring of smaller nephridia, (2) a single larger nephridium.

* Q.J.M.S. July 1884, Plate 24, fig. 3, and Plate 26, fig. 8.

The ducts leading to the exterior of the body vary slightly in structure in different parts of the body.

1.—*In the clitellar region* (Figs. 6 and 28) each duct passes through the longitudinal muscle layer, where, close to the cœlom, it may apparently be joined by branches from other ducts, and then runs on through the circular fibres. So far it is distinctly intra-cellular (Fig. 6, *neph.*) and is always somewhat coiled, so that the duct when cut in section has the characteristic appearance of a large number of sections of little ducts so arranged as to form a continuous string (cf. fig. 18.) This can be seen most clearly in the clitellar part, where the body wall is thicker. The duct on its way through the muscle layers is surrounded by a sheath of connective tissue fibres, and is always accompanied by a very distinct blood-vessel. (*bv.*) This vessel may sometimes, as represented by BEDDARD in *Acanthodrilus,** form a loop round the nephridium, but more generally (as drawn in figs. 6 and 28) forms a loop at one side of the duct when the latter is passing through the special glandular development, which is characteristic of the clitellum. The intra-cellular duct passes just within the layer of gland cells, and there opens into the extra-cellular duct leading to the surface. The structure of this part was found to be most clearly shown in worms which had been killed by dropping them into a warm saturated solution of corrosive sublimate. In the ordinary spirit specimens, the structure, though discernible, after having once realised its true nature by means of the better preserved ones, is not nearly so clearly visible, owing doubtless to the greater contraction of the tissues.

The duct is of large size, and owing to its not running in a perfectly straight line, but being thrown into a series of small folds, it presents the appearance in section of a series of vesicular spaces lying closely one above the other, and often showing openings into each other. The walls are extremely fine and thin. In section the thin film-like wall of one side of the duct may be often seen (*neph.*, fig. 28) its protoplasm, rendered visible by the presence of very fine granules indeed and oval nuclei of a large size, containing scattered chromatin fragments. The outlines of the cells, which thus form an extremely thin pavement epithelium, are not distinguishable. Sections of the tube show at the edges the nuclei bulging out the thin walls (*n.*) When the surface of the body is reached, a very curious differentiation in the epidermis is seen. A certain number of them become so arranged as to form a sphere. The different cells composing this are swollen out medianly where the nucleus is placed, and taper off towards each end. The two ends are attached respectively to the two poles of the sphere, and along the axis of the latter passes a tubular cavity opening at the one end to the exterior, and at the other into the nephridial duct, the lining cells of which are directly continuous with those lining the axial cavity of the sphere. The cuticle does not pass down the duct.

* Op. cit. Plate 30, fig. 10.

There are one or two nuclei (*n.*[1]) close to the internal pole, the cells connected with which cannot be detected. They are similar in size and appearance to the nuclei of the cells forming the sphere, which again seem to be somewhat larger than those of the ordinary epidermic cells.

Just where the duct enters the epidermic sphere are some 4-6 muscle cells, often with branched ends, which, from their arrangement, may be regarded as forming a sphincter for the opening of the duct, to the long axis of which they are placed at right angles (*m.*) BEDDARD, in describing a species of *Acanthodrilus** in 1885, states that at the opening of the nephridium the columnar cells bend over towards each other on either side of the aperture. This appearance may perhaps be due to the development of a structure, such as is above described, but in his recent description of *A. multiporus,* he figures a different arrangement, in which the small cubical cells of the duct simply swell out into a sub-spherical shape within the epidermis. In the clitellar region, the ducts appear to pass right through the muscle layers, without branching as they approach the exterior.

2.—*In the posterior region of the body* (Figs. 18 and 27) the ducts are somewhat different, and resemble much those of *Acanthodrilus.* A single duct has the appearance represented in Fig. 18. The intra-cellular portion resembles exactly that above described in structure, but when this has passed through the longitudinal muscle fibre layer, it opens just within the circular fibre layer into an extra-cellular duct, which may (Fig. 18) run straight to the exterior without branching, or may give off one or more branches. Its cells are cubical, and this part forms a strong contrast in structure to the same division in the clitellar region. The external opening shows precisely the same modification of the epidermic cells into a sphere, through the axis of which runs the duct. The muscle cells do not appear to be developed. The blood-vessel accompanying the duct is always present, though not in the form of a coil, and runs forward to form branches, which will ultimately ramify amongst the muscle fibres and the epidermic cells.

Very frequently, in fact most generally, the duct leading to the exterior may, as soon as it has passed through the layer of longitudinal fibres, branch. This branching commences when the duct becomes inter-cellular (Fig. 27), and each duct of which, there may be two or three, has its own separate opening.

There is no distinction between the ducts of the larger and smaller nephridia, and ducts passing to the exterior arise from the longitudinal duct which are not definitely in connection with special nephridia, and the branches of the various ducts may pass over in the body wall from one segment to another.

In no part of the body is there any relationship between the nephridiopores and the setæ, even when the nephridia become more localised.

Such a relationship is described by BEDDARD as occurring in *P. aspergillum,* in the posterior region of the body.

* Proc. R.S. June 1885, p. 460.

Reproductive Organs.—The macroscopic appearance of these structures has been described by Mr. FLETCHER.

When the body of the earth-worm is opened (Fig. 1), a series of racemose structures (*vs.*) are seen in certain of the anterior segments, overlapped and almost hidden from view by the strongly developed septa. They vary in development according, doubtless, partly to the age of the worm, and partly to the time of the year at which the animal is examined.

In the eighteenth segment, a long closely coiled tube is seen on either side, pushing through the comparatively thin walls bounding the segment in which it lies. This is the prostate gland.

Figs. 3 and 4 represent diagrammatically the relative positions of the different reproductive organs. Fig. 3 is supposed to be seen from the side, Fig. 4 from the dorsal surface.

1.—*Male Organs.* These consist of two pairs of testes ($t.^1$ $t.^2$), attached close to the ventral surface to the posterior faces of the septa, bounding anteriorly the tenth and eleventh segments respectively. In addition to these there may occasionally be found an extra pair in the same position in the twelfth segment ($t.^2$) Each testis is about 1·5 mm. in diameter, and consists of a small central portion, from which radiate numerous stiff processes, most largely in the plane of the septum, close to which the testis lies.

In the tenth and eleventh segments are the two pairs of large ciliated openings of the *vasa deferentia.* These are white coloured, and have their margins, as usual, thrown into very deep folds. The whole internal surface of the funnel-shaped opening is ciliated, and full of ripe spermatozoa.

No trace of the *vasa deferentia* can be seen on dissection; they lie in the connective tissue beneath the peritoneal epithelium, and run back in this position to the eighteenth segment, where they enter the prostate gland.

The two vasa deferentia are completely separated from each other throughout their whole course (Fig. 30.) The great thickness and strength of the septa render it difficult to cut this part of the animal in section, but a complete series was obtained of longitudinal sections showing the whole course of the two *vasa deferentia,* which certainly run through a length of three, or in the fully expanded worm, even four inches in the body wall. The funnel is very close to the septum, and is composed of small ciliated cubical cells. It looks very thin when cut in sections, and forms—with its small cubical cells, only covered externally by a very small quantity of connective tissue, and its widely open mouth—a strong contrast in form and structure to the nephridial openings. The duct (Fig. 30) runs from each funnel through the septum, which is here very thick, but in doing so, does not run straight, but first of all curves upwards, coils about to a certain extent (not shown in the diagram), and then passing downwards towards the ventral surface, crosses over a special small bridge of muscle fibres and connective tissue (*a*), and so reaches the ventral body wall. Probably this extra length and the special bridge of muscle may be contrivances to allow of the sudden expansion and contraction of the great muscular septa in this part of the body, without hurt to the *vas deferens.* In the body wall the duct runs directly backwards (Figs. 3 and 4, *vd.*,[1] *vd.*[2] and Fig. 30, *vd.*) The second opening and *vas deferens* have precisely the same relationship to the septum as the first; and the two *vasa deferentia* in passing backwards lie close together, the second immediately above the first. This relationship is retained (Fig. 30) until the prostate gland (*pr.*) is reached. Throughout the entire course each tube contains, in its circumference, some eight cubical cells, never more apparently, and is always richly ciliate the whole length. In the eighteenth segment the two ducts run upwards within the connective tissue of the prostate gland, and then turning downwards again (Fig. 30) follow the course of the duct leading to the exterior, running through the strong circular and longitudinal muscles surrounding the opening of the prostate, until they enter side by side. The cilia stop exactly where the ducts enter the prostate.

The *Prostate Gland* (Figs. 3 and 4, *pr.*) is, as said before, a large coiled mass on either side in the eighteenth segment. What its function is must be regarded as doubtful. It may be divided in *Megascolides* into two distinct parts, (1) an outer smaller part leading to the exterior, and serving both as the opening for the gland and for the *vasa deferentia.* This has simply (Fig 30) the form of a tube lined by a layer of deep and distinctly nucleated columnar cells, directly continuous with the epidermic cells at the mouth of the gland (*mo.*) In its upper part this tube is much coiled. It is surrounded by a great development of circular and longitudinal muscle fibres. Possibly the straight portion of the tube into which the *vasa deferentia* open and pour their contents (*vo.*), and which opens on the papilla before referred to in the swollen part of the clitellum in the eighteenth segment, may be eversible. There is no trace whatever, so far as could be seen macroscopically and by means of sections, of any penial setæ.

2.—The second portion of the prostate, comprising almost all the coiled duct part, has a very different structure; its walls are much thicker, and consist of two distinct layers—an inner and an outer. The inner is composed (Fig. 29, *sp.*[1]) of a single layer of cells, though occasionally these may be very long and extend into the second part. They are columnar in shape, and placed with their long axes radiating from the lumen of the tube (*int.*) Their chief peculiarity consists in the way in which they absorb staining material (borax carmine and hæmatoxylin), and hence appear in section to be very much darker than the outer-lying cells. The cells are, as a general rule, filled with a granular protoplasm, and much resemble in form those of an ordinary columnar epithelium, save that they are much more loosely placed together, and each has an internal rounded end, whilst (as represented in the figure) many of them may be larger than the others and extend far into the outer layer. Some of the cells have an empty appearance—as if they had poured their contents into the lumen—and in none of them can any nuclei be detected.

The cells of the outer layer on the other hand are much more numerous, and form a layer more than twice as thick as the inner ones. Each cell has the form of a unicellular gland, with a more or less swollen external end and a somewhat narrow neck internally, which may be seen sometimes passing in between the cells of the inner layer. These stain much less readily than those of the outer layer, and in them, as a general rule, nuclei are to be seen. Possibly, the deep staining of the inner cells may hide the nuclei, but these are not even to be detected in occasional cells which are more lightly stained. Between the two layers is a slight development of connective tissue and a layer of blood-vessels, which are sometimes seen, as in the figure, branching along the plane of division between the inner and outer cells. Other branches ramify in and out amongst the gland cells of the organ. Externally is an encasing layer of connective tissue (*ct*), beneath the surface of this are numerous little masses of yellow-brown pigment spots, which give a general brownish tinge to the prostate gland. It is difficult to say what is the function, if any, or origin of these little definite masses of colouring matter. The connective tissue over the various coils of the ducts is continuous, and thus the latter are massed together to form on each side of the body a structure of considerable size.

The *Vesiculæ Seminales.* These are seen as racemose glands attached to the anterior surface of certain of the anterior septa, directly the body is opened from the dorsal surface. (Fig. 2, *vs.*) They differ very much in appearance from those of *Lumbricus,* not being pouch-like, and are usually present in the eleventh to the fourteenth segments inclusive, but may not be so largely developed in younger specimens. They are quite diagramatically shown in Fig. 4. Their appearance at first sight is very much like that of both testis and ovary, and they have once been described as the former. The organ is generally best developed in the fourteenth and least in the eleventh segment. Sections at once show its real nature and prove that it is the place in which the spermatozoa undergo almost their entire development. How they get in is not easy to understand.

The testis (Fig. 12) consists in part of a great mass of germ cells, which have undergone but very little of their definitive development, and in part of a mass of protoplasm in which numbers of nuclei are scattered about forming merely a syncytium. The stalk of the testis attaching it to the septum is composed mainly of muscle fibres (*m.*) and connective tissue, which serve as a support for the structure. These run out into the ray-like processes, one of which is supposed to be cut in section in Fig. 12. It consists almost entirely of a mass of protoplasm, in which cell outlines can scarcely and only in very few parts (though this might possibly vary at different periods of the year) be distinguished, but in which are an immense number of nuclei with very distinct specks of chromatin. The nuclei are of two or three different sizes, and here and there the outline of a cell enclosing one or two of them may be seen (*a.*) In the central part of the testis the nuclei are small and similar, or even more minute ones may be seen in the stalk. These nuclei always appear to have a single spot of chromatin. The larger ones are in the rays where they all appear to be nearly of one size, and have very clear chromatin spots irregularly arranged around the periphery close to the nuclear membrane.

No further development seems to be undergone in the testes, which can be found apparently at any time of the year. Worms secured in June, September and March contained them. They have at all times the same external appearance and the same microscopic structure, even in different worms in which the development (so far as size and extent is concerned) of the seminal reservoirs varies considerably. The evidence that these structures are really testes is both positive and negative. (*a*) Positive (1) inasmuch as they contain structures indentical with the earliest stages in the development of spermatozoa, not only as found in other worms, but also as present in the seminal reservoirs of *Megascolides.* (2) Their position with regard to the segments of the body and relationship to the septa. (*b*) Negative—inasmuch as they differ uniformly in structure from the other reproductive organs of which it might be possible to regard them as early stages in development, viz., vesiculæ seminales and ovaries.

In the vesiculæ seminales, spermatozoa are, on the other hand, seen in every stage of development. The whole structure, besides occurring in scattered divisions in four distinct segments separated from each other by thick muscular septa, is divided up into a great series of capsular chambers, in which very different stages of development are met with at the same time.

How the testicular cells get into the seminal reservoirs cannot be stated, and it is difficult to imagine how from the testes in the tenth and eleventh segments the germ can pass backwards into the fourteenth segment, as the basal opening allowing of the passage of the ventral nerve-cord is very small indeed, and the septa very thick. It is to be remembered, however, that the testes lie on the ventral side, and so close to the openings through which, in alternate expansion and contraction, currents of the cœlomic fluid doubtless flow.

In *Lumbricus,* the testis is enclosed during growth of the seminal reservoirs, and in *Microchæta* the testis is enclosed in a special cœcum of the reservoir, but, as stated above, the testis of *Megascolides* is never enclosed, and can be easily found at all times of the year.

Each capsule of the reservoir is encased by connective tissue, and within the walls ramify numerous blood-vessels. The same seminal capsule, as a general rule, contains sperm in very different stages of development. The different stages are represented diagramatically in Fig. 15, which is supposed to be a single capsule cut in section, and containing within itself the different stages, not necessarily seen in the one capsule, but to be found at the same time in the same animal.

The youngest stage is probably the small mass of cells (3) still joined together, but with their outlines distinguishable and their nuclei resembling exactly the largest ones in the testis. Probably small masses of testicular cells break away from the testis, and in some manner are taken up by the vesiculæ seminales. The cells then separate from one another, and come to lie freely within the capsule. The great supply of blood-vessels is probably connected with the further development of the sperm cells, which increase greatly in size. Their nuclei divide, but so far as can be seen, the protoplasm of the cell does not do so. At first the nuclei, as in the figure in the left-hand corner (2), are somewhat spherical, and contain distinct chromatin spots. A later stage shows a number of oval dark-staining nuclei, arranged roughly round the periphery of a granular central mass of protoplasm. To this may now be given the name of spermatosphere.

In certain of the spermatospheres, the nuclei take stain throughout, as in the figure. A somewhat later stage is to be found, in which processes of protoplasm project from the surface of the spermatosphere (*sp.*), each containing an oval nucleus, and in the latter the chromatin forms a crescent-shaped structure at the outer end—a curious stage corresponding to that already described and figured by Bloomfield as occurring in *Lumbricus.** At this stage the central granular mass of protoplasm is clearly differentiated as the sperm-blastophore. Later on, the nuclei come to lie at the inner ends of the processes, and the protoplasm to gradually elongate into a pointed thread-like structure (*sp.*) At the same time, the developing spermatozoa all come to point in the one direction. Each sperm element elongates, the nuclear end forming the head, the clear protoplasm the tail, and all the tails lie close together, so that the whole mass of spermatozoa forms a flame-shaped structure, in the broad end of which is the sperm-blastophore. When the former are mature, and ready to separate from one another, the latter cannot be detected, though possibly it is concealed from view by the elongate rod-shaped heads of the spermatozoa, which take the stain deeply.

The ripe sperm comes finally to lie in the cœlom, probably either by discharge ot a capsule in which it is contained, or else by means of forcing its way through the capsule walls. There is no direct connection between the openings of the *vasa deferentia* and the seminal reservoirs, which are most largely developed in the three segments behind the one containing the second pair of openings of the male ducts.

Within the vesiculæ seminales are, as usual, found capsules containing the embryos of a gregarine.

2.—*Female Organs.* These consist of a single pair of ovaries attached to the posterior face of the septum, between the twelfth and thirteenth segments, close on either side of the ventral line. Each has externally much the same appearance as a testis, but the projections from the small central mass are rather more racemose than radiate. The open end of the oviduct lies close to each ovary (Figs. 3 and 4, *od.*), and has the usual ciliate funnel shape. It is somewhat smaller than the corresponding

* Q.J.M.S. 1880.

male opening, but is formed of the same small cubical cells. The oviduct leads down through the posterior septum of the thirteenth segment into the ventral body wall of the fourteenth. Its walls (Fig. 31) are composed of columnar ciliate cells, much more numerous than in the case of the *vasa deferentia.* The two ducts incline towards the median line, and open one on each side, very close together, in the middle of the fourteenth segment. They have no relation to the setæ, opening in front of and to the ventral side of these.

Though the testis and ovary closely resemble each other externally, sections at once show a great difference between the two. (Figs. 11 and 12.) At all times, so far as can be ascertained—certainly in winter, spring, and summer—the ovary contains large well-developed ova. A section through an ovary of a worm obtained in March is represented in Fig. 11, as seen under a magnifying power of 2,200 diameters.

Only one of the projections from the central part is represented. The whole ovary has a diameter of rather more than 1 mm. The central part is composed, very much as the testis, of a mass of protoplasm, amongst which are muscle fibres and connective tissue serving as supporting structures (*ct.*) In the ovary ramify numerous blood-vessels (*bv.*) In parts outlines of cells may be distinguished, but as a rule the protoplasm forms an indefinite mass, in which many nuclei of various sizes are scattered. The smallest ($o.^5$) are very minute, and resemble those in the testis stalk. Others, gradually increasing in size, are seen ($o.^4$ $o.^3$) Around these the protoplasm is difficult to distinguish, since it takes stain but slightly. Larger nuclei ($o.^2$) lie further away from the centre of the ovary, and around them the protoplasm is becoming marked off into distinct areas, and also differs in its ability to take stain. In the nuclei the chromatin fragments are arranged roughly in a circle near to the external surface. At the extremities of the projections, the cells are still larger ($o.^1$), and have the appearance of mature ova. These cells have undergone great growth, and their nuclei are very large and distinct, and generally spherical in shape. In the largest one, which forms the extremity of one projection, its inner end being buried deeply amongst smaller cells, the nuclear membrane can be distinguished, together with a nuclear network with chromatin fragments, and a somewhat eccentrically placed mass of chromatin, in which lies a still more darkly-stained portion. In the other large cells, owing doubtless to the different results produced by reagents, the chromatin appears distributed in various ways, but there is always one large main portion placed eccentrically, and besides this, there may be smaller fragments irregularly scattered. These ova grow in size, nutriment being possibly afforded to them by the absorption of the smaller cells at their inner ends, as well as by the numerous blood-vessels in the ovary, and when mature they fall into the cœlom, and enter the open ciliated end of the oviduct, which lies close beneath the ovary on either side.

As far as development goes, a small number of cocoons have been secured, and I hope soon to be able to procure many more, and to work out the development completely. The cocoon is very large—1½–2 in. in length and ¾–1 in. in breadth. It is leathery in consistence, rounded at either end, with a short coiled string left where the ends were finally closed. The cocoon corresponds to the size of the burrow, and each contains only one embryo. What size the embryo attains before leaving the cocoon I cannot say, but have found them coiled up within the cocoon, and reaching the length of 5–6 in. The cocoon is filled when the embryo is young with a milk-white fluid, corresponding to, though rather thicker than, the cœlomic fluid, and is probably composed in part of the latter.

The *spermathecæ* are four in number, and very large. There is one pair in the eighth and one in the ninth segment. (Figs. 1, 3, and 4, *r.s.*) Each one has the form (Plate 5, fig. 23) of a bag with a pointed extremity at its free end, and a short stalk for attachment to the body wall at the swollen end. Each lies on the ventral surface of the body, and their ducts to the exterior pass slightly forward, so as to open just (Fig. 1, $r.s.^1$ *o.*, $r.s.^2$ *o.*) within the posterior edge of the segment next in front of those in which they really lie. A slight line on the surface of the worm encloses, as shown in the figure, a distinct area in which the receptacula open. No setæ can be detected so far forward in the body of the worm I have examined, but these openings lie close to the segment boundaries, and would seem to have no relations to setæ. They open at about the same distance from the median line as the ventral pair of setæ, but quite in the posterior region of the segment.

The receptacula are marked by very distinct grooves running longitudinally (Fig. 23), and up each side passes a clearly-marked muscular slip (*musc.*) This may perhaps be useful in ejecting the contents of the receptacle, as on contraction the two slips would force the contained material to the exterior. The grooves all converge towards the apex, and on examining the surface carefully, circular muscle fibres can be detected running beneath the longitudinal ones on the exterior. At the attached end, and very close to the body wall, is a small diverticulum, as in other species of the genera described by FLETCHER, though in them (*M.* (*Notoscolex*) *camdenensis* and *M. grandis*) the spermathecæ are much narrower and more tube-like, and in the former the diverticulum more prominent and further away from the external opening. The surface of the diverticulum in *M. australis* is marked by projecting coils, which are not well represented in the lithograph. When cut in section longitudinally, the structures represented in Fig. 25 are seen. Internally, the sac is lined by a layer of columnar epithelium, the oval nuclei of which lie close to their outer ends. Most externally are the longitudinal and inter-twined muscle fibres; just within these the circular fibres, much fewer in number, are cut through. Between the latter and the epithelium is a considerable space filled with connective tissue, amongst which are many nuclei, whilst next to the epithelial cells is a layer formed of very numerous branching and interlocking blood-vessels. The great development of the blood-vessels in connection with the columnar epithelium cells indicates the fact that the inner lining of the spermatheca has a secretive function. In examining the contents of the spermathecæ in several worms at different seasons, I was surprised to find no trace of spermatozoa, but simply remains of a fluid containing granules and masses of nucleate corpuscles. The latter are aggregated into the form of spheres, and it is difficult to say what is their real nature.

Sections showed that the spermatozoa, at all events in those examined, were confined to the diverticulum, near the base, and in its hollow spaces they were densely crowded together. The space follows the external markings, and the whole communicates with the main cavity of the spermatheca by means of a narrow passage. The walls of the diverticulum are devoid of the columnar epithelium, and formed mainly of connective tissue. It is possible that the walls of the main cavity may secrete a fluid from the blood, which is necessary to maintain alive the spermatozoa until such time as they are needed to be placed in the cocoon. According to JACKSON,* VEJDOVSKY states that the fluid forms the spermatophores.

Remarks on the Nephridial System.†—The most interesting points in the anatomy of *Megascolides* are concerned with the nephridial system. During the last few years our knowledge of the structure and arrangement of the nephridia of *Chætopods* has been very much enlarged, and though in the absence of fuller information concerning the development of the organs, it is not perhaps possible to arrive at any final conclusions, still the data available is sufficient to warrant a comparison of the *Chætopod* nephridia with those of certain other worms. Such a comparison has lately been attempted by BEDDARD in the light of his discoveries with regard to the structures in *Acanthodrilus* and *Perichæta*. The nephridia of *Megascolides* may perhaps serve to render some points still more clear.‡

BEDDARD has argued very forcibly in favour of the view of a direct relationship existing between the nephridia of *Hirudinea* and *Chætopoda* on the one hand, and of the *Platyhelminthes* on the other.

Certainly the existence of provisional larval nephridia in various *Hirudineæ*, *Polychætæ*, and *Oligochætæ* is a point of great difficulty in homologizing the permanent nephridia of the latter forms with those of *Platyhelminthes*. BERGH, as quoted by BEDDARD, holds that the above mentioned larval structures, together with those of *Mollusca*, are homologous with the nephridial system of the *Platyhelminthes*. Whilst on the one hand, BERGH asserts that the larval nephridia of the *Hirudinea* are

* Forms of Animal Life. 2nd edit., p. 206.

† The suggestions made in the following pages differ somewhat from those made in a letter on the same subject, which was published in *Nature*, June 28, 1888.

‡ In the absence of access to any but a very meagre supply of original literature on this subject in Melbourne, I am indebted both for the facts stated with regard to other worms, and the views held by other investigators, to the valuable series of papers by BENHAM and BEDDARD, and the second edition by JACKSON of "The Forms of Animal Life," and to the memoir of BOURNE for facts regarding the *Hirudineæ*.

quite independent of the adult ones, WHITMAN states that they are not. BEDDARD further points out that the larval nephridia of *Oligochætæ* discovered by VEJDOVSKY "occur at the anterior end of the body, where no permanent nephridia are developed. Furthermore, these organs lie in the cœlom, perforating the mesentery which separates the first from the second segment; hence BERGH's objection to the homology between the larval and permanent nephridia, on the score that the former do not lie in the true cœlom, is removed." In the *Platyhelminthes* the excretory system has the form of a series of fine tubes formed of perforated cells, the terminal one of each branchlet being a flame cell. The latter may be wanting in the larval nephridia of other worms, though otherwise the structure of both sets is similar; and in others, again, where no free larval stage is present, the structures may still more lose their resemblance to one another. In *Dinophilus* also, which, according to WELDON,* is "a form representing in its main features a stage in the evolution of *Chætopods*," and possessing undoubted *Turbellarian* affinities, the excretory system resembles that of a *Polychæte* larva. The difficulties seem to lie in—(1) the presence of larval nephridia, which have, as BERGH supposes, no connection with the adult nephridia; (2) the structural resemblances between the adult nephridia of *Platyhelminthes*, and the larval ones of *Chætopods* and *Hirudineæ*. The question of connection with the cœlom of the organs, supposed by BERGH to be homologous in the three latter groups, is not perhaps of such importance. In the first place, according to BEDDARD, the larval nephridia of *Oligochætæ*, discovered by VEJDOVSKY, *do* open into the cœlom; and beyond this it would scarcely be safe to conclude that structures present in *Chætopods* and *Hirudineæ*, and evidently homologous in the adults of the two latter groups, were not homologous with structures in *Platyhelminthes*, simply because of the nature of the cavities into which they opened; especially also taking into account the fact quoted by BEDDARD, that in *Capitellidæ* the nephridia lie within the mesoderm, and not in the cœlom, and that in *Polygordius* the greater part of the nephridium is similarly situated. As to the difficulties arising out of the fact that two sets of nephridia are present, it must be remembered, first of all, that, apart from HATSCHEK's observations on *Polygordius*, WHITMAN states that there is a connection between the structures in *Hirudineæ*. Further, it is a point of importance, as BEDDARD points out, that these are always placed at the anterior end of the body, and so do not correspond in position with the nephridia of *Platyhelminthes*. It is possible again that these simple larval nephridia are purely larval structures, not phylogenetically related to those of the adult forms of their ancestors; or that, again, they are portions of the adult nephridia precociously developed, just as portions of other structures are developed in the larvæ for use during larval stages, in either of which cases the great obstacles to comparing the adult nephridia of earth-worms and *Platyhelminthes* would be done away with.

* Q.J.M.S. August 1886, p. 117.

These, of course, must remain mere conjectures, unless the existence of a definite connection between the larval and adult structures be established, and HATSCHEK'S and WHITMAN'S observations confirmed. Meanwhile, it is interesting and suggestive to note the variations in structure met with in the nephridia amongst the members of the groups *Chætopoda* and *Hirudinea,* leading back, as it were, to the *Platyhelminth* nephridial system. There are now known a series of gradations between the single pair of highly developed nephridia, quite separate from each other, and placed one in each segment of the body, and a well developed irregular nephridial network with no internal funnel-openings, and only one pair of posteriorly placed external openings, or an enormous number of minute nephridial tubules, with a connecting network, and a great number of irregularly arranged openings in each segment.

It must be remembered that in *Platyhelminthes* there are no structures which can be exactly said to be homologous with the nephridial tubules of *Chætopods,* the network of ducts lying in the body wall beneath the peritoneal epithelium in such forms as *Perichæta* and *Acanthodrilus,* and more especially in the Hirudinean *Pontobdella,* being, I would suggest, really the structures directly homologous with the *Platyhelminth* network of tubes, whilst the nephridia of *Chætopods* themselves are to be regarded as outgrowths and special developments of these tubes, their formation being to a large extent associated with the development of special sinuses and spaces within the mesoderm into which they depend.

BEDDARD is of opinion that "it is unnecessary to regard the funnels of the *Annelida* as new structures," and draws attention to the fact (1) that in *Stylaria* the single cell, which by its proliferation forms the funnel, becomes ciliated, and acquires a lumen before it undergoes division ; (2) that in *Clepsine* the funnel only consists of two cells. LANG, on the other hand, regards them as new structures, not represented in *Platyhelminthes,* and ED. MEYER, as quoted by HARMER,* has shown that in *Polychæta* (*Terebella*) the ciliated funnel arises quite independently of the body of the nephridium—a fact strongly in favour of LANG'S view, as is also the varied development of the nephridia, as seen in a series of adult forms within the limits of the *Oligochætæ.*

The development of the funnels in *Clepsine,* and more especially in *Pontobdella,* would be of great interest and importance in connection with this question. Meanwhile, seeing further that the funnels are not present in what must be regarded as the most primitive nephridial system amongst *Chætopods,* and only appear in forms in which the organs are somewhat highly differentiated, it is perhaps safer to conclude that at all events in *Chætopoda* the funnels are new structures, not represented in *Platyhelminthes.*

From this point we may deal separately with the *Hirudinea* and the *Chætopoda,* as I would suggest that though the nephridial system of each is derived from one of a

* Q.J.M.S., 1885. P. 280.

Platyhelminth type, yet the development of the two groups has proceeded, starting from the same point, along somewhat divergent lines.

The difference is due to the greater development of the cœlomic space in the *Chætopoda* than in the *Hirudinea,* and the more complete division of the body of the former by means of septa into a series of compartments, each almost completely separated off from the ones on either side of it. There is at the present time a strong contrast in the two groups in this respect, and it is one which has probably held true since the time at which each group separately branched off from common *Platyhelminth*-like ancestors to pursue its own course of development. We may believe this to be true, even though at the same time we agree with BOURNE * that the cœlom of the leeches has once been more highly developed than it is now, and that "the leeches have thus had an ancestor which, in possessing a cœlom, was already a great advance upon any *Platyhelminth* form."

It was the development of this definite space in the mesoderm, which resulted in, or at all events was closely connected with, the formation of the definite internal openings of the nephridia in the leeches and, as I would suggest, of the present nephridial tubes of the *Chætopoda.*

1.—*The Hirudinea.*—The simplest form of nephridial system known in leeches is that of *Branchellion.* As described by A. G. BOURNE,† this consists only of a network of tubules, with no internal openings, and only a single pair of posteriorly placed external openings. The only indication of segmentation lies in a slight crowding of the tubules together at intervals. There can be little question of the close relationship of this to the system as found in the *Platyhelminthes,* and it might possibly be that further examination of the living form would result in the finding of flame cells.

In *Pontobdella*‡ a similar network is present, but there is in addition a segmental arrangement clearly indicated by the presence in each segment of an internal pair of ciliated funnels, and also of a pair of external openings. The former open into a definite cœlomic space on each side of the body.

The resemblance between the network, again, of *Pontobdella* and a *Platyhelminth* is close; the difference between the two lies in the presence of the two sets of openings. It must be noted that LANG has shown that a definite, though rudimentary, metameric arrangement of the nephridial tubes obtains in some planarians in which secondary external openings may be developed by means of branches from the longitudinal trunks, and that a paired arrangement of these may even be seen. The ciliated funnel is united to the network by a very short tube. Its development, as above suggested, may be supposed to be connected with the presence of the definite

* Op. cit. P. 499. † Op. cit. P. 481.

‡ Op. cit. P. 478.

cœlomic space. Whether it is an entirely new structure, or developed as a modification of a pre-existing flame cell, it is quite impossible to say definitely, though the simplicity of the structure in such leeches as *Clepsine* may perhaps indicate its development from a flame cell, more especially if, as suggested by Hartog,* a flame cell be really an internally ciliated cell.

The segmental arrangement of the network, almost absent in *Branchellion*, and indicated in *Pontobdella*, is carried to a much greater extent in other leeches, the segmentally arranged portions losing their connection with each other, and each one acquiring its internal and external openings. The ducts, though aggregated into a definite tubular structure, still lie embedded in the mesodermic tissue, only their internal funnels lying freely in the cœlomic spaces, and having short tubes which connect them with the aggregated portion of the network. In *Hirudo* itself there still persists a part which Bourne regards as the remnant of a formerly existing connection between one nephridium and another.

The stages of development in *Hirudinea* may be, briefly, somewhat as follows :—

(*a*) A complete network of tubules (certainly at first with "flame cells,") and with posterior openings, and no, or only the faintest, trace of segmental arrangement. Such a stage is now possibly seen in *Branchellion*.

(*b*) A complete network of tubules, with paired external openings, and internal ciliated funnels opening into definite cœlomic spaces. This stage is now seen in *Pontobdella*. The internal openings may be developed by modification of pre-existing flame cells, or be entirely new formations.

(*c*) An aggregation of the network into portions segmentally arranged, forming definite paired nephridial tubes, each independent of the others, and with its own internal and external openings. This now exists in the adults of most leeches, as *Hirudo* and *Clepsine*.

2.—*In the Chætopoda.* An important difference in the nephridia of this group, as compared with those of *Hirudinea*, seems to have been brought about by the development of much larger and more extensive spaces within the mesoderm, which have moreover a segmental arrangement, and but very little linear connection with each other.

Taking the group as a whole, we find two sets of structures present in connection with the nephridial system :—

(*a*) A network of tubules in the body wall, and hence embedded in mesoderm.

(*b*) A series of regularly or irregularly arranged coiled tubes depending from (*a*) into the successive cœlomic chambers. With them may, or may not, be associated definite nephridial funnels.

* Ann. Mag. Nat. Hist. 1887. P. 326.

Both of these structures are present in what are to be, without much doubt, regarded as the more primitive form of nephridia in *Chætopods;* whilst in more modified ones, the second set of structures is present only.

Of the two, the first is to be regarded as directly homologous with the network present in *Platyhelminthes,* whilst the second is a secondary development.

This gives a somewhat new view as to the relationship existing between the various nephridia of the groups, and differs from that of Beddard and others in regarding the highly developed nephridia of such forms as, for example, *Lumbricus,* as secondary developments, formed primitively as outgrowths from a nephridial network homologous with that of *Platyhelminthes* and still persisting in *Perichæta,* their existence being intimately associated with the formation of definite sinuses and spaces within the mesoderm. A series of gradations is found amongst adult forms in the number, structure, and arrangement of the nephridia. In what may be regarded as the more primitive ones—*A. multiporus, P. aspergillum,* &c.—there is present a regular network of ducts with coiled nephridial tubules depending from it into the cœlom, and very many in number in each segment. In *P. aspergillum* the simplest form is seen in which the nephridia are quite irregularly scattered, and the network is a continuous one from segment to segment. In *A. multiporus* an aggregation of the nephridia takes place in the posterior region of the body, with a consequent lessening of the extent of the network, which is not continuous from segment to segment. In the more highly developed forms the nephridia are restricted in number, usually, though not always, (as, for example, in *Capitellidæ* amongst the *Polychætæ*) a single pair being present in each segment, as in *Lumbricus.* Each nephridium is in *Chætopods* considerably larger and more highly developed than in the case of those where many are present. In one adult *Polychæte—Lanice conchilega**—a longitudinal duct connecting consecutive nephridia exists in the adult. A similar (?) longitudinal duct has been described as present in the embryo of *Lumbricus* and *Criodrilus,* placing the various nephridia in connection with one another, and Hatschek's well known description of the development of the nephridia in *Polygordius* indicates a definite connection between the successive ones in this form.

Between the two extreme forms, in one of which a complete network with very numerous small nephridia with no internal openings are present, and the other, in in which a pair of large nephridia with internal openings is developed in each segment in no serial connection with each other, at all events in the adult, a most important intermediate stage is found in *Megascolides australis.* This serves in a remarkable manner to bridge over the wide interval, and to show the path by which the nephridia of *Lumbricus* may perhaps have been developed from the primitive original network of ducts in a *Platyhelminth* ancestor. It possesses both large and

* Cunningham. Q.J.M.S. Nov. 1887, p. 250.

small nephridia, the latter alone present at the anterior end of the body, whilst both are developed in each segment posteriorly. The latter only have ciliated funnels opening internally. Each consists of two distinct portions, in one of which the duct is *intracellular*, in the other the duct is *intercellular*, and opens to the exterior. The latter may be supposed to represent the more highly developed nephridial opening with vesicular portion present in other worms. In the larger nephridia, a third part is present at the intercellular opening of the nephridial funnel into the cœlom. This may in various worms be of greater or less extent, but in *Megascolides* appears to be very small. In *A. multiporus*,* BEDDARD describes an aggregation of the nephridial tubules into eight definite tufts, one corresponding to each seta in the hinder part of the body. In some cases two nephridiopores correspond to a single seta. The aggregation is not quite perfected, as "occasionally a single tubule was observed to perforate the body wall between the setæ" in positions corresponding to septa of connective tissue, which break the continuity of the longitudinal muscle layer. BEDDARD suggests that such septa represent the last trace of setæ, which have now disappeared. These irregularities are interesting, as showing that the present condition of the nephridia in the posterior part of the body in *A. multiporus* is due to an aggregation of the nephridial tubules, each tuft connected with a seta being the result of a massing together of a certain number of nephridial tubules to form one mass, as evidence of which may be instanced the occasional presence of more than one nephridiopore. In *Megascolides*, the differentiation has been at once carried further, and along somewhat different lines, and it must be noticed that *the differentiation in both A. multiporus and Megascolides commences in the posterior region of the body*— a point of importance when we come to consider the relationship of the nephridia to the genital ducts.

In *Megascolides*, the small nephridia are very much more numerous in the anterior part of the body than in the posterior; but side by side with this, a secondary development of large nephridia has taken place in the latter. If we examine the nephridia *in situ* we find, as previously described, that the large ones are only present in the anterior half of the last hundred or so segments of the body, a ring of smaller ones being present in the posterior half of each segment. In the middle region of the body, the large nephridia can for a certain number of segments be distinguished, but with no internal openings, and gradually come to form one of a group of nephridia slightly larger than the rest. Passing forwards, the single one becomes less and less distinguishable in size from the other members of the group of which it thus forms one,

* I cannot tell from BEDDARD's paper whether the *Acanthodrilus* described there is the same form which he had previously described in the P.R.S. (No. 238. 1885) as possessing eight nephridia in each segment—one corresponding to each seta. Both worms came from New Zealand. In the first paper the nephridia are described as being single structures, in the second as being tufts of nephridial tubes, the external orifices of which are, as a general, though not universal, rule, associated with the setæ. If they are not identical forms, it is very interesting to see the aggregation perfected in the first worm described, with the result that one definite nephridium corresponds to each seta.

until it completely merges into the rest, and nothing but small nephridia are present, which, as the anterior end of the body is approached, cover the whole body wall internally. In addition to this, where the larger nephridia are present, there exist (1) a network of ducts connecting the smaller nephridia in each segment, and (2) a well-developed longitudinal ventral duct on each side, running from the smaller nephridia forwards to the larger nephridium, and then continued on, but much finer in structure, to the ventral surface of the next segment, where it communicates with the longitudinal duct passing to the next large nephridium.

These series of structures reveal (1) the method of formation of the large nephridium from an aggregation of small ones, with a subsequent formation of an internal opening, and (2) the loss of a continuous network in the anterior part of the segment, as the smaller nephridia have become aggregated towards the ventral surface, still retaining their connection with the other nephridia, and hence the final result of a ventral single duct when the single nephridium becomes established.

In *Megascolides*, all the smaller nephridia are not, so to speak, used up in forming the one pair of large nephridia, but we can easily suppose a case in which, as in *Perichæta aspergillum*, there is primitively a large number of nephridial tufts in each segment, with a network continuous from segment to segment. If these become aggregated, so as to form a single pair of nephridia in each segment, then as they pass down towards the ventral surface (supposing the aggregation, as has usually happened, to take place in that direction), the network still connecting the nephridia, if it persists at all, will eventually assume the form of a longitudinal duct, passing from one group of nephridial tufts or one single nephridium, according to the stage of development arrived at, to the next in order along the ventral surface.

It will be seen from this that there is no necessity to assume that a longitudinal duct, when present, is the homologue of a longitudinal duct of a *Platyhelminth*, but is rather to be regarded as a modification of the network of ducts brought about by aggregation of the nephridia (1) into a series of tufts, and (2) the further development of these into large nephridia. The simplest nephridial systems of *Hirudinea* and *Chætopoda* alike, present no structures similar to the longitudinal duct of a *Platyhelminth*. This, at all events, does away with the necessity of supposing a double origin for the nephridial systems of *Chætopoda*,* one from ancestors with a network of ducts, the other from ancestors with a pair of longitudinal ducts, and at the same time, upon different grounds, brings us to the same conclusion as BEDDARD—"that the longitudinal ducts of *Lumbricus*, *Lanice*, &c. (we may now add *Megascolides*), have not any relationship to that of the *Platyhelminths*."

One great difficulty remains in the fact that, according to WILSON, the longitudinal duct in the embryo *Lumbricus* is epiblastic in origin. Until the development of the nephridial systems in the various forms has been consistently

* BEDDARD, Op. cit. P. 408.

studied, it will be impossible to establish any certain homologies. Meanwhile, it is important to remember that in *Chætopods* there is a very clear distinction of the nephridial duct into two parts—(1) an intracellular part, and (2) an intercellular part leading to the exterior, connected with which is the vesicular part. It may be that the first part is always mesoblastic in origin, the second epiblastic. In this case, the longitudinal duct and network of *Megascolides* and the network of other forms are mesoblastic, and hence different in origin from the duct present in the embryo *Lumbricus.* These points can only be determined by further, and especially embryological, investigations. The various stages in the development of the *Chætopod* nephridia may perhaps be somewhat as follows :—

(1) A stage (in some *Platyhelminth*-like ancestor) in which in an unsegmented body a continuous network of nephridial tubules, with flame or internally-ciliated cells, the former uniting to form longitudinal canals leading to the exterior.

(2) A modification (as seen in *Dinophilus gyrociliatus*) in which the excretory organs are still in the form of a network, with flame cells, but with secondary external openings in each segment, irregularly arranged, as in some planarians, regularly arranged, as in *Dinophilus.*

(3) A further modification, resulting in the formation of numerous irregularly-arranged outgrowths from the nephridial network, having the nature of coiled tubules, which are directly continuous and identical in structure (duct intracellular) with the network. These form the nephridia of the more highly-developed worms. Their development is to be regarded as intimately associated with that of segmentally-arranged cœlomic chambers, such as are at any rate but feebly represented in the *Hirudinea,* in which the tubes of the network itself, still lying within the mesoderm, become aggregated to form the nephridia.

(4) In connection with these numerous nephridial tubes, many external openings leading into the still persisting network are formed. (*P. aspergillum.*)

(5) The aggregation of the small nephridia into groups, commencing in the posterior region of the body (as in *A. multiporus* and *M. australis*). The nephridia are sometimes aggregated in relationship to the setæ, and as the aggregation proceeds so the external openings diminish in number and the network lessens in extent.

(6) The formation of large nephridia either out of an aggregate of small nephridia, or by the special growth of one of an aggregation of small nephridia. Each large nephridium acquires secondarily an internal opening into the cœlom. These openings, which have a very definite relationship to the cœlomic chambers, are formed apparently later in the developmental history of the nephridia in *Chætopod* than *Hirudinea,* and cannot be supposed to be related to the flame cells, but to be new formations within the group. Their formation also proceeds from the posterior towards the anterior end, and as it goes on the small nephridia gradually diminish in

number, and the network undergoes corresponding decrease with, it may be, as in *Megascolides*, the formation of a single duct on each side of the segment in connection with a network in the parts where the small nephridia still persist.

(7) The final disappearance of all trace of the small nephridia, and with them of the network and longitudinal duct. There then remains in each segment, as in most adult earth-worms, a limited number—usually one pair—of large nephridia, with internal and external openings.

Connection of Nephridial Organs and Genital Ducts.—Lankester was the first to suggest a probable connection between the two structures in earth-worms, and also to suggest that in the earth-worm two sets of nephridia had primitively been developed,* of which one now persists as the nephridial organs; the other only remains in the segments bearing the genital organs, and has become modified into genital ducts, the nephridia of this system having hence disappeared everywhere save in the genital segments. These two sets of nephridia were supposed to be related to the two pairs of setæ—the persistent nephridia to the ventral, and the nephridia now persisting as genital ducts to the dorsal pair of setæ.

Subsequent investigations have shown that he was perfectly right in supposing that primitively there was more than one pair of nephridia to each segment, but it is now very doubtful indeed whether there is much evidence in favour of his theory that the genital ducts are to be regarded as modified nephridia in the *Terricolæ.*

The evidence derived both from the structure of the two sets of organs, and from a consideration of the state of development of the respective structures in different earth-worms is opposed to the truth of his view.

First, with regard to the structure, which is very suggestive, though not perhaps of so great importance as the second class of evidence. The general structure of a *highly developed* (but not primitive) nephridium in an earth-worm is that of a tube with a funnel-shaped opening into the cœlom at one end, and an opening on to the surface of the body at the other extremity. In some part of the funnel-shaped structure the duct is inter-cellular, but the funnel, apparently without exception, leads back into an *intra-cellular duct,* always of considerable length and complication, and it is *this intra-cellular duct which forms the most characteristic portion of a nephridium, and which is never absent, however slightly the inter-cellular portion may be developed.* The more primitive the nephridium (as in *Acanthodrilus, Megascolides,* &c.,) the less developed becomes the inter-cellular part, which forms a duct leading from the intra-cellular part to the surface, and in connection with which—but only in the most highly developed forms—a vesicle may be developed.

On the other hand, the whole of the genital duct is inter-cellular, so that if the vasa deferentia or oviducts correspond to nephridia, all the intra-cellular portion of the duct between the funnel and the inter-cellular duct opening externally must have been entirely lost.

* Q.J.M.S., 1865, p. 18. On the Anatomy of *Lumbricus.*

Benham, in his valuable general summary* of the various organs of earth-worms, dealing with the question of the homology of the genital ducts and nephridia, says that the modification which the nephridium undergoes to form a genital duct consists either in—

(*a*) A fusion of a series of nephridia, or

(*b*) A disappearance of a part of the nephridium, or

(*c*) A shifting of the position of the pore.

Now, so far as our present information goes, we have no actual evidence of any one of these occurrences taking place to form a genital duct. Benham says, "In the case of the male duct, each of these modifications is exhibited. In the somites, in which lie the ciliated rosettes, the external extremity of the nephridium has disappeared. In the somite carrying the male pore, the funnel region of the nephridium is absent, whilst in the intervening somites both these regions have aborted, and a fusion of these various parts has taken place to form the more or less elongated duct." Now, as above stated, the whole of the male duct is inter-cellular in nature, whereas, according to this suggestion, the only parts of the nephridia which are inter-cellular have disappeared, save the ciliated rosettes at the commencement of each tube and the external openings at their terminations, leaving in the intermediate segments merely the typical *intra-cellular* parts of the nephridia to form a duct, the *vas deferens* which is characterised by its uniformly *inter-cellular* character!

Other difficulties again arise in connection with the male duct, as, for example, the presence of two perfectly distinct ducts running side by side in *Megascolides,* and of even "four separate sperm ducts, each with its external pore in *Acanthodrilus* and *Moniligaster.*"†

Similarly in the oviduct all intra-cellular portions of the duct must have disappeared, and the same again with the spermathecæ; in fact, the total disappearance of what forms the most characteristic portion of the nephridia is, even on the assumption that when converted into genital ducts the nephridia lost their primitive function, a very remarkable occurrence. If this difficulty stood alone it need not perhaps be regarded as an insuperable objection, but there is in addition the second class of evidence derived from an investigation of the respective development of the two sets of structures in various earth-worms.

The latter we may, simply as far as their nephridia are concerned, divide into three sets :—

(1) Those with very numerous small nephridia in each segment, with no internal but many or several external openings in each segment, which may or may not have a definite relationship to the setæ. (*Perichæta, Acanthodrilus,* &c.)

* Q.J.M.S., Feb. 1886, p. 265. † Benham. Op. cit., p. 260.

(2) Those with numerous small nephridia in each segment, similar to those in (1), and with, in addition, large nephridia in certain segments with internal openings (only example known as yet, *Megascolides*).

(3) Those with a limited number of large nephridia only in each segment—usually one pair (*Lumbricus*, &c.)

Now of these three divisions, there can be little doubt that the one characterised by the presence of a great number of nephridia scattered over the body wall without definite arrangement is in a more primitive condition, as far as its nephridia are concerned, than the one characterised by the presence of a single highly-developed pair in each segment of the body. Such a worm as *P. aspergillum*, with its very numerous scattered nephridia, stands in very much the same relationship to other worms in this respect as that in which *Peripatus* stands to other *Arthropods* in the matter of tracheal tubes.

There is only one other course open, and that is to regard the condition found in *Lumbricus* as a primitive one, and that in *Acanthodrilus* as not more highly developed, which could scarcely be held but degenerate. This view might be held, but there is, so far as I can see, no evidence in its favour, and it would be contrary to all analogy. We must regard *P. aspergillum* as more primitive in its nephridial system than *Lumbricus*. Between them and bridging over the great differences in structure in these two extreme types come (1) *Acanthodrilus*, and (2) *Megascolides*. In both of these we get differentiation, rendering them more highly developed than *Perichæta*, and giving indications of the final state reached in *Lumbricus*.

The most primitive nephridium with which we are hence acquainted in *Oligochætæ* has no internal opening resembling in this respect the ancestral *Platyhelminth*, from which it may be supposed to have been derived. Such nephridia are characteristic of *P. aspergillum* and *A. multiporus*, which do not appear to have yet reached the stage in which the secondarily-formed ciliated funnels place the nephridial ducts in connection with the cœlom.

In the *Perichæte* worm, the small nephridia are in their most primitive condition, and still irregularly scattered; but in *Acanthodrilus* and *Megascolides* the system is somewhat more highly differentiated. In both of them the modifications commence at the posterior end of the body, resulting in the former in the aggregation of the nephridia corresponding with the setæ in position, and in the latter in the formation posteriorly of large nephridia with internal openings. At the anterior end the small nephridia are present in such enormous numbers, more especially in the segments containing the genital organs, that they line closely the whole body wall.

At the same time, the genital ducts and copulatory pouches are equally highly developed in all the forms. It thus follows that genital ducts, highly developed, and consisting, amongst others, of *vasa deferentia*, traversing no fewer than seven or eight segments, are developed in certain earth-worms (*Perichæta* and *Acanthodrilus*), in which the very numerous primitive nephridia have no internal openings; and in another

(*Megascolides*) in which highly-developed nephridia, with internal openings, are only present in the posterior region of the body. If the hypothesis with which we started be correct, viz., that the *Perichæta* and the *Acanthodrilus* are primitive forms, so far as their nephridial system is concerned, it follows *that in these forms, and hence presumably in all Terricolæ, the genital ducts have no connection with the nephridia, and are not to be regarded as nephridia specially modified to serve the purpose of conveying genital products to the exterior.* A nephridium, before it can function as a genital duct, must have an internal ciliated funnel, and in *Perichæta* and *Acanthodrilus* the nephridia have not reached this stage of development, and yet genital ducts are present, which not only have internal openings, but differ in important respects histologically from the nephridia. The relationship of the openings of the ducts to the setæ, or the absence of such arrangement, can by itself be regarded as evidence of but slight value, and yet it is really the only direct evidence, if such it can be considered, in favour of a connection between the two sets of structures. It is perfectly possible that the same causes which have apparently operated, with the result that a relationship often exists between the nephridial openings and the setæ, operated quite independently to produce the same result in the case of the genital ducts.

Further investigations, especially with regard to the development of the genital ducts, may, if for example it could be proved that the nephridial system of *P. aspergillum*, *Megascolides*, &c., are degenerate, give some clue to the homologies of the genital ducts. At the present time our knowledge seems to indicate that in earth-worms an homology does not exist between these and the nephridia.

EXPLANATION OF THE PLATES.

PLATE 1.

bc	...	buccal cavity.
clt	...	special swellings in the clitellar region.
dil	...	dilatation of alimentary canal.
d p	...	dorsal pore.
d v	...	dorsal blood-vessel.
f o	...	female genital opening.
g z	...	gizzard.
int	...	intestine.
m	...	muscular slips passing from septum to septum.
mo	...	male genital opening.
n	...	ventral nerve cord.
ne	...	small nephridia.
o	...	ovary.
od	...	oviduct.
oes	...	œsophagus.
phar	...	pharynx.
pr	...	prostate gland.
rs^1 rs^2	...	spermathecæ.
rs^1o rs^2o	...	openings of spermathecæ
s^1 s^2	...	setæ.
sept	...	septum.
spg	...	cerebral ganglion.
t^1 t^2	...	testis
tr v	...	transverse blood-vessel.
vd vd^1 vd^2		*vasa deferentia.*
vd^1o vd^2o	...	internal openings of *vasa deferentia.*
vs	...	*vesiculæ seminales.*
x	...	clitellum.

Fig. 1.—Represents a somewhat diagrammatic view of the ventral surface of the worm in the anterior region of the body to show the segments, annuli and openings of the reproductive organs. The openings of the receptacula lie in the seventh and eighth segments, very close to the boundaries of the segments. Each pair has a line on the surface enclosing it. The female openings are on the 14th segment, in front of, and having no relation to the setæ. The male openings (*mo.*) are in the special ridges in the 18th segment, and correspond in position to the innermost pair of setæ. In some worms another ridge is seen occupying the posterior part of the

20th, and anterior part of the 21st segment. The setæ are seen as far forward as the 12th segment, in front of which they cannot be detected. The outlines of the segments are clear, and much more strongly marked than the annuli. The figure shows the tapering anterior end, the swollen part succeeding this, then a somewhat narrower portion, and then the swollen clitellar region.

Fig. 2.—Represents a mature worm, dissected from the dorsal surface. The body wall is cut open by a median incision, and the organs represented *in situ.* Anteriorly are the very strong cup-shaped septa (*sept.*), bound together by special muscular slips (*m.*), and completely concealing the alimentary canal from view. Passing backwards, they gradually become much thinner, and more membranous in appearance, until, in the 19th segment, they entirely lose their muscular nature. In especially segments 15-18 inclusive, the muscular slips are very long, and pass from one segment to another. The septum of segment 15 forms a special covering for the dilatation of the alimentary canal (*dil.*) The blood-vascular system is coloured red. Anteriorly, only the strong muscular lateral vessels (*tr. v.*), or "hearts," can be seen. Behind the 15th segment, the dorsal blood-vessel is seen, with a pair of transverse vessels passing off from each side in every segment to the walls of the alimentary canal (*tr. v.*) In segments 12, 13, and 14 the racemose vesiculæ seminales (*vs.*) project from between the strong septa, and in segment 18 the two prostate glands push aside the septa, which are here membranous and transparent enough to allow of the coiled glands being, in part, seen through them. The walls of the body cavity are lined by an enormous number of small coiled tubules—the nephridia which are especially abundant in the clitellar region.

Behind the part which is cut open, four segments are shown, with the large (very evident dorsal) pores (*dp.*) lying in the lines of division.

Fig. 3.—A diagrammatic longitudinal vertical section through the anterior part of the worm. The alimentary canal runs through the centre, divided into a thickly walled pharynx (*phar.*), as far back as the end of the 4th segment; a short œsophagus and thick walled gizzard in the 5th segment; a tubular portion of the intestine in segments 6-11 inclusive; a dilatation of the intestine in each of the segments 12-18; the tubular intestine behind these. The reproductive organs are represented. The two receptacula seminis in the 8th and 9th segments, with their ducts running forwards so as to open just with the next segment in front of that which contains the organ. Each receptaculum (*r. s. o.*) has a slight diverticulum near the fixed end. The testes, (*t.*, the second one is marked by mistake *vd.*) attached by short stalks to the anterior septa of segments 10 and 11. The two internal openings of the *vasa deferentia* (*vd. o.*, and $vd.^2$ *o.*) The two *vasa deferentia*, running quite distinct from each other (*vd.*, and $vd.^2$) to open in the 18th segment into the prostate gland (*pr.*), which opens to the surface in the same segment (*mo.*) The ovary in segment 13 (*o.*) The internal opening of the oviduct in segment 13 (*od.*) The external opening in segment 14 (*fo.*) The vesiculæ seminales (*vs.*) in segments 11-14 inclusive. The

septa are shown cup-shaped anteriorly. The first one bounds the 5th segment, and no septa are present in front of this. For the sake of clearness, the anterior septa have not been represented in their real thickness. The nerve cord is shown (*n.*) with the cerebral ganglia (*spg.*)

Fig. 4.—A diagrammatic longitudinal horizontal section of the anterior part of the body to show the blood-vessels and the reproductive organs. The latter are shown as in Fig. 3. In addition, in segment 12, is the extra testis ($t.^2$), sometimes present. The dorsal blood-vessel gives off in the posterior part two lateral vessels on each side, supplying the walls of the intestine; and in front of, and including the 13th segment, only one, which runs round the intestine to the ventral vessel. Each of these forms a "heart."

PLATE 2.

al	...	alimentary canal.
al bv	...	lateral blood-vessel to walls of alimentary canal.
al^1 *bv*	...	blood-vessel on dorsal wall of alimentary canal.
b	...	basement membrane layer beneath cells of epidermis.
br c	...	brown cells.
bv	...	blood-vessel.
circ m	...	layer of circular muscle fibres.
ct	...	connective tissue.
cut	...	cuticle.
d bv	...	dorsal blood-vessel.
dv	...	diverticulum of the tube enclosing the dorsal blood-vessel.
dv o	...	opening of diverticulum into tube.
ep	...	cœlomic epithelium.
epi	...	epidermis.
ep^1	...	epithelium of alimentary canal.
gl	...	gland cells of clitellum.
gob	...	modified gland cells of epidermis (Fig. 7), and of epithelium of alimentary canal (Fig. 5.)
gob n	...	nucleus of modified gland cell.
glo	...	opening of gland cell of clitellum.
h	...	lateral blood-vessel modified into heart.
lat bv	...	blood-vessel running by the side of the alimentary canal.
long m	...	layer of longitudinal muscle fibres.
m neph	...	muscle cells at external opening of nephridial duct.
neph	...	nephridial duct.
n	...	nuclei scattered in the basement membrane (Fig. 7.)

n	...	ventral nerve cord.
n^1 n^2 n^3	...	branches of ventral nerve cord.
pig	...	pigment masses.
sept	...	septum.
sept bv	...	blood-vessel supplying septum.
v bv	...	ventral blood-vessel.
y	...	cells in diverticulum of tube around dorsal blood-vessel.
x	...	tube surrounding dorsal blood-vessel.

Fig. 5.—Transverse section through a small portion of the dorsal wall of the alimentary canal in the hinder region of the body. Half of the dorsal blood-vessel (*d. bv.*) is represented, and half of the tubular structure (*x.*) surrounding this, together with two diverticula (*dv.*) arising from it. Of these, the upper one is almost completely filled with large nucleated cells pressed closely together (*y.*), with strands of connective tissue (*ct.*) crossing from side to side. The lower one is almost empty, though some cells still remain, the others having doubtless passed into the tube (*x.*) Both diverticula open into the tube, and the latter is lined internally and externally by cells of the peritoneal epithelium. The walls of the alimentary canal are coated internally by columnar epithelium cells, with spherical nuclei (*ep.*[1]) Amongst them goblet cells (*gob.*) are present. The layer of circular muscle fibres is well developed, and above and below this is a network of blood-vessels, with connecting vessels passing through the muscle layer. More externally lie the longitudinal fibres, and outside these again, the cells of the peritoneal epithelium, modified into brown cells. These are absent in the mid-dorsal line within the tube (*x.*), and from them long thin processes can be traced through the muscle layers to the epithelium lining the alimentary canal. (These processes are finer, and not so clearly marked as in the figure.) Each brown cell has a very distinct spherical nucleus placed where it begins to grow narrow.

Fig. 6.—Section through the modified skin of the clitellar region. The epidermic cells pass inwards, and their pointed internal ends lie in a thick homogeneous basement membrane. In this lies also a great number of red-brown pigment masses, which also pass downwards, surrounding the blood-vessels. Beneath the epidermic cells lies a great development of unicellular glands, each of which has a swollen internal end, and a narrow tubular part passing upwards towards the surface (*gl.*) Some of the glands are much more swollen than others, and each contains a definite nucleus. Amongst them are coiled blood-vessels, and the openings of the nephridia (*neph.*), the inter-cellular part of the ducts of which are very vesicular in nature, with extremely thin walls. Amongst the gland cells are pillars of connective tissue (*ct.*), which divide into forks resting upon the circular muscle fibres. These pillars surround the nephridial ducts, and are continuous with the basement membrane beneath the epidermic cells.

Fig. 7.—Section of epidermic cells, with the cuticle externally, in the region outside the clitellum. The inner ends of the cells pass down into the basement membrane (*b.*), and are not clearly defined. In the membrane lie scattered nuclei, and blood-vessels pass up amongst the bases of the cells, and sometimes form loops (not shown in the figure), which reach very close to the surface. Certain of the cells are transformed into large irregularly shaped goblet cells (*gob.*), the interior of which shows a granular protoplasm with vacuolar spaces, and usually a nucleus pushed to one side. Beneath the basement membrane lie the circular muscle fibres.

Fig. 8.—Diagrammatic representation of one complete segment of the body, and a portion of another behind the 14th segment, to show the blood vascular system. The body wall is supposed to be completely removed, and the septa in position. The alimentary canal is represented as a simple tube, passing through the septa. Above it lies the dorsal blood-vessel (*d. bv.*) This gives off—(1) two vessels in each segment, one on either side, to the septum (*sept. bv.*); (2) two pairs of vessels in each segment, one pair on either side, to the walls of the alimentary canal (*al. bv.*) Beneath the alimentary canal is the ventral blood-vessel (*v. bv.*), from which arises one branch on either side in the posterior part, supplying the anterior face of each septum. From this vessel a branch passes off on each side to the body wall, supplying the nephridia, &c. The ventral blood-vessel, together with the nerve cord, passes through an opening in the septum ventrally, and from the nerve cord arise three branches on each side ($n.^1$ $n.^2$ $n.^3$)

Fig. 9.—A similar representation of segments 12, 13, and 14, and part of 11. Segments 12 and 13 are alike, and show the development of the vascular system peculiar to segments 13-6 inclusive. The dorsal vessel is dilated, and gives off, in the posterior part of the segment, a large vessel (*h.*), which runs round and joins the ventral vessel. This is muscular and dilatable, and forms the "heart." From it arises a branch, which runs towards the dorsal wall of the alimentary canal, and divides into two parts, of which one joins its fellow of the other side, and the two together form a single median vessel on the roof of the alimentary canal ($al.^1$ *bv.*); the other runs downwards, and again divides into two, one of which joins a lateral blood-vessel at the side of the canal (*lat. bv.*), the other passes to the septum, and also gives branches to the body wall. No other branches beyond the "hearts" are in connection with the ventral blood-vessel in these segments. In the 14th segment the vessels are similar to those in the segments behind (cf. Fig. 8), with the exception that the lateral blood-vessel is continued into it, and lies by the side of the alimentary canal, without having any connection with the other vessels in the segment.

By an unfortunate mistake, the two septal blood-vessels arising from the ventral blood-vessel posteriorly, just as in Fig. 8, have been omitted. These are present in every segment behind those in which the hearts are developed.

PLATE 3.

al	...	alimentary canal.
bv	...	blood-vessel.
com	...	nerve commissure.
ct	...	connective tissue.
d p	...	dorsal pore.
d bv	...	dorsal blood-vessel.
ep	...	epithelium lining pharynx.
g	...	ganglion cells.
g f	...	giant fibre.
$l\ n^1$	...	nerve branches to prostomial region.
$l\ n^2$	...	nerve branches to lower lip region.
musc circ	...	circular muscles.
mus	...	muscle fibres.
n	...	nuclei.
ner	...	ventral nerve cord.
ne	...	nerve fibres.
o	...	mature ovum.
$o^1\ o^2\ o^3\ o^4\ o^5$	...	various stages in the development of ova within the ovary.
ph n	...	nerve supply to walls of pharynx.
p	...	stiff pseudopodial processes of cœlomic corpuscles.
sal	...	salivary gland.
sal d	...	salivary duct.
sal o	...	opening of salivary gland.
s o g	...	cerebral ganglia.
sp	...	sperm-blastophore.
sperm	...	developed spermatozoa.
1 2 3	...	early stages in the development of spermatozoa.
sept	...	septum.

Fig. 10.—Transverse section through a portion of the pharynx wall, together with the attached nephridia, modified into salivary glands (*sal.*) The wall consists of epithelial cells surrounded by a mass of connective tissue and muscle fibres, blood-vessels, and nerve fibres. The salivary glands are encased in connective tissue, and resemble in structure nephridia, their ducts being intra-cellular. The ducts join together (*sal. d.*), pierce the walls of the pharynx, and open into the latter ; the cells of the epithelial lining (*sal. o.*), becoming arranged in such a manner as to form a spherical body, through whose diameter the duct runs. Amongst the salivary glands, are bands of longitudinal muscles (*long. musc.*), beneath the pharynx lie the blood-vessels, into which the single ventral vessel (cf. Figs. 8 and 9) divides, and the ventral nerve cord. The latter is cut through shortly behind the spot at which it

divides into the two commissures. Only one giant fibre (*g. f.*) is present so far forwards.

Fig. 11.—Section through a single one of the numerous racemose projections from the surface of the ovary. The upper end of the figure represents the part attached to the body of the ovary, and consists of a syncytium—a mass of protoplasm not defined into cells, and amongst which numerous nuclei are scattered. The nuclei are of various sizes—o^5, o^4, o^3, o^2—with well-marked chromatin fragments, usually, in the above, arranged peripherally. The more highly-developed ova lie on the outside (o^1), and contain large and very distinct nuclei, with nuclear membranes, and one especially large mass of chromatin. The end of the projection is occupied by a single mature ovum, with large nucleus inside, which is a network and a large mass of chromatin, smaller chromatin fragments being scattered through the nucleus. ZEISS, apo. obj. 2·0 mm. Ocular compens. 18. Magnifying power 2250.

Fig. 12.—Section through one of the projecting rays of the testis. The whole structure is a syncytium, amongst which are blood-vessels and numerous strands of connective tissue and muscles. The nuclei are of different sizes, the smallest, which are very minute, being placed in the stem. Sometimes, a line of demarcation can be seen around one or two of the larger nuclei, as in Fig. 12A. The little mass of protoplasm measured ·05 mm., and included two nuclei. ZEISS, apo. obj. 2·0 mm. Ocular compens. 18.

Fig. 13.—A single seta, showing the slightly swollen internal end, to which muscles are attached. The swelling one-third from the free tip and the pointed free end. The setæ are very small, and the one figured measured 5 mm. in length.

Fig. 14.—Represents a diagrammatic longitudinal vertical section through the body, to show the relationship of the septa to the external markings of the segments. The left is the anterior end, and the septa are inserted *behind* the line indicating externally the boundary of the segment. A result of this is that dorsally the septa are pouched in the middle line, into which opens the dorsal pore, which always lies in the line of division between the segments (*d.p.*)

Fig. 15.—A capsule of the vesiculæ seminalis, in which are represented the various stages of development of the spermatozoa seen in the organ at the same time, though not necessarily in the one capsule. The figure, though showing structures, each of which exists, as represented in the vesiculæ seminalis, is hence diagrammatic. 3 shows a mass of cells not long ago split off from the testis. 1 shows the separate cells. 2 show the increase of nuclei without corresponding division of protoplasm and separation into separate cells. *Sp.* show various stages in the development of the spermatospheres, the developing spermatozoa being attached to the central sperm-blastophore. *Sperm.* shows a mass of fully-developed spermatozoa, with their deeply staining rod-shaped heads massed together, doubtless around a sperm-blastophore at one end, and their tails, forming a flame-shaped structure, at the other

end. The developing spermatozoa are contained in capsules of connective tissue of varying size, which are richly supplied with blood-vessels (*b.v.*)

Fig. 16.—Represents the anterior end of the alimentary canal, removed with the nervous system. Dorsally are the cerebral ganglia (*s.o.g.*) On each side pass off the commissures, from which arise (1) near the dorsal end a nerve forwards to the prostomial region, (2) near the ventral surface a nerve forwards to the lower portions of the mouth, (3) at the side of the pharynx a large flat sheet of nervous tissue, which spreads out upon and gives branches off into the walls of the pharynx.

Fig. 17.—Group of cells from the blood (*a*) and from the cœlomic fluid (*b*), the latter with stiff pseudopodial processes.

PLATE 4.

ac bv	...	lateral blood-vessels to wall of alimentary canal.
b	...	basement membrane.
bv	...	blood-vessels.
ct	...	connective tissue.
ct neph	...	special connective tissue fibres around the nephridial ducts.
d bv	...	dorsal blood-vessels.
dv	...	diverticulum of tube surrounding dorsal blood-vessels.
ep	...	cœlomic epithelium.
epi	...	special epidermic cells modified to form the openings for the nephridial duct.
gang	...	ganglion cells.
g f	...	giant fibre.
gob	...	goblet cell.
int	...	intestine.
m	...	special muscle fibres at the sides of the nerve cord.
musc circ	...	circular muscle fibres.
musc long	...	longitudinal muscle fibres.
n	...	nuclei of connective tissue cells surrounding nephridial duct.
neph	...	nephridium.
neph int	...	intercellular portion of nephridial duct.
sept	...	septum.
x	...	tube surrounding the dorsal blood-vessel.

Fig. 18.—Transverse section through the body wall at the point of attachment of one of the smaller nephridia. Externally lie the cuticle and epidermic cells, amongst which are very numerous goblet cells. The epidermic cells have their bases embedded in the basement membrane (*b.*), within which lies the layer of circular muscle fibres,

which are smaller, and thrown into folds externally. Amongst the fibres are numerous blood-vessels. The layer of longitudinal fibres consists of groups of fibres, each of which is angular in section. The groups are surrounded by connective tissue, a layer of which lies between them and the cœlomic epithelium. The nephridium consists of a number of intracellular ducts cut in section, and surrounded by a mass of connective tissue cells, whose outlines cannot be distinguished. Amongst them ramify very many blood-vessels (*b.v.*) A special blood-vessel accompanies the duct through the body wall. The duct is thrown into folds in the latter, and hence presents the appearance of a series of sections. The intracellular opens into the intercellular, just within the circular layer of muscle fibres, and the intercellular part runs straight to the exterior opening through the special spherical structure formed by the epidermic cells.

Fig. 19.—A transverse section through the ventral nerve cord in the posterior region of the body. The section is taken through the part lying between the origins of the lateral nerve branches. The whole is surrounded by connective tissue, which on either side passes off into the supporting laminæ running to the body wall. Special muscle fibres (*m.*) running along each side of the cord are cut through. The nervous matter is distinguishable into two parts, (1) an inner double cord of nerve fibres, and (2) a darker looking outer layer of fibres and ganglion cells, confined to the lateral and ventral aspects. The ganglion cells are large, and as a rule have but one process, which runs into the central part. Dorsally are four giant fibres, each with a special sheath of wavy-looking connective tissue fibres. The cœlomic epithelial cells are more columnar on the ventral than the dorsal surface.

Fig. 20.—A portion of the alimentary canal within the last twenty segments of the body, together with the body wall ventrally. The strong septa at right angles to the canal are seen with their supports radially arranged. The dorsal blood-vessel (*d. bv.*) is surrounded by a white tubular structure (*x*), from which in each segment diverticula, irregularly arranged, are given off. The smaller nephridia are seen to lie in the posterior part of each segment.

PLATE 5.

bv ... blood-vessel.
ct ... connective tissue.
d p ... dorsal pore.
ep ... epithelium of alimentary canal (Fig. 24.) of receptaculum seminis (Fig. 25).
i ... straight portion of larger nephridium.
musc circ ... circular layer of muscle fibres.
musc long ... longitudinal layer of muscle fibres.

$n^1\ n^2\ n^3$	...	lateral nerve branches.
neph	...	smaller nephridia.
neph 1	...	larger nephridia.
neph 1 *o*	...	internal openings of larger nephridium.
sept	...	septum.
sept o	...	ventral opening in septum to allow of passage through of nerve cord.
v bv	...	ventral blood-vessel.

Fig. 21.—Somewhat diagrammatic representation of the ventral part of the body wall in the hinder region of the body, cut away to show the two kinds of nephridia *in situ.* The body wall is flattened out, and all but the lower portion of the septa cut away. In the mid-ventral line is the nerve cord, running through the apertures in the septa, and giving off three branches on each side in each segment. Of these, two ($n^1\ n^2$) lie near the posterior end, and one (n^3) nearly in the middle of the segment. The smaller nephridia form a row between the two anterior nerves, and are numerous. In each segment is a single pair of large nephridia. These lie in front of the nerve branches, and at the same level as the ventral-most amongst the smaller ones. Each has a branch passing forward to the septum through which it passes, and opens by a ciliated funnel. The smaller ones are devoid of internal openings.

Fig. 22.—A portion of the dorsal body wall in the hinder part of the clitellar region cut away, so as to show the dense mass of small nephridia with which it is coated. These are separated into two lots by a median dorsal groove, out of the roof of which pass the dorsal pores (*d. p.*) Each septum is pouched in the median dorsal line, so that the dorsal pore lies slightly in front of the internal attachment of the septum.

Fig. 23.—This, by mistake, is numbered 33. One of the receptacula seminis removed from the body. The surface is marked by longitudinal grooves, and up each side runs a strong muscular slip (*musc.*) Close to the attached end is a diverticulum (*dvt.*), the surface of which is thrown into folds.

Fig. 24.—A transverse section through the wall of one of the intestinal dilatations, showing the folds into which the epithelium is thrown. The columnar cells of either side of a fold being only separated from each other by a network of blood-vessels. Externally lies a thin layer of circular fibres, and outside these the longitudinal fibres, with a small amount of connective tissue.

Fig. 25.—Section through the wall of the diverticulum, taken along a line parallel to the length. The internal surface is coated by a deep columnar epithelium, beneath which is a network of branching blood-vessels embedded in connective tissue. External to this lie, first, the circular fibres, and next, the more strongly developed longitudinal fibres.

PLATE 6.

a	...	bridge of connective tissue, across which passes the *vas deferens*.
b	...	intra-cellular part of the nephridial funnel.
bv	...	blood-vessel.
c ep	...	cœlomic epithelium.
ct	...	connective tissue.
d	...	ventral longitudinal duct connecting the various nephridia.
ep	...	epidermis
ep^1 ep^2	...	special modifications of the epidermic cells at the external opening of the nephridia.
ept	...	columnar ciliated cells lining the oviduct.
int	...	internal surface of the prostate.
m	...	muscle fibres surrounding the nephridial funnel (Fig. 26). Fibres forming a sphincter at the external nephridial opening (Fig. 28).
m o	...	external opening of male organs.
musc circ / *musc long*	...	circular and longitudinal layer of muscle fibres.
neph	...	small nephridia.
neph 1	...	large nephridia.
neph 1 *o*	...	internal opening of large nephridium.
neph o	...	external opening of large nephridium.
n	...	nuclei of cells forming nephridial duct.
n^1	...	special nuclei where the duct enters the epidermis.
ov	...	oviduct.
pig	...	pigment masses.
pr	...	prostate gland.
sept	...	septum.
sp^1 sp^{11}	...	cells forming the inner and outer parts of the walls of the prostate gland.
v d	...	*vas deferens*.
$v\,d\,o^1$, $v\,d\,o^2$	...	internal openings of the *vasa deferentia*.
v o	...	opening of *vasa deferentia* into prostate.
1 2 3	...	the three rows of cells which line the entrance to the nephridial funnel.

Fig. 26.—Section through the nephridial funnel. The upper lip overhangs the lower. The duct, after passing through the septum (*sept.*), enlarges, being still intra-cellular (*b.*) At the open end are three rows of cells (1, 2, 3,) increasing in size towards the outermost, which line the margin of the funnel. These bear long cilia,

which are continued down into the duct, and extend backwards into the body of the nephridium. The funnel is enclosed in a sheath of connective tissue, amongst which lie many circularly disposed muscle fibres.

Fig. 27.—Diagram to show the relationship of the nephridia. Three smaller nephridia are shown, and one larger one. Two of the smaller belong to the same segment as the larger one (*neph.* 1.) These two smaller ones open into a longitudinal intra-cellular duct (*d.*) running beneath the cœlomic epithelium; into this opens the larger nephridium, from which a finer duct runs forward through the septum to the nephridial funnel. A small duct passes beneath the septum to the next segment, opening into the longitudinal duct, which is connected with the small nephridium. The ducts are indicated in the figure by the parts more darkly shaded. From the longitudinal duct arise at intervals (and having no constant relationship to the nephridia) a series of ducts leading down through the body wall. Within the muscle layers, the ducts change from being intra to inter-cellular in nature. The inter-cellular ducts usually branch, and each branch has its own external opening, at which the cells of the epidermis become modified.

Fig. 28.—Section through the external opening of a small nephridium in the clitellar region. The duct, with its very thin walls, is vesicular in nature, and the thin film-like pavement epithelium is distinguishable by its slightly granular appearance, and its large oval nuclei, irregularly arranged. Where an optical section is obtained at the edges, the nuclei are seen to cause bulgings in the wall, which is darkly coloured in the drawing. The epidermic cells are arranged at the external opening so as to form a spherical structure, through the centre of which the duct runs, its walls being continuous with the cells forming the axis of the sphere. These are more darkly stained ($ep.^1$) than the other cells ($ep.^2$), and no nuclei could be detected in them. The cuticle is not prolonged into the duct, and just where the latter enters the epidermis are a few muscle cells, acting, doubtless, as a sphincter (*m.*) Zeiss, obj. apo. 2 mm. Ocular compens. 18. Magnifying power, 2,250.

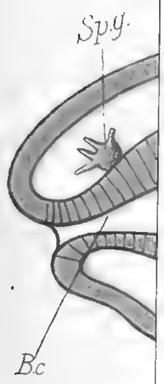
Fig. 29.—Section through part of the wall of the prostate gland. The cells lying internally ($sp.^1$) are more darkly stained than the outer ones, into which they sometimes project, and contain no nuclei. The outer cells ($sp.^{11}$) have swollen ends, and ducts running towards the inner surface of the gland, and contain nuclei. Pigment masses of a yellow-brown colour occur on the outer edge of the organ, beneath the enclosing connective tissue. Zeiss F., ocular 4.

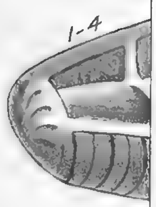
Fig. 30.—Diagrammatic longitudinal vertical section through the segments containing the *vasa deferentia.* The openings into the body cavity of the two are shown, the funnels being composed of cubical ciliated cells, and being hence very unlike the nephridial funnels. The *vasa deferentia* run back quite independently of each other into the prostate gland, certain of the segments being omitted in the figure. The ducts lie in the connective tissue just above the longitudinal muscle

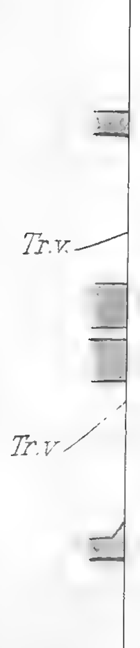
fibres, and never unite to form a single one. They are ciliated up to the point at which they open into the duct of the prostate gland (*v. o.*) The latter is lined by columnar epithelial cells, continuous, at the opening of the structure, with the epidermic cells.

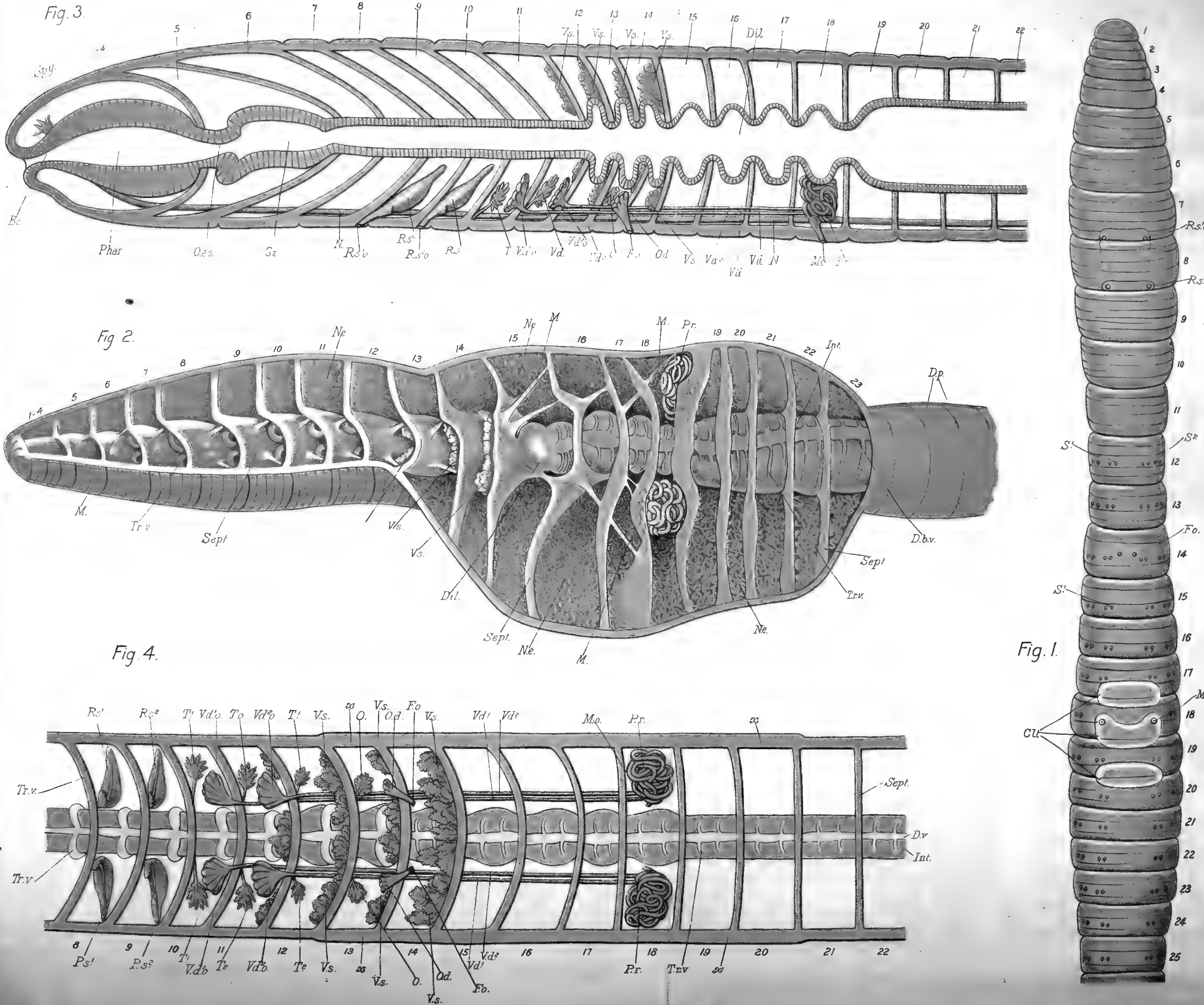
Fig. 31.—Section through the oviduct, showing the deep columnar ciliated cells of which it is formed. Those of the *vasa deferentia* being cubical.

Fig.





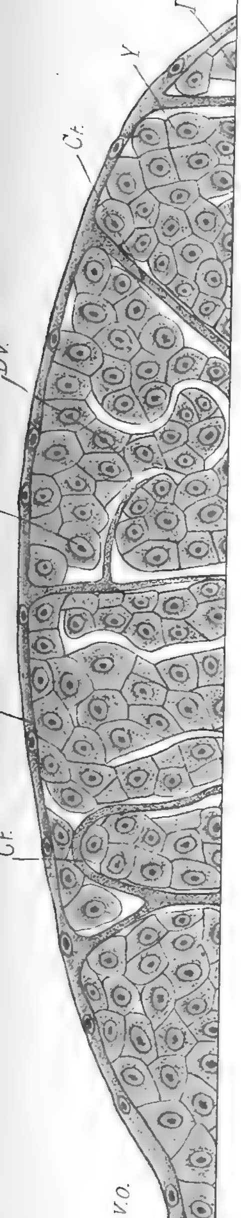


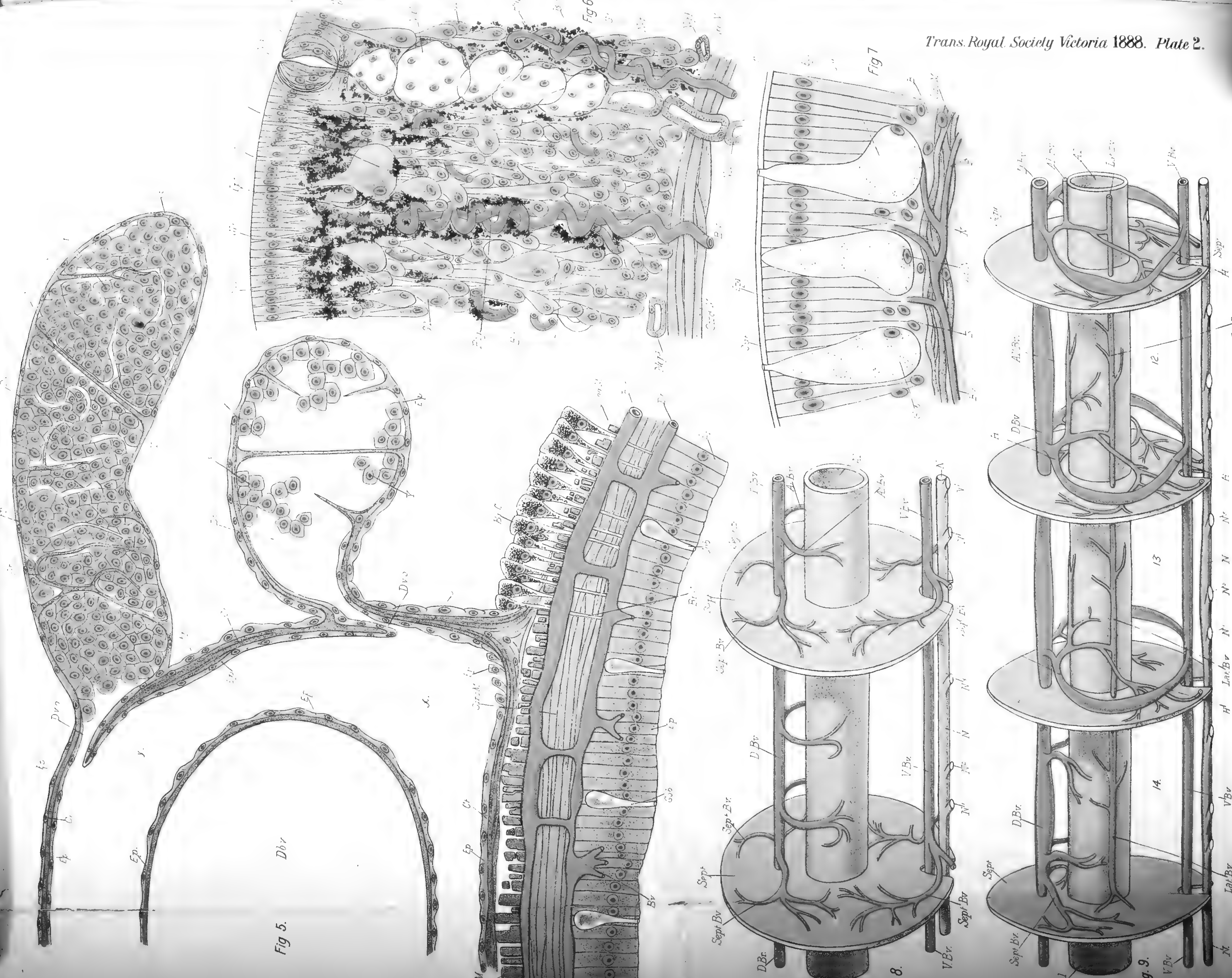


W B Spencer del J.J.Wild Lith.

MEGASCOLIDES AUSTRALIS.

Troedel & Co Print.





W. B. Spencer del, J. J. Wild Lith.

MEGASCOLIDES AUSTRALIS.

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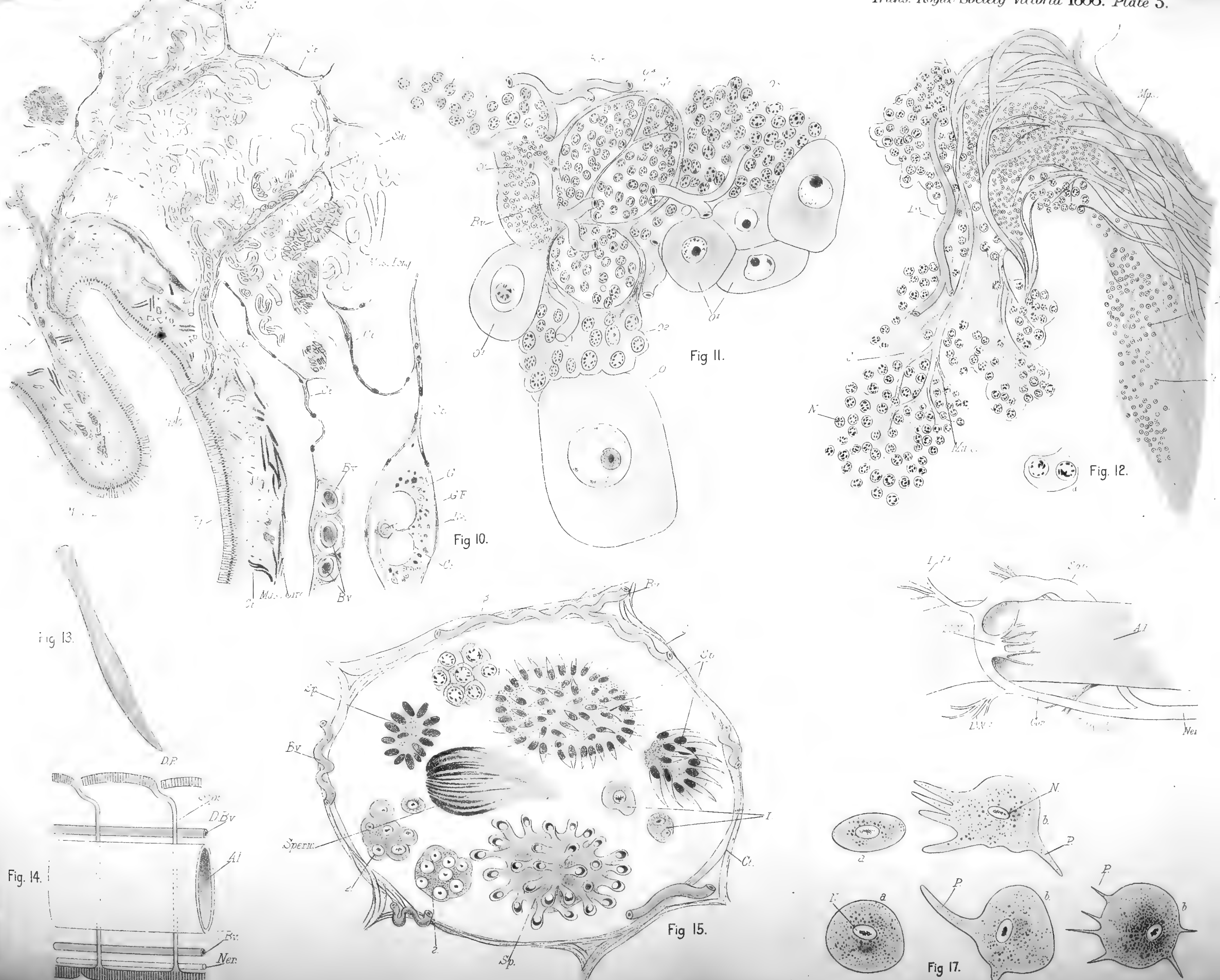
Fig

Fig. 14.



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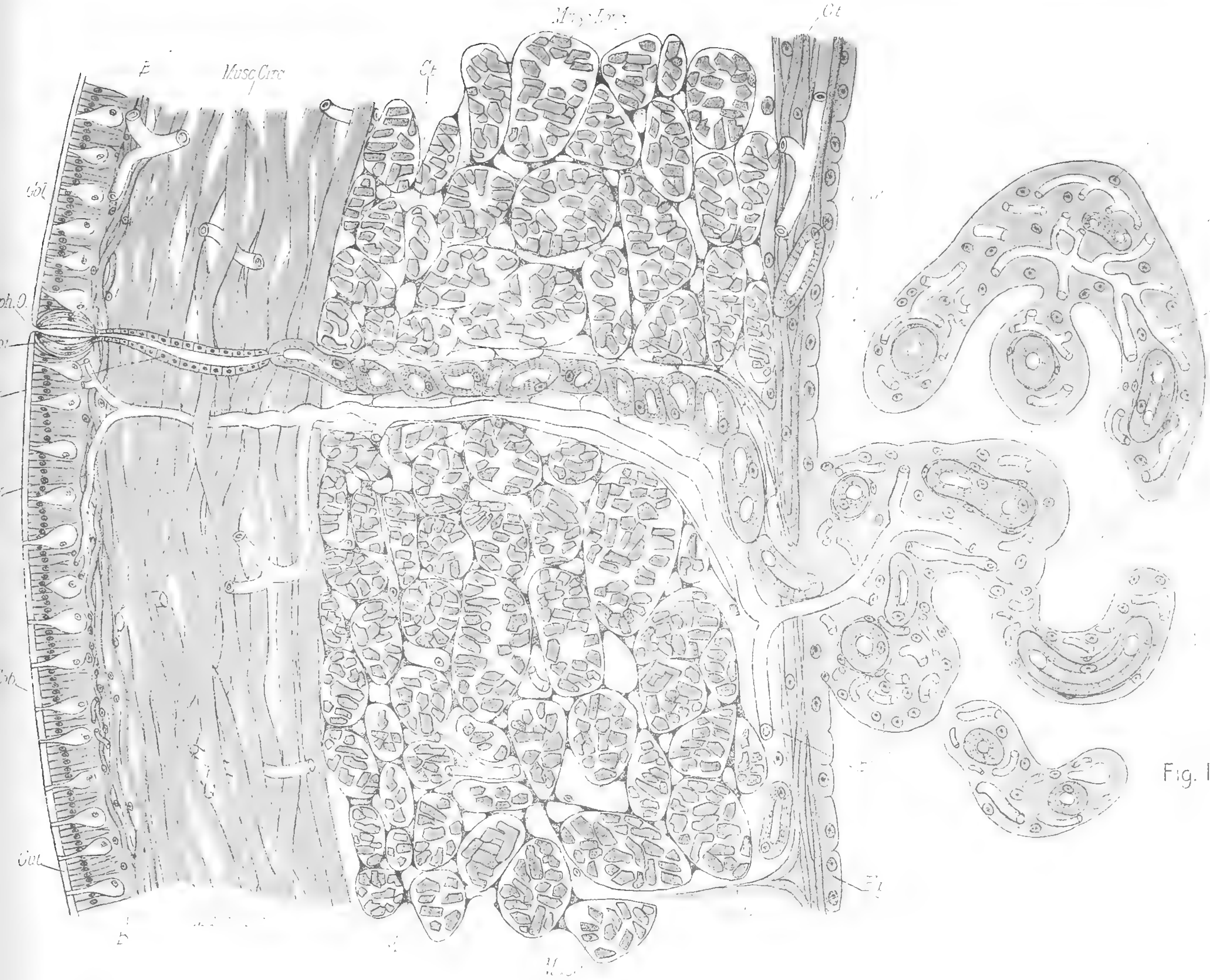

Fig. 18.

Fig. 19.

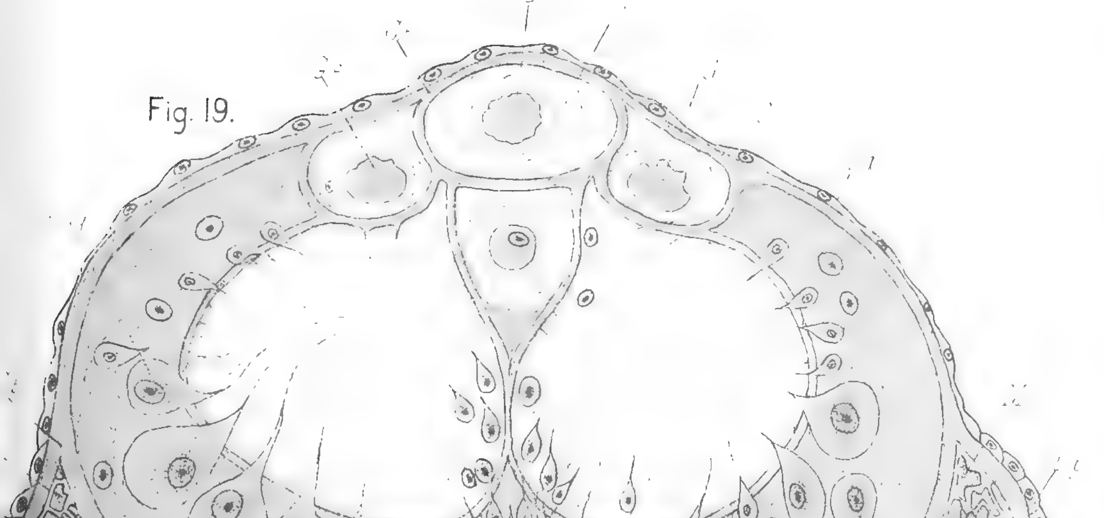

Fig. 20.

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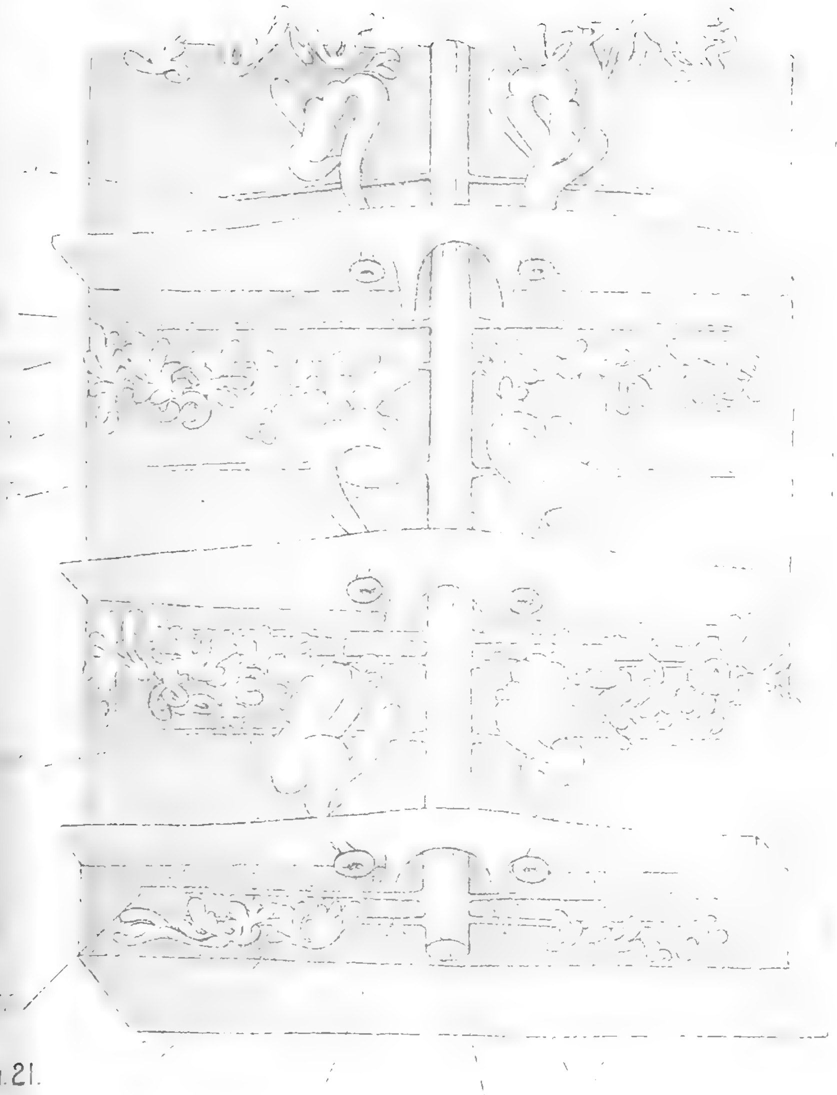


Fig. 21.

Fig. 22

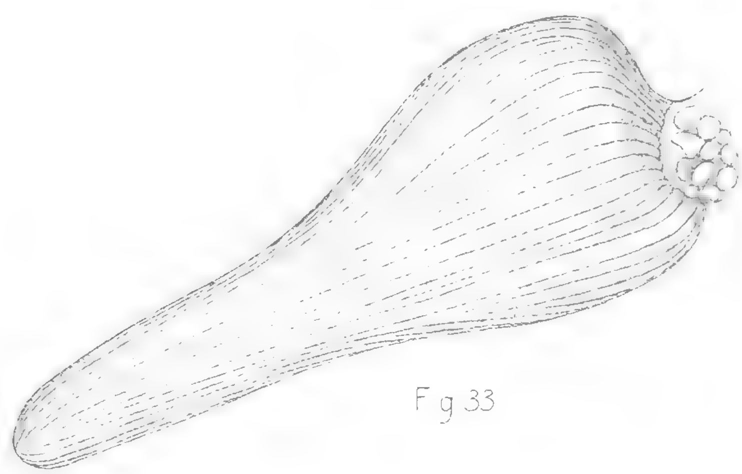


Fig. 33

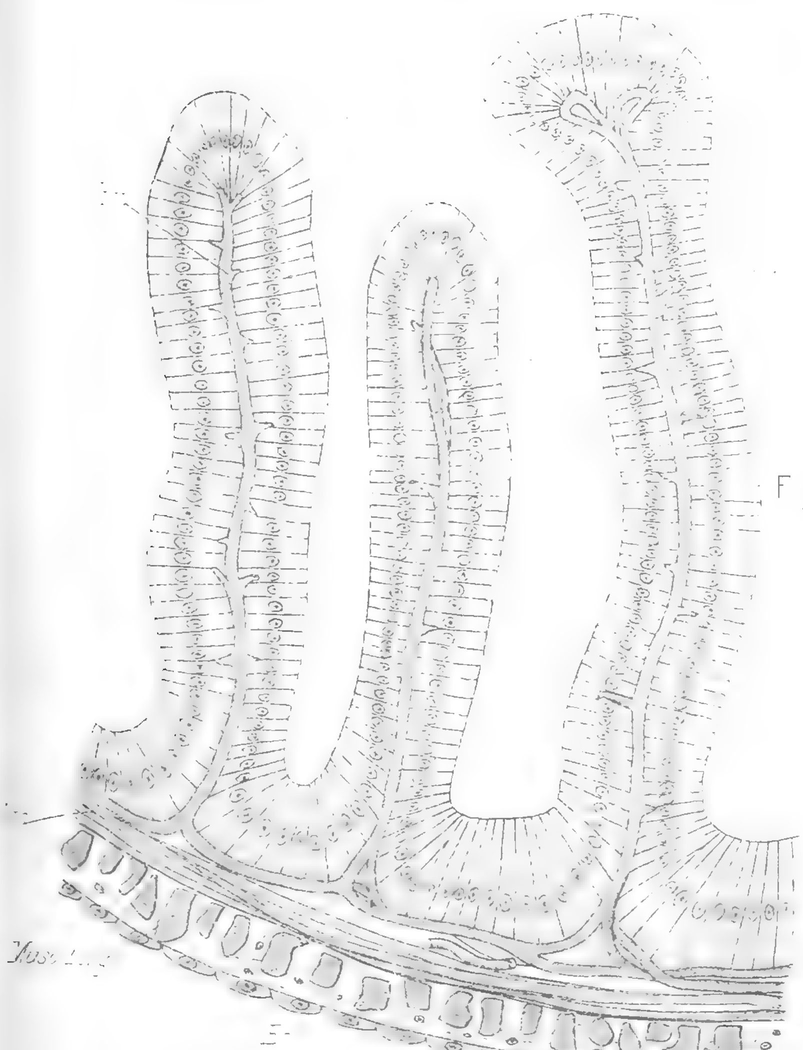
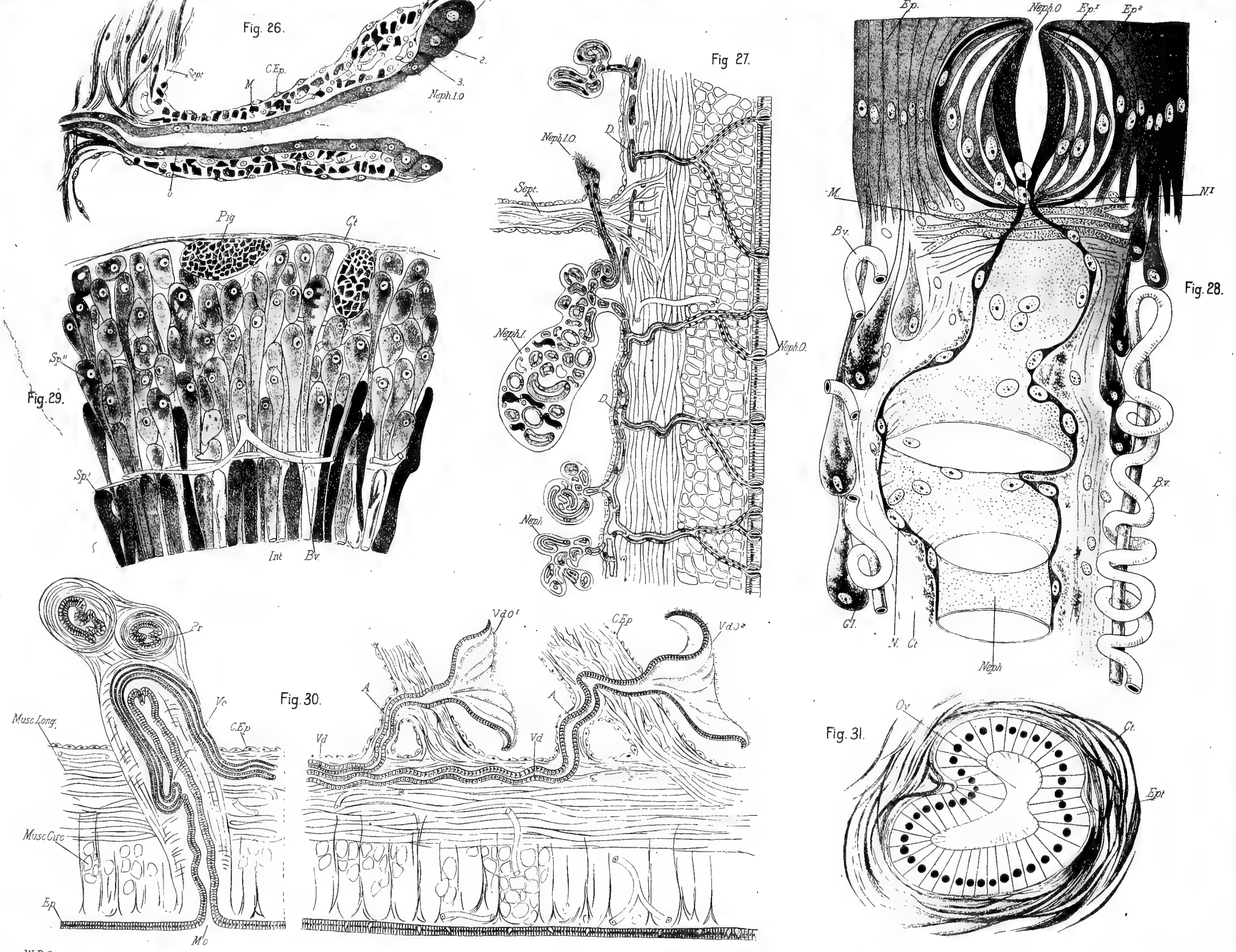


Fig. 24

Fig. 25

J.J.Wild. Lith.

MEGASCOLIDES AUSTRALIS



W. B. Spencer del.

MEGASCOLIDES AUSTRALIS.

Troedel & Co Lith.

TRANSACTIONS

OF THE

ROYAL SOCIETY OF VICTORIA.

VOL. I. PART II.

CONTENTS.

EDITED BY PROFESSOR W. BALDWIN SPENCER, M.A., HON. SEC.

MELBOURNE.
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1889.

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—1889.—

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ARTICLE I.

Records of Observations on Sir William MacGregor's Highland-Plants from New Guinea, by Baron von Mueller, K.C.M.G., M.D., Ph.D., F.R.S.

(Read Thursday, September 12, 1889.)

I. *Phytographic Expositions.*

Ranunculus amerophyllus; F. v. M.

Quite dwarf; root fibrillous; leaves very small, mostly basal, from ovate-to cuneate-lanceolar, entire or some distantly denticulated, as well as the petioles and peduncles imperfectly beset with rigid appressed hairlets; flowers singly terminating the peduncular stems; fruitlets oblique-ovate or dimidiate-roundish, smooth, somewhat turgid, their style much recurved.

Mount Victoria, between small Hymenophyllum and dwarf Danthonia. Nearer related to R. Muelleri from the Australian Alps, than to the two species occurring in the Sunda Islands, namely R. Javanicus and R. diffusus, which grow at from 4000 to 9000 feet elevation. So perhaps other Ranuncles may occur indigenously in New Guinea. I have been unable to identify this Papuan species with any from the Himalayas or from elsewhere. It differs from R. Muelleri, so far as from the few and flowerless specimens can be judged, in the remarkable smallness of all its parts and in the much recurved style. The degree of variability of these plants must however yet fully be ascertained hereafter; thus it would seem that R. dissectifolius is connected as a luxuriant variety with R. Muelleri.

Drimys piperita; J. Hooker, icones plantarum, t. 896 (1852).

Mount Knutsford.—Only fruiting specimens could be obtained, but these precisely agree with the typical plant, discovered at a height of about 11,000 feet on Mount Kini-Balu of Northern Borneo by Sir Hugh Low. As many as eight fruitlets may be seen to proceed from one flower.

Drimys Hatamensis; Beccari, Malesia I. 185 (1877).

Musgrave-Range, from 7000 feet upwards; near the summits of the Owen Stanley's Ranges.

To this species seem referable plants from the above noted localities. As might be expected, those from the cooler altitudes are reduced in size, their leaves thus often being shortened to rather less than one inch, and more recurved at the margin. Moreover it was shown already in 1860 (Plants of the Colony Victoria, p. 21) that D.

aromatica in the mild valleys attains a height of fully 30 feet, whereas in our subalpine zone it becomes dwarfed to a very small shrub, the length of the leaves varying from one to four inches correspondingly. D. Hatamensis in the lower regions is less acrid-aromatic than in the higher. In all specimens, now examined, the number of sepals and of petals is two; the former are ovate-orbicular, the latter hardly as long as the sepals; the stamens number from 20 to 30. In the staminate flowers occasionally also two pistils occur.

Hypericum Macgregorii.

Glabrous; stems erect or ascending, somewhat lignescent towards the base; angules of the branchlets slightly prominent; leaves copious, small, sessile, of rather tender texture, from oval to lanceolar-elliptical, blunt, flat or somewhat incurved, equally green on both sides; flowers on short stalks, singly terminating branchlets; sepals lanceolar-elliptical, entire; petals twice or thrice as long as the sepals, elliptic-cuneate; stamens about twenty; filaments disconnected, unless at the base; hypogynous glandules none; styles three, free, about three times shorter than the filaments; ovulary completely three-celled; placentaries axillary; fruit ovate-ellipsoid, faintly streaked; seeds cylindric-ellipsoid.

At the highest elevations of the Owen Stanley's Ranges among Styphelia and Potentilla.

From a few inches to 1½ foot high.

H. gnidioides differs in more rigid and somewhat longer leaves, shorter petals, one-celled ovulary and therefore sutural placentaries; H. Aegyptiacum has the leaves blunter, the flowers smaller, the stamens distinctly connate into three sets, the hypogynous glandules developed, the styles shorter and the ovules less numerous; H. quadrangulatum is a larger plant in all its parts with cymous inflorescence, with more numerous and fasicular stamens, longer styles and streaked pericarp; H. avicularifolium, H. Aucheri and H. saturejifolium are at once distinguished by their glandularly ciliolated acute sepals. H. Phrygium has biovulate fruit-cells; H. cuneatum possesses broader leaves and mostly axillary flowers; H. repens is very distinct already by its glandularly fringed petals, and all these species differ variously in respective other characteristics. Blume in 1825 and 1852 indicated several species from Java, irrespective of H. Japonicum, but they belong to a section of the genus (Norysca) different to that (Euhypericum) of our new and probably endemic Papuan species, the genus Cratoxylon being more developed in the Sunda Islands than Hypericum.

Elaeocarpus latescens.

Leaves conspicuously stalked, of very firm texture, mostly obovate but rounded towards the upper end or even somewhat truncate, almost flat, minutely and distantly denticulated, above soon glabrous, beneath bearing a brownish close vestiture and there prominently and ascendingly costulated; flowers small, several or only few in mostly axillary racemes; stalklets hardly longer than the sepals and as well as these and the peduncles closely beset with brownish hairlets; sepals linear-semilanceolar; petals fringed to nearly one-third of their length, imperfectly invested with appressed colourless hairlets outside; stamens 16-20; anthers pointed, about as long as the filaments; ovulary as well as the lower part of the style beset with appressed hairlets.

On the Musgrave-Range, at an elevation of about 8000 feet.

E. coriaceus (Hooker icon. 154, E. obovatus, Arnott 1836 not G. Don 1831) approaches in form of leaves and in several other characteristics to this Papuan subalpine species; but the absence of copious vestiture, the shorter petioles, the mostly terminal racemes, the somewhat larger flowers, the shorter filaments and the blunt anthers distinguish that Ceylon congener well; the fruit of our new plant is not yet known, and may also be very different. E. foveolatus possesses the vestiture of E. latescens, but is otherwise still more distinct from it. E. ferrugineus, which comes evidently near Blume's E. tomentosus, is larger in all its organs and has acuminate leaves. E. Jackii (Monocera ferruginea, Jack in Hooker's bot. Miscellany II., 86) differs in much larger and pointed leaves, and is likely also distinct in its flowers, they remaining hitherto undescribed. E. montanus is easily separable by its larger leaves with foveoles at the midline beneath and with lesser vestiture, by somewhat broader sepals, by longer petals much beset with hairlets on both sides, by blunt anthers and perhaps also by its fruit.

What Miquel mentions as conspecific with E. reticulatus from Timor, is probably referable to E. Arnhemicus.

Sagina donatioides.

Cushionlike-tufted, glabrous; stems very short, slightly rough; leaves crowded, rigid, quite short, spreading, with broad base sessile, linear-semilanceolar, channelled, pungent, thickened and paler at the margin; flowers solitary, terminal, on very short stalks; bracteoles none; sepals linear-semilanceolar, concave, very acute, somewhat turgid at the base; petals hardly semiemersed, from a cuneate base ovate, very tender, long-persistent; stamens ten, considerably shorter than the petals; anthers yellowish; fruit ellipsoid, five-cleft; seeds renate-ovate, dark-brown, slightly rough.

Summits of the Owen Stanley's Ranges.

Leaving the flowers out of consideration, the aspect of this plant is precisely that of Colobanthus Benthamianus. On first sight it might be placed generically into Arenaria, on account of its close resemblance to species of the sections Dolophragma and Eremogone; but the fruit in all instances, which come under my notice, is regularly five-cleft, precisely as in Colobanthus, the valves however being placed opposite to the sepals; this latter characteristic, as well as the presence of petals and the double number of stamens, removes the plant from Colobanthus. It fits fairly well into the section Spergella of Sagina, inasmuch as the petals of S. nodosa are also much surpassing the sepals, and as the number of stamens is likewise 10.

Drapetes ericoides, J. HOOKER, icones plantarum t. 895 (1852).

Mount Musgrave, and also in the highest region of the Owen Stanley's Ranges up to Mount Victoria.

The specimens, obtained now, are still taller than that figured from Kini-Balu, some measuring nearly a foot in height, but others are partly procumbent and then ascendant.

Rubus Macgregorii.

Branchlets closely beset with short spreading colourless hairlets and bearing small recurved prickles; leaves on short stalks, mostly trifoliolate; stipules narrow-lanceolar, almost glabrous, with hardly any denticulations; leaflets comparatively small, rather firm, almost sessile, cuneate-obovate or verging into a rhomboid form, duplicately crenate-serrate, occasionally short-lobed, often unarmed, above almost glabrous, beneath slightly paler and along the there prominent venules beset with soft hairlets; flowers on terminal short peduncles two or three; pedicels and peduncles bearing a close vestiture and some prickles; calyx unarmed, outside imperfectly beset with short appressed hairlets, its segments acuminate, entire; petals about as long as the calyx, nearly glabrous; stamens somewhat shorter than the petals; styles glabrous; receptacle densely invested with hairlets; fruitlets about fifteen, rather large, almost glabrous; endocarp reticular-rough.

Mount Victoria.

To judge from the two specimens received, which are but few inches long, this would seem a dwarf almost herbaceous species, in aspect much like R. fragarioides and R. Thompsoni, so as to resemble more a strawberry-plant than a bramble. It cannot be regarded as identical with either of the two congeners mentioned, differing from R. Thomsoni in neither very membranous nor much acuminated leaflets, in broader stipules and in not invested fruitlets; while from R. fragarioides it may already be distinguished by being provided with prickles, the leaflets not being quite glabrous, the stipules being narrower and pointed, and by having more numerous fruitlets; from R. alpestris it seems also quite distinct in dwarf growth, rather smaller leaflets, more copious and always glandular indument, absence of prickles on the calyces (that characteristic perhaps unreliable) and larger petals. The leaflets would most likely be sometimes increased to five, as in some of the allied plants. The affinity to R. Gunnianus, R. arcticus, R. saxatilis and some other of the dwarf kinds of Rubus is more distant still.

Rubus diclinis.

Branches elongated, bearing numerous minute prickles and a dense vestiture consisting of spreading short pale-brownish hairlets; leaves mostly trifoliolate; leaflets on conspicuous stalklets, almost or quite unarmed, of firm texture, ovate or verging somewhat into a roundish form, often short-acuminate, narrowly and closely denticulated, above much wrinkled and bearing scattered hairlets, beneath prominently costulated as well as reticular-venulated and bearing a short soft vestiture; racemes axillary, irregular, densely beset with short spreading hairlets; peduncles prickley, bearing besides the pale-brownish indument also dark glandular-tipped bristlets; bracts narrow; flowers quite small, only imperfectly bisexual; calyx unarmed unless at the base, its segments deltoid-semilanceolar, without any acumination, also inside invested; petals enclosed or hardly exserted, beset with hairlets towards the base; receptacle with a penicillar indument; stamens rather numerous; filaments ciliolated; pistillate flowers containing only very minute rudimentary stamens around the disk; ovularies about twenty, densely invested; styles glabrous upwards; pistils of the perfect staminate flowers diminutive or rudimentary.

Mount Knutsford and Mount Musgrave.

The diclinism, though not quite absolute, brings this species systematically near to R. Australis and R. Moorei, from both of which however it is already separable in form, denticulation and lesser rigidity of the leaflets, further in simpler inflorescence and perhaps also in fruit, that of R. diclinis remaining unknown.

Potentilla leuconota; D. Don, prodomus florae Nepalensis 230 (1835).

Rhizome thick, somewhat tortuous and woody; stems erect or in some instances partially depressed, occasionally dwarfed, as well as most other parts of the plant bearing close appressed vestiture of whitish or greyish rather shining hairlets; leaves more numerous at the base of the stem, fewer and distant upwards; stipules broadish, incised at the upper end, some much dilated; leaflets rather small, sessile, mostly obovate-elliptical, by pointed ascending denticles serrulated, invested on both sides, the upper gradually decreasing in size, with few or without any intervening smaller leaflets, those of the lower leaves rather numerous, those of the successive upper leaves less in number or but few; flowers rather small, never numerous; peduncles one-flowered slender, somewhat elongated, singly terminal or one or more axillary; involucellar bracts about as long as the segments of the calyx, usually somewhat incised at the upper end; receptacle densely beset with short hairlets; petals yellow, slightly surpassing the calyx; stamens uniseriate; filaments very short, glabrous, broader towards the base; styles glabrous, very short, without any turgidity, inserted near the middle of the ovularies, early deciduous; fruitlets numerous, very small, oblique-ovate, glabrous.

Owen Stanley's Ranges and Mount Musgrave from 8000 to 13,000 feet elevations.

P. Mooniana can be distinguished by a less close indument, by more regularly developed smaller leaflets interjacent to the larger, by less pointed denticles of the leaflets, by usually entire stipules and bracts, as well as by almost paniculate flowers; P. Siemersiana is similarly different, except that it shows the silk-like vestiture of P. leuconota also. S. peduncularis has the flowers and fruitlets larger. It was the intention to describe this as a new endemic species, because the flowers in the Papuan specimens are not subumbellate and much more than one-third inch in diameter and the fruitlets very numerous. But as Sir Joseph Hooker refers a Potentilla, gathered at an elevation of 11,000 feet on Kini-Balu, also to P. leuconota, it would seem, that the Papuan plant belongs to the same specific cyclus of forms in a genus, acknowledged to be particularly prolific in varieties. Imperfect specimens of a similar Potentilla with less dense but longer indument have been gathered along with P. leuconota, of which it may be an extreme form. A new disposition of the species of Potentilla has been indicated by Dr. W. O. Focke this year (Abhandl. naturwiss. Verein Bremen x, 411-420 t. vii.)

Metrosideros Regelii.

Glabrous; branchlets quadrangular; leaves small, very firm, short-stalked, from cuneate-to orbicular-ovate, flat or at the margin somewhat recurved, conspicuously and somewhat pellucidly dotted, shining and dark-green above, paler beneath; flowers in the axils of the uppermost leaves solitary, on very short stalks; bracteoles minute, appressed to the calyx, almost ovate, slightly ciliolated, deciduous; tube of the calyx towards the base hemispheric and faintly triangular, towards the summit expanding beyond the ovularly; lobes of the calyx very short, semiorbicular; petals quite small, membranous, roundish, very slightly contracted at the base, rosy-red; stamens much longer than the petals, about 15, all in one row; filaments red; anthers ovate-ellipsoid, yellowish, almost centrifixed, horizontal; style about as long as the filaments; ovularly three-celled; ovules several in each cell.

On Mount Musgrave at an altitude between 7000 and 8000 feet.

Although the fruit remains unknown, a generic position can be allotted to this plant with fair safety; it is probably of dwarf stature. Leaves $\frac{1}{4}$ to $\frac{1}{2}$ inch long. Petals measuring only about $\frac{1}{8}$ inch. Stamens and style fully $\frac{1}{2}$ inch long. Ovules fixed to axillary placentaries. The plant in some respects reminds of M. scandens, M. hypericifolia and M. buxifolia. The ovularly and fruit of a few congeners are five-celled. Whether Myrtella also belongs to this genus, must hereafter be shown, when the fruit has become known. It is worthy of remark, that no species of Metrosideros has been discovered anywhere in continental India. With this new elegant and comparatively hardy plant of probably easy raising, I have specifically connected the name of Dr. Edward von Regel, in congratulatory remembrance of his recent semicentenary professional jubilee, and in recognition of his vast services for phytography and horticulture, rendered in highly influential positions as Councillor of State of the Russian Empire, and as Director of the Imperial Botanic Garden of Petersburg.

Epilobium pedunculare, Cunningham in Annals of Nat. History, III., 32 (1838).

Crest of the Owen Stanley's Ranges.

The plant from thence accords better with that above named, than with any other form. Critical specific limitation may involve however an alteration of the name also for this Papuan plant, if we resort to the former more conservative circumscription of what then were called species in this genus. Observations concerning this subject were offered 1864 in my publication on the "Vegetation of of the Chatham-Islands" pp. 15, 16. Professor Haussknecht in his elaborate "Monographie der Gattung Epilobium" (1864) has given on Tafel xxiii a good delineation of E. pedunculare. Dr. Beccari mentioned already the occurrence of Epilobium in New Guinea, having found one high up on Mount Arfak, probably this species, which then, as isolated, could not be there affected by the otherwise so frequent hybridism in this genus. The Papuan plant, here noted, is not cognate to any of the Himalayan congeners. As yet no representative of the genus seems to have been found in the Sunda-Islands.

Helicia Cameronii.

Branchlets beset with short crisp greyish hairlets; leaves comparatively small, on very short stalks, scattered, elliptic-or lanceolar-ovate, soon glabrous, entire, hardly paler beneath, flat or at the margin slightly curved, their secondary venules much concealed; racemes often lateral, short-stalked, closely many-flowered; pedicels very short, connate at their base, as well as the rachis provided with a short vestiture; bracts very small, almost semilanceolar, quickly deciduous; petals long, soon glabrous; anthers nearly sessile, slender, conspicuously exceeded by the semi-elliptic apex of the connective; style long, as well as the ovulary glabrous; stigma rather elongated, not much thicker than the style, faintly furrowed; hypogynous scalelets quite connate into a slightly four-lobed disk; ovules lateral.

Mount Knutsford.

The leaves are smaller than those of any other species, measuring, even when well developed, only about one inch in length, notwithstanding the flowers being as large as those of H. robusta, to which species however this Papuan plant is allied in many respects, thus also in the hypogynous disk not being divided into four distinct portions. But the nearest systematic position can with certainty only be indicated, when hereafter the opportunity arises for obtaining fruits also.

This Papuan species is the only known as yet from a subalpine region; whether it descends to lower elevations, and then assumes a greater height and also larger dimensions of the leaves, remains to be ascertained. The genus extends far beyond the tropics, thus one species to the Manning-River in 32° S., another to a region in Japan at 33° N. This, the only Papuan congener as yet known, is dedicated to J. B. Cameron, Esq., the second in command during Sir W. Macgregor's expedition, who aided much in obtaining in the course of that enterprise many botanic specimens, and from whom, as a professional surveyor, we may expect further and perhaps early geographic discoveries in the great Papuan Island.

Galium Javanicum; Blume Bijdragen tot de Flora van Nederlandsch Indie, 943 (1826).

Crest of Owen Stanley's Ranges among Epilobium.

To this is very closely cognate our G. australe; when De Candolle described the latter (1830), he had not seen Blume's plant; in Java it occurs also only on high mountains.

Mikania scandens; Willdenow, species plantarum III, 1743 (1803).

Mount Musgrave.

Recorded previously from New Guinea by Martelli; not yet found in Australia. The only one of numerous American species, which wandered away to the eastern hemisphere, where it has retained as an isolated species its constancy since centuries, not developing, as might have been expected, new forms.

Anaphalis Mariae. (Leontopodium Mariae, F. v. M. Coll.)

Procumbent or ascendent, sometimes rather extensively creeping; stems slender, simple or few-branched, bearing a dense white vestiture; leaves small, spreading or turned downward, from lanceolar to broadish-linear, always acute, entire, sessile, recurved along the margin, above glabrous or glabrescent, beneath densely beset with somewhat cottony white hairlets; headlets of flowers few, at or near the upper end of the stem or branches, occasionally two or solitary, mostly short-stalked; involucral bracts white at least upwards, the majority narrowly lanceolar-elliptical, glabrous except near the base, soon spreading; the inner radiating, towards the base brownish cuneate and almost stalk-like; receptacle small, depressed, glabrous; flowers numerous, the perfect staminate towards and at the centre, the extremely thin perfect pistillate flowers towards and at the periphery; achenes cylindric, laxely beset with minute hairlets; pappus-bristlets fully as long as the corolla or rather longer, uniseriate, white, delicate-capillary, slightly scabrous, those of the staminate flowers denticularly somewhat thickened towards the upper end.

Mount Knutsford with Trigonotis.

The specific name of this new species is gladly chosen in honour of one of the accomplished daughters of the discoverer of this plant, by his special request.

Anaphalis nubigena from the Himalayas differs in more erect growth, in longer, less copious and less spreading leaves, with a tomentum also on the surface, and further in more venular-streaked involucral bracts.

A. lanata (Gnaphalium lanatum, G. Forster, prodr. 55 ; G. Keriense, Cunningham in J. Hook. Fl. New Zealand I, 138; Helichrysum micranthum, Cunningham in D. C. prodr. VI, 189), is still more alike the Papuan plant, diverging mainly in larger and less rigid leaves and in less denticularly rough pappus-bristlets, the anantherous flowers being very numerous in some of the headlets almost to the exclusion of the bisexual flowers, and the extensive dimorphism being also otherwise clearly perceptible. A prostrata (Helichrysum prostratum, J. Hooker, Flor. Antarctic. I, 30 t. 21 ; Gnaphalium prostratum and G. bellidioides J. Hooker, Handb. of the New Zealand Flora I, 152), is another closely cognate plant, but with more appressed vestiture, broader and blunter leaves and solitary often only short-stalked capitulum ; also this species shows sometimes more anantherous flowers than others in the headlet. The same can be said of A. trinervis (Gnaphalium trinerve, G. Forster, prodr. 55), which includes G. Lyallii as a variety, and resembles very much the Himalayan A. triplinervis. All these plants have the fruits of the bisexual flowers imperfectly developed. It may be added yet to these notes on Anaphalis or Antennaria, that the Gnaphalium fasciculatum (Buchanan in Transact. N. Zeal. Inst. 529, plate xix.), reminds much of the Tasmanian Antennaria Mereditthæ. Whether the capitula of all the species of Raoulia are really monomorphous, can be best ascertained by extensive field-observations in the various native haunts of these plants. The writer having had ample opportunities for observing the very numerous gnaphaloid plants of Australia during more than forty years in their native localities, may be entitled to enunciate some independent views on the limitation of genera within this tribe of Compositæ. It seems to him, that a primary characteristic might be derived for Cassinia, Filago, Helipterum, Helichrysum and Gnaphalium, in *plants with flower-headlets all of one form*, and for Antennaria, Leontopodium and Anaphalis in *plants with flower-headlets always of two forms*, Raoulia being a doubtful genus between these two series, rather entitled to merge into the second than into the first. Gnaphalium, the earliest of these, as limited in recent times, stands to Helichrysum almost in the same relation as Erechtites to Senecio, if its section Omalotheca became transferred to Helichrysum, a measure not objectionable, because we have in Australia species of Helipterum and Helichrysum with quite the involucre of the legitimate Gnaphaliums. Filago offers an approach to Cassinia, in which the involucre is also variable. Far more difficult it is, to settle the generic limits of the second group, now indicated, and indeed the question remains open for discussion, whether Antennaria would best be upheld in the original circumscription, given by the elder Gaertner as far back as 1791, he including within that genus also the subsequent Leontopodium. It was further shown by myself (Report of the Royal Society of Tasmania, 1881, p. 44-46), that Antennaria Leontopodina of the North-Western Himalayas is merely a state of Leontopodium alpinum, the habit of that genus being repeated even within Raoulia by Helichrysum Leontopodium. It is equally difficult to keep Anaphalis apart from Leontopodium and thus indeed also from Antennaria, of which I consider it a section, although on this occasion I have for convenience's sake maintained that genus; but the best proof of its intenability is given by the fact, that species from New Zealand, which are extremely similar to some of the Himalayan kinds as well habitually as structurally, have hitherto stood in Gnaphalium or in Helichrysum, as indicated above through comparisons with the Papuan congener. Helipterum corymbiflorum bears some resemblance to large-radiated species of Anaphalis, while a further approach to that genus is offered by the section Schoenia of Helichrysum and by Pteropogon of Helipterum.

Aster Kernotii.

(Olearia Kernotii F.v.M. MSC.)

Somewhat shrubby; branchlets densely beset with a thin floccous brownish vestiture; leaves numerous, on very short stalks, of quite firm consistence, rather long, from broad-linear to narrow-elliptical, closely crenulated and often along the margin repressed, above glabrous and rugulous, beneath bearing closely intricated whitish hairlets, at the apex blunt or hardly pointed; headlets of flowers small, mostly in terminal short panicles; involucral bracts forming several rows, the outer almost semi-lanceolar, the inner narrow-lanceolar; corollas not wholly glabrous, those of the marginal flowers with rather short ligular expansions; achenes narrow, somewhat compressed, scantily beset with hairlets; pappus-bristlets about 30, the outer generally thinner and somewhat shorter.

Mount Musgrave.

Had this been found in Australia, it would have been considered an Olearia, simply on phytogeographic account. It seems however preferable, to maintain the genus Aster in its ampler demarcation, though the abolishing or sustaining of Olearia as a genus remains optional. It may however here be observed, that the shrubby growth of Olearia proves a fallacious characteristic inasmuch as a dwarf form of O. ciliata is flowering and fruiting at only a few inches height. The regular and blunt crenules of the leaves give this Papuan plant quite a remarkable aspect. The style of some of the central flowers remains often undivided. On the crest of the Owen Stanley's Ranges occurs an allied plant with flat elliptic leaves.

This remarkable plant is dedicated to Professor Will. Kernot, M.A., a son of Australia, and now President of the Society to whom this essay is submitted.

Vittadinia Alinae.

Rhizome ramified, descending or somewhat procurrent; stems short, rather hard; leaves quite small, crowded on short somewhat clasping petioles, beset as well as the branches and most other parts of the plant with jointed spreading hairlets, cuneate or verging into a lanceolar or rhomboid form, flat at the margin, often deeply and acutely denticulated at and towards the upper end; headlets of flowers small, singly terminating slender conspicuous peduncles or occasionally almost sessile; involucral bracts in about three irregular rows, narrow-lanceolar, somewhat pointed, slightly scarious at the margin, the outer often more than half as long as the inner; peripheric flowers nearly biseriate, their ligular expansions linear-lanceolar, about as long as the tube; stigmas of the central flowers extremely narrow, pointed, subtle-barbellate; achenes when well developed moderately compressed, bearing minute appressed hairlets; pappus-bristlets in two rows, ciliolar-rough, the outer mostly half as long as the inner.

On Mount Victoria, among Styphelias. Gladly named by desire of the discoverer in honour of one of his young daughters.

Some individual plants, even when full in flower, only two inches high, others reaching six inches in height.

I have left this plant reluctantly out of the genus Aster, into which I had first placed it, and to which it approaches fairly well in its involucre and pappus; the augmented number of ligulate flowers bring it rather to Erigeron, it being indeed not very distinct in some respects from our southern Erigeron pappochromus; but the finely pointed stigmas of the bisexual flowers are particularly those of Vittadinia, of which it has also more the aspect, so that it may be best to keep the plant in that genus.

The late Dr. Wilhelm Hillebrand offered some very apt remarks on Vittadinia and Tetramolopium as regards their generic limits in his Flora of the Hawaian Islands, p. 197 (1888). Perhaps it would be advisable, to reduce Vittadinia to Erigeron altogether, its peculiar stigmas occurring also in the Oritropium of that genus.

Vittadinia macra.

Stems generally several, erect or recumbent towards the base, branchless or variously branched; leaves very small or minute, crowded, mostly appressed, as well as the peduncles and bracts bearing an imperfect lanuginous indument, from broad-linear to narrow-elliptic, with broad clasping base sessile, somewhat concave, blunt, entire; headlets of flowers small, singly terminal, on short peduncles or almost sessile; involucral bracts in about three irregular rows, broad-linear, bluntish or hardly pointed, the outer often more than half as long as the inner, all without conspicuously scarious margin; peripheric flowers nearly biseriate, their ligular expansions rather broadish, hardly longer than the tube; stigmas of the central flowers extremely narrow, subtle barbellate; achenes bearing minute appressed hairlets, those of the central flowers remaining seedless and thus very slender; pappus-bristlets in two rows, ciliolar-rough, pale-brownish, the outer generally more than half as long as the inner.

Summit of Mount Victoria.

In outward appearance this plant is much like Drapetes ericoides, but the leaves are persistent. The extreme thinness of the stigmata of the bisexual flowers may be connected with the imperfect development of their fruit; in the latter respect this and the foregoing species approach the South-African genus Steirodiscus. There are reasons for placing both species either in Aster or Erigeron. Only after a detailed re-examination of the vast number of asteridous plants, now known, it will be possible, to fix with precision the respective generic positions of all of them; even if genera could in every instance be rigorously defined. Large generic complexes with any needful subgenera are for practical purposes always the most convenient, and are least taxing to the memory of the systematist.

Myriactis bellidiformis.

Perennial, generally dwarf, greyish from a close silk-like vestiture; leaves comparatively small, rather firm, mostly or all basal, on slender petioles, elliptical, distantly and minutely glandular-denticulated, flat or at the margin somewhat recurved; stems unbranched, peduncular, but often bearing one or two leaves smaller than the others and particularly narrower; headlets of flowers singly terminal; bracts in two or three rows, considerably overlapping, nearly lanceolar, almost without any conspicuous scariosity at the margin; estaminate flowers in several rows, the ligules of their corollas quite narrow, their tube very short; stigmas of bisexual flowers capillary-narrow; achenes narrow-elliptical, truncate, thinly margined, glabrous, those of the central flower imperfectly developed.

Summit of Mount Victoria with Ranunculus. Fibrilles of the root thickly filiform. Remnants of the petioles persistent, disintegrating into setular fibres. Leaves generally from two-thirds to one inch long, often exceeded in length by their stalks. Stems from few to several inches long. Headlets of about half an inch width. Involucral bracts of rather firm texture, mostly acute. Peripheric corollas about a quarter of an inch long, often longitudinally incurved; their style and stigmas very much shorter. Anthers blunt at the base. Fruits very small, not seen in a ripe state.

It has not been deemed desirable, to exclude this plant from the genus Myriactis merely on account of the sterility of at least a portion of the central flowers and the extreme thinness of their stigmas. But we might for this and the following species establish a subgenus under the name *Hecatactis,* which—if deemed preferable—could be raised to generic rank. Myriactis in its typical forms, as occurring in Persia, Iberia, Turkestan, the Nilgerries, the Himlayas, Java and Sumatra belong there also mainly to the cool or even cold regions, reaching in Sikkim according to Sir Jos. Hooker elevations of 12,000 feet. Moreover small states of M. Wightii are externally not at all dissimilar to our new Papuan plant, their rhizome being also quite woody and clearly perennial, and as such the species is already noted by De Candolle. The material, which served now for dissection, had suffered in transit, like many of the other specimens, brought under so much difficulty and peril from the Papuan Highland, so that on the present descriptions may perhaps be improved in future from ampler supplies.

In Sir William MacGregor's collection from the same spot occurs a plant, congeneric and possibly conspecific with the one, just described, for which the designation *radicans* might be chosen ; its stem is partly creeping and much rooting; its leaves are much narrower, indeed broad-linear and almost or quite glabrous, but the stems bear some indument, and the ligular expansions of the peripheric flower, are somewhat broader.

Lagenophora Billardierii.

Cassini in Bulletin de la Société philomatique 34 (1818).

Summit of the Owen Stanley's Ranges.

The fruit on the only specimen obtained is in a very young state, but so far as can be judged from the material before me, the plant is identical with the typical species, the terminal cylindric elongation of the fruit being observable.

Ischnea.

Involucral bracts about eight, almost biseriate, of equal height, nearly elliptical, somewhat scarious. Bracts between the flowers none. Peripheral flowers in one row, estaminate, their corolla ligulate ; corolla of the rest of the flowers with five deltoid short lobes. Anther-cells without any basal appendage. Stigmas of the peripheric flowers extremely short, quite blunt. Fruits of the peripheral flowers seed-bearing, almost dimidiate-ellipsoid, slightly incurved, streaked-angular, the circular apex placed almost laterally. Fruit of the other flowers remaining undeveloped. Pappus none.

Ischnea elachoglossa.

Summit of the Owen Stanley's Ranges. A glabrous weak herb, a few inches high. Root extremely thin, somewhat creeping, its fibrelles capillary-thin. Stems unbranched. Leaves narrow-linear, entire, flat or along the margin incurved, the lowest rather crowded and to about one inch long, the upper distant and gradually shorter, the uppermost very short. Headlets of flowers singly terminal. Involucral bracts about one eighth of an inch long, keelless. Receptacle flat. Flowers not very numerous. Ligules of the marginal flowers about one sixth of an inch long, narrow-elliptic, entire, their colour in the dried state not ascertainable. Corolla of the bisexual flowers hardly one twelfth of an inch long. Fruits of the peripheric flowers dark-brown, about one tenth of an inch long.

This singular plant is allied to one of the rarest in the world, the exclusively Italian Nananthea perpusilla. Generically it is different mainly in the fruits of the bisexual flowers not becoming perfected, and in the turgidity and curvature of the marginal achenes. Some approach to Aphanostephus is also noticeable. In reference to Allardia, which genus belongs to this series of the Composites, it might here be noted, that it has to give way to that of Waldheimia, which was published in 1842, therefore two years earlier; thus the alteration of the names of four plants, all from the Indian Highlands, is involved. See on this subject also observations of mine in the Bulletin de la Société Impériale des Naturalistes de Moscou 1877, Append. p. 42.

Senecio haplogynus.

Robust, almost glabrous; leaves from ovate-to narrow-lanceolar, entire or imperfectly denticulated, the upper short-stalked or quite sessile, but never amply clasping; headlets of flowers rather small, rayless, corymbously aggregated; involucre twice as long as broad, its constituting bracts about eight; accessory bracts only two or three, very short, acute; flowers in the headlets not numerous; several of the outer flowers estaminate, their corolla rigidulous, from a broadish base gradually much narrowed upwards and at their summit but slightly denticulated, their style often partly emerged with extremely short broadish and blunt stigmas; corolla of the bisexual flowers very slender except at and near their summit; anther-base lobeless; style also almost undivided with the stigmas conspicuously dilated at the termination; achenes thinly cylindrical, almost glabrous, few-streaked; pappus-bristlets numerous, very tender, subtile-capillary, denticular-rough.

Summit of Mount Knutsford.

Lower portion of the plant unknown yet. Upper leaves somewhat crowded, one to two inches long, acute. Inflorescence rather compact. Involucral bracts almost lanceolar, about a quarter of an inch long, but little over-reached by the flowers, in part scarious along the margin. Anantherous flowers sometimes outnumbering the bisexual flowers. Fruits slender, nearly one-tenth of an inch long; length of pappus not much more.

Bentham and J. Hooker observed already (gen. plant II, 208), that occasionally some thin solely pistillate flowers occur in species of Senecio; hence the only characteristic, which separates Erechtites from that genus, is unreliable, and therefore the present plant may be placed into either genus. More of the aspect of a Senecio than of an Erechthites, it is placed with the former, although estaminate flowers occur constantly in rather conspicuous numbers. The extreme shortness of the stigmas even in the estamininate flowers, rendering the style almost undivided, seems quite anomolous in this large genus and even in the whole order.

Senecio erechthitoides.

Scantily beset with hairlets; leaves lax, upper elliptic-lanceolar in outline, sessile, somewhat clasping, rather deeply indented; flowers comparatively small, terminally clustered; involucre before expansion about thrice as long as broad; its constituting bracts ten to twelve; accessory bracts two or three, much shorter, quite narrow; estaminate flowers several, ther corolla extremely thin, their style enclosed; their stigmas capillary without any terminal dilation; corolla of the bisexual flowers gradually and very moderately dilated upwards, the denticulation quite short; anther-base lobeless; achenes very slender, closely streaked, somewhat beset with minute appressed hairlets, marginally dilated at the top; pappus-bristlets extremely tender, minutely denticular-rough.

Crest of the Owen Stanley's Ranges.

The plant bears considerable resemblance to S. radiolatus (F. v. M. Vegetation of the Chatham-Islands 24 pl. IV.) but the outer flowers are erechthitoid; these however number too few for placing it exactly into Erechthites, unless for its reception a new section within that genus was purposely instituted.

Taraxacum officinale.

G. H. Weber in Wiggers primitiæ floræ Holsaticæ 56 (1780).

Mount Knutsford, bedded into the turf, constituted by various other plants. There occurring only in the very small form, distinguished as a Himalayan alpine plant under the name Leontodon parvulus by Wallich. This undoubtedly must be regarded as indigenous in the Papuan Highlands. It has been found neither on the high mountains of the Sunda-Islands nor in the Australian Alps. In our continent here the plant is clearly an immigrated one.

Vaccinium acutissimum.

Glabrous; leaves on very short stalks, elliptic-lanceolar, ending in a pointed long acumen, entire at the margin, biglandular at the base; racemes short, generally several together at and near the end of branchlets; bracts basal, somewhat deltoid, pointed; pedicels nearly as long as the flowers; undivided portion of the calyx almost hemispheric, lobes semi-ovate and minutely ciliolated; corolla urceolar, its tube from about the middle upwards gradually constricted, its lobes several times shorter than the tube, rhomboid-roundish; stamens hardly half as long as the corolla; filaments about twice as long as the anthers, beset with crisp hairlets; anthers without posterior appendages, the pointed empty apices only about half as long as the polliniferous cells; style reaching the lobes of the corolla, glabrous; stigma very small, truncate; ovularly depressed, five-celled, multiovulate.

Mount Musgrave.

Ripe fruit unknown yet.

From the description, offered by Dr. Beccari (Malesia I, 209), V. paradisearum must be specifically distinct from this in not glabrous branchlets, much longer racemes, pedicels not jointed under the calyx, corolla-lobes linear and longer than the tube. The leaves of our plant are in form very similar to those of V. Dunalianum, which however has mostly axillar solitary racemes, pointed calyx-lobes, glabrous filaments, anthers much longer than the filaments with posterior appendages and long empty tubes, also a less shortened ovularly. The leaves of the new Papuan species again are very much like those of V. Korthalsi (Miquel Annal. Mus. Lugd. Batav. I, 40, but that Java-plant has larger flowers on longer pedicels, a calyx-limb with but slight sinuation and without ciliolation, anther-cells about as long as the filaments and rather shorter than the terminal tubules.

Vaccinium Helenae.

(Agapetes Helenae, F.v.M. MSC.)

Branchlets beset with short colourless spreading hairlets; leaves comparatively small, of very thick texture, short-stalked, from orbicular-to elliptic-ovate, blunt, soon glabrous, almost flat or at the margin slightly recurved, entire, shining on both sides, irregularly glandular-dotted beneath, their thin venules visible on the surface only; pedicels scattered or two or few together, finally lateral, about as long as the calyx or somewhat longer, recurved, rather robust, very angular, as well as the calyx bearing scattered hairlets; bracts basal, pointed; calyx semiellipsoid-campanulate, its lobes several times shorter than the tube, almost deltoid; an articulation between the pedicel and calyx; corolla large, three times longer than the calyx, cylindric but towards the base gently narrowed, nearly glabrous outside; lobes deltoid semi-lanceolar, many times shorter than the tube; stamens inserted towards the base of the corolla, enclosed; filaments almost glabrous, equal in length to the anthers, downward dilated; anthers nearly half as long as the corolla, glabrous, slightly rough without any posterior appendages, their base blunt, curved inward, protruding somewhat beyond the point of insertion, the empty slender at last longitudinally dehiscent tubules twice as long as the polliniferous cells; style glabrous, slightly exserted; stigma depressed, somewhat dilated beyond the width of the style, almost lobeless; ovulary five-celled, reaching nearly the calyx-lobes; placentaries ovate, convex, extending upwards hardly beyond the middle of the fruit-cavities; ovules very numerous, obliquely narrow-ellipsoid.

Mount Victoria.

Leaves generally from half to one inch long, shining above. Corolla fully an inch long, probably red. Ripe fruit not yet obtained. This Vaccinium or Agapetes has for its specific name that of a young and accomplished daughter of the discoverer. V. Myzomeleae, of which the size of the leaves remains unrecorded, is glabrous throughout, has the leaves more narrowed at the base, the pedicels devoid of bracteoles at the middle, a somewhat shorter corolla more constricted under the lobes, much shorter stamens with thinner filaments and blunter anther-lobes. V. puxophyllum (Agapetes buxifolia, Nutt. in Hook. Bot. Mag. 5012) has the leaves crenulated and gradually narrowed towards the base, the calyx-lobes and coralla-lobes longer, while the anthers are minutely appendiculated at the base. It has been given formerly already as my opinion, that Agapetes should merge into Vaccinium; because the length of the corolla and the disposition of the flowers are affording no definite characteristics, several species effecting the transit.

Vaccinium Macbainii.

Glabrous; branchlets robust, angular; leaves rather small, on very short stalks, of quite firm consistence and thick texture, from orbicular-to elliptic-ovate, flat, faintly and distantly crenulated and glandularly denticulated, shining on both sides, scattered-dotted beneath, biglandular at the base; their main-venules rather prominent; corymbs crowded between the upper leaves, each with several or few flowers; pedicels stoutish, angular, recurved, about as long as the flowers, bearing two small deltoid-semilanceolar persistent bracteoles near the base; an articulation between calyx and pedicel; tube of the calyx companular-semiovate, lobes thrice shorter than the tube, nearly deltoid; corolla rigidulous, somewhat longer than the calyx, beyond or to the middle cleft into semilanceolar lobes; stamens slightly shorter than the corolla; filaments broadish, somewhat coherent and ciliolated; anthers anteriorly extended downward along the filaments but free there, almost equally broad throughout, their tubules connate; style partly exserted, with a scarcely broader stigma; ovulary impressed at the centre of its summit, multiovulate.

Mount Knutsford.

Leaves hard, blunt, three-quarters by one and a half inches long, broadest towards the base. Corolla measuring about one-third of an inch in length, its inner lining membrane less deeper slit than the outer more solid stratum. Stamens monomorphous, about one-quarter of an inch long; style longer. Fruit-calyx turgid.

The leaves are very much like those of V. Hèlenæ, unless larger and stronger venulated, but the size and structure of the flowers is very different. The deeply divided corolla brings this species near V. pardisearum, the leaves of which however are very different in form, the racemes longer, the bracteoles deciduous, the calyx-lobes ciliolated, the corolla-lobes narrower, the filaments much beset with hairlets, and the fruit may also be very different. With this richly flowering shrub from the highlands of New Guinea, there from the region of the lark, has now been connected the name of the Hon. Sir James MacBain, K.C.M.G., President since several years of the Legislative Council of Victoria, President also of the Centennial International Exhibition of Melbourne, who in these and many other leading positions here sustained worthily the dignity of our colony, and unceasingly promoted the spread of religiosity and of scientific knowledge as well as the development of industrial resources in this country.

From the same region was received a plant of a floral disposition and structure quite or almost alike, but with comparatively thin leaves of larger size and less lustre. From experiences on other kinds of plants in the Australian Alps I should regard this as a mere variety, originated in sheltered valleys, though its aspect is so different. The fruit of this is from a very blunt base truncate-ovate, slightly urceolar and nearly one-third of an inch long. The seeds are very numerous, angular and often truncate; their testa is unenlarged. The affinity of V. Helenæ to V. Macbainii is also obvious; but the scanty infloresence and particularly the agapetoid elongation of the corolla-tube, of the anther-tubules and of the style render the plant very distinct; were it otherwise, it would have been also reduced to V. Macbainii.

Vaccinium amplifolium.

Glabrous throughout; branchlets robust, not angular; leaves large, particularly firm, on very short petioles, nearly ovate or verging into an orbicular form, entire, almost flat, shining on both sides, biglandular at the base, their main-venules rather distant, more prominent beneath than above; flowers comparatively small, few together in axillary very short almost fascicular racemes; peduncles stout, angular; pedicels thin, about as long as the flowers, bearing near the base two very small deltoid bracteoles; calyx separable from the pedicel by distinct articulation, companular-semiovate, minutely denticulated; lobes of the corolla considerably shorter than the tube, deltoid; stamens enclosed, five exterior, their filaments glabrous, extremely short, broadish, flat; filaments of the five inner stamens obliterated; anthers elongate-ellipsoid, devoid of any posterior appendages, provided with conspicuous terminal tubules; stigma hardly broader than the upper end of the style; ovulary five-celled, impressed at the centre of the summit; placentaries placed in the lower part of the ovulary-cells; ovules numerous.

Mount Musgrave.

The result of the dissection rests on one remaining unexpanded flower, so that some allowance must be made for the shortness of the description of the anthers and other floral organs. The leaves in size are disproportionate to the flowers, being one and a half to two and a half long, while the nearly developed flowers measure hardly above a quarter of an inch in length. Fertilisation takes place, whilst the flowers are yet unopen. This Vaccinium approaches the section Dimorphanthera (F. v. M. in Britten's Journal of Botany XXIV, 290), which indeed may constitute a distinct genus. In leaves and flowers this new plant resembles V. Teysmannii; but I find the calyx of that plant conspicuously lobed, the stamens monomorphous, the filaments densely beset with hairlets, the anthers almost devoid of tubules, and both differ likely also in characteristics of the ripe fruit. Some affinity exists also to V. laurifolium and V. ellipticum. The resemblance of some of these plants to species of Medinilla is significant.

Vaccinium ambyandrum.

Dwarf; branchlets beset with spreading soft whitish hairlets; leaves very small, on extremely short petioles, from oval-to elliptical-lanceolar, slightly crenulated or almost entire, glabrous, at the margin flat or somewhat recurved; flowers small, in axillar few-flowered racemes or solitary, bent downward; rachis or peduncle beset with hairlets; pedicels very short, concealed by minute imbricate bracts; bracteoles hypocalycine, conspicuous, semilanceolar-deltoid, ciliolated, somewhat connate; tube of the calyx hemiellipsoid, glabrous; lobes nearly deltoid, ciliolated, three times shorter than the tube; corolla membranous, of somewhat greater length than that of the calyx, ovate-urceolar, outside glabrous, inside at and towards the orifice beset with hairlets; its lobes almost semiovate, several times shorter than the tube; stamens glabrous, about half as long as the corolla; filaments twice as long as the anthers, flat towards the base, finely narrow towards the upper end; anthers yellow, ellipsoid-ovate, glabrous, almost centrifixed, devoid of posterior appendicles and of conspicuous terminal empty tubules, broadly opening at the summit of the polliniferous cells; style angular, glabrous, as long the corolla; stigma truncate, without any dilatation; epigynous disk glabrous, slightly crenulated; placentaries turgid; ovulary five-celled; ovules numerous.

Summits of the Owen Stanley's Ranges.

Leaves mostly a quarter to one third of an inch long. Total length of flowers rather above one third of an inch. Filaments inserted at the base of the corolla. Ovulary totally enclosed within the calyx-tube and connate with it.

This plant can rightly not be excluded from the genus Vaccinium, of which it has the normal completely inferior ovularly, although the aspect is more that of some species of Pernettya and Gaultiera. The anthers are almost those of Diplycosia discolor; but as Vaccinium Teysmannii has also no tubules to its anthers, the separation of our plant from Vaccinium would not be justifiable merely on that ground. Of the several species of Diplycosia, described by Beccari, no specimens are available here for comparison; but that distinguished naturalist placing them unreservedly into Vacciniaceæ, indicates a position in Vaccinium itself, according to perigynous insertion of stamens and corolla; whereas the genuine species of Diplycosia, as originally defined by Blume and subsequently confirmed by Bentham and J. Hooker, would best form a section of Gaultiera according to the hypogynous insertion of corolla and stamens, and the necessarily thus only basal fixture of the ovulary, the bracteoles counting merely for a sectional position of these plants in their genus. The anthers of our new plant, as regards their form, remind of those of Wittsteinia.

Vaccinium parvulifolium.

Branchlets thin, densely beset with very minute hairlets; leaves quite small, short-stalked, almost obovate or somewhat orbicular, nearly flat or slightly bent, glabrous, devoid of any denticulation, shining on both sides, their venules beneath slightly prominent; flowers axillary, solitary, very small, glabrous throughout; pedicels thin, shorter than the flowers, without any conspicuous bracts and bracteoles; adnate portion of the calyx semiovate, several times longer than the deltoid lobes; corolla of about the length of the calyx, hardly longer than broad, its lobes much shorter than the tube; stamens at least half as long as the corolla; filaments very narrow; anthers somewhat longer than the filaments, provided with tubules about as long as the cells and with very minute acute posterior appendicles; style stoutish, longer than the stamens; stigma truncate; fruit very small, globular-semiovate, smooth, five-celled; ovules several in each cell.

Mt. Musgrave, at elevations from 7000 to 8000 feet.

Leaves rigidulous, the majority from a quarter to a third of an inch long. Flowers only seen on this occasion in a still unopened state, the corolla then a sixth of an inch long. Fruit seemingly not becoming succulent, but two only available not fully matured and possibly somewhat deformed, the cells apparently to a small extent subdivided. Seeds, well ripened, not accessible for examination.

This plant stands evidently in near relation to V. obovatum, but the calyx is shorter lobed, the filaments are very conspicuous, the anthers glabrous and their appendicles hardly perceptible. Comparison with V. microphyllum, which remained by autopsy unknown even to Miquel, could here not be instituted; the brief diagnosis, given of it by Blume, is quite insufficient for recognition of that species, at any rate when obtained from beyond the Sunda-Islands. V. Rollinsonii is distinguished by few-flowered racemes, longer calyx-lobes, some vestiture on the inside of the corolla and on the filaments, as well as by absence of conspicuous anther-tubules.

Gaultiera mundula.

Dwarf; branchlets beset with scattered setular brownish hairlets; leaves very small, firm, on extremely short petioles, generally lanceolar-ovate, glabrous, flat, crenular-serrulate, the denticles pointed at first; flowers very small, solitary or two or racemously few together, on short pedicels, glabrous; bracts rather minute, blunt, imbricate, persistent; bracteoles usually close to the calyx, semilanceolar-deltoid, deciduous; calyx deeply five-cleft, remaining unsucculent or its undivided portion somewhat enlarging, the lobes deltoid-lanceolar; corolla hardly double the length of the calyx, its tube several times longer than the lobes; stamens three times shorter than the corolla; filaments hardly longer than the anthers, almost capillulary-thin; anthers ovate, somewhat truncate, minutely apiculate, but unprovided with posterior appendiles and terminal empty tubules; style very short; stigma almost or quite lobeless; fruit capsular, only basifixed, slightly surpassed by the calyx, deeply valvular-dehiscent, impressed at the middle of the vertex; seeds very numerous, minute, pale-brownish, shining, often truncate.

Summit of Mount Victoria.

Rhizome somewhat woody. Leaves a third to two-thirds of an inch long, not unlike those of Vaccinium ambyandrum. Calyx during anthesis only an eighth of an inch long, exceptionally four-cleft. Corolla measuring about a sixth of an inch in length; anthers opening terminally. Diameter of capsule nearly a quarter of an inch. G. (Diplycosia) discolor has larger leaves much paler beneath, the orifice of the corolla as well as the filaments and ovulary beset with hairlets; but the anthers are also devoid of appendices and tubules. G. nummularioides has proportionately broader leaves beset with setular hairlets, always solitary flowers, tubulated anthers, and the calyx at last conspicuously succulent. G. ciliolata from Mt. Kini Balu is still more distinct. G. Blumei (Vaccinium microphyllum Bl. Bijdrag. 851) has according to the notes of Beccari and Clarke somewhat larger and blunter leaves, seemingly never racemous flowers, blunter calyx-lobes, again tubulated anthers, and may differ in further characteristics. Our Papuan plant is also near to G. antipoda, although that species has the flower always solitary, the anther-cells bicuspidate and the fruit-calyx normally baccate; the alpine state, however, as elucidated and illustrated by Sir Jos. Hooker (Fl. Tasm, I. 242 tab. LXIII) is almost representative of our plant so far as stature and leaves are concerned. If still further proof was wanting of the intenability of the genus Diplycosia, it could be supplied by a glance on the excellent illustration from South American specimens of Gaultiera microphylla in the Flora Antartica II, t. c. XVI, that plant indeed being closely akin to the Papuan congener just described, though its bracteoles are smaller, its filamants towards the middle dilated, its anther cells doubly pointed, while the undivided portion of the calyx is finally much longer than the lobes.

Rhododendron gracilentum.

Branchlets thin, somewhat rough; leaves very small, in whorls of few, short-stalked, from ovate-to elongate-lanceolar, slightly recurved at the margin, faintly crenulated, beneath much paler and there grandular-dotted; flowers comparatively small, terminal, on conspicuous very thin pedicels; calyx membranous, nearly obliterated, glandular-dotted outside, at the margin slightly lobed; corolla almost glabrous, its tube cylindric, about three times longer than the lobes; stamens, ten, about as long as the corolla; filaments capillary, glabrous; anthers dark, only about twice as long as their breadth; style beset with minute hairlets; stigmas, united truncate, hardly dilated; ovulary cylindric-conical, somewhat rough, five-furrowed.

Mount Musgrave, at 8000 to 9000 feet elevation.

Leaves a third to two-thirds of an inch long. Pedicels about half as long as the flowers. Corolla probably red, bearing outside some squamular glandules, measuring about three-quarters of an inch in length; the tube hardly more than a sixth of an inch wide. Style during anthesis nearly half an inch long, upwards very thin. Fruit as yet unknown. In general aspect the plant resembles to some extent small forms of Prionotes cerinthoides, but the leaves are not so much crenulated. Prionotes indeed has more the aspect of an Agapetes than that of an epacrideous plant. Among congeners this one can as regards near affinity only be compared to R. Papuanum; but the characteristics of that plant, as given by Beccari, are too much at variance with those of ours, to consider both forms of one species; he describes the leaves as broader, particularly upwards, the pedicels as of nearly twice the length of the flowers, the calyx as more indented, and the stigmas as conspicuously disconnected. R. ericoides has crowded leaves of less breadth, and almost lanceolar calyx-segments, but is otherwise not dissimilar.

Rhododendron Lowii; J. Hooker, icones plantarum, 883 (1852).

Mount Musgrave.

To this Rhododendron has been referred the species with large yellow flowers, especially mentioned as being so showy in Sir W. Macgregor's diaries. It differs from the typical plant, obtained at Kini Balu, only in pedicels twice as long as the flowers, in corollas of somewhat larger size, in rather longer as well as narrower anthers and particularly in the much dilated almost hemispheric stigma of a width three times greater than that of the style. In the absence of any knowledge, concerning the fruit of both the Borneon and the Papuan plant, it has not been ventured, to separate the latter specifically, less so as the very marked difference in the size of the stigmatic body may perhaps be accounted for by dimorphism. Should however hereafter from ampler collections the specific diversity of the two plants be demonstrable, then the name *megalostigma* might be assigned to the Papuan plant.

The tube of its corolla is five-plicate; the hairlets on the filaments are longer than those on the style; the united stigmata measure fully an eighth of an inch; the disk is deeply divided into rounded lobes, and bears a very close brownish short vestiture.

Here it might aptly be remarked, that if anthers of Rhododendrons (and indeed many other plants) were, when freshly gathered, wrapped in oil-silk or tinfoil, they could early be turned to horticultural use for hybridising.

Rhododendron phaeochitum.

Branchlets provided with a close indument of dark-brown stellular hairlets; leaves on rather short stalks, cuneate-ovate, slightly pointed, at the margin somewhat recurved, above punctular-rough and glabrescent, beneath dotted with copious brown stellular hairlets; flowers few together terminal; pedicels very conspicuous, slender, brown from a close vestiture; bracts broadish, rather short, soon glabrous; calyx reduced to an almost annular membrane, but occasionally producing a linear-filiform lobe; corolla deep-red; its tube nearly thrice as long as the lobes, cylindric, slightly more widened towards the orifice, bearing outside brown much scattered stellular hairlets and inside glittering simple appressed colourless dispersed hairlets; lobes roundish, glabrous, somewhat crisped; stamens ten, some of the longest slightly exceeding the corolla; filaments at their lower portion beset with soft pale very short hairlets; anthers hardly three times longer than broad; stigma-cover somewhat dilated, five-furrowed; disk undularly bent, closely ciliolated; ovulary cylindric-conical, as well as the style provided with a brown stellular indument.

Mount Musgrave.

Vestiture slightly squamular. Leaves at and near the summit of the branchlets somewhat crowded or even whorled, the majority there about two inches long. Bracts rather scarious. Pedicels during anthesis about three-quarters of an inch long. Total length of corolla almost one and a half inches, width of tube a third of an inch nearly throughout. Ovulary of expanding flower three times shorter than the style.

Near R. rugosum; the following are its discrepancies. Leaves blunter and not conspicuously rugular; corolla-tube narrower and proportionately longer; corolla-lobes smaller; style only towards the upper end glabrous. In estimating these differences it should be kept in mind, that as yet we do not know the range of variability of either plant here now compared. The new species shows also some affinity to R. album.

I have been unable to understand clearly the distinguishing marks of some congeners from descriptions in the Malesia.

Rhododendron spondylophyllum.

Branchlets rough from minute papillular or stellular squamules; leaves rather small, in whorls of three or few, almost sessile, mostly cordate-ovate, but somewhat acute, imperfectly recurved at the margin, almost grandular-rough on both sides;

flowers three or few, terminal, on very short pedicels; calyx reduced to a very narrow membrane; tube of the corolla cylindric, about three times as long as the lobes, gradually somewhat widened upwards, outside scantily lepidote, inside towards the base beset with scattered very short hairlets; stamens ten, nearly as long as the corolla; filaments on their lower portion bearing scattered hairlets; anthers hardly more than twice longer than their breadth; style less than half as long as the corolla; stigma-cover slightly dilated; disk annular, almost glabrous; ovularly five-furrowed, as well as the greater portion of the style bearing a velvet-like indument.

Mount Knutsford.

Leaves one to one and a half inches long, but only few on our only specimen. Length of corolla about one inch. Anthers barely one-tenth of an inch long. Style of expanding flower hardly half an inch long. Ovularly also proportionately short. Stands in close relationship to R. verticillatum; but that plant seems smoother, has the flowers with much ampler corolla, the anthers rather longer, the style nearly glabrous and the ovulary bearing a squamular indument.

Through future more extensive material the characteristics, here given, may become enlarged. A new monography of Ericaceæ, inclusive of Vacciniaceæ, is more now wanted than almost any other descriptive treatises on orders of plants, as the vastly accumulated collections, obtained from various parts of the globe, also within this large ordinal complex, needs critically connected investigations. The collection contains also a fragmentary specimen of an allied and possibly conspecific plant; of this the leaves are distinctly stalked, ovate, slightly pointed and smoother; the corolla-tube is much more slender, though the lobes are broadish; the filaments are nearly or quite glabrous, and the pistil bears a very close stellular indument. It might receive as a variety or species the name R. leptanthum.

Rhododendron culminicolum.

Branchlets almost glabrous; leaves small, on short stalks, mostly whorled, from elliptic-ovate to broad-lanceolar, nearly flat, quickly glabrous, beneath dotted, their venules faint; flowers comparatively small, terminally few together; stalklets quite slender, about thrice shorter than the flowers; calyx reduced to an almost circular membrane, but often also extended into one or two acute lobes; corolla almost glabrous outside, its tubes cylindric nearly throughout, about thrice as long as the lobes, inside towards the base bearing simple short hairlets; stamens ten, almost as long as the corolla; filaments beset with spreading hairlets at their lower portion; anthers only about doubly as long as broad; style nearly as long as the stamens, upwards glabrous; stigma-cover slightly dilated; disk broadish, annular, faintly ciliolated; ovulary cylindric-conical, bearing a velvet-like vestiture.

Mount Victoria.

Leaves one and a half to two inches long, two-thirds to one inch broad. Corolla probably red, its total length about one and a third inches. Fruit unknown yet, which like in other instances of this genus may afford some of the best characteristics for diagnosis.

Readily to be distinguished from R. Lochae by smaller and somewhat pointed leaves and much narrower carolla; the latter is more like that of R. retusum, which species in some respects resembles that of Correa speciosa. From R. Keysii chiefly distinguished in shorter petioles, scanty inflorescence, more curved and downward more attenuated corolla-tube, but larger corolla-lobes. Perhaps this new plant is nearest to R. spondylophyllum, of which it has the flowers, although the leaves are very different in form and as well as the branchlets smoother, while the pedicels and style are longer.

Styphelia montana; F. v. M., Fragmenta Phytographiæ Australiæ, VI. 45 (1867).

On Mount Victoria and on others of the loftiest elevations of the Owen Stanley's Ranges.

All the specimens, obtained there, belong to the variety Hookeri; among them are some with broadish, others with narrow corolla-tube. Sir George Verdon found this species also lately on the summit of Mount Macedon, which is a locality of lesser height than any, from which within the colony of Victoria this plant was brought before. It may be added, that the leaves of Styphelia Tameiameiæ are undistinguishable from those of the broad form of Styphelia montana, unless they are more narrowed towards the base; the precise relation of these two plants to each other requires further to be investigated. Good material of the Hawaian plant is not available to me here for comparison. Leucopogon Colensoi may be conspecific.

Decatoca.

Sepals five. Lobes of the corolla five, broadly overlapping. Stamens five, placed below the corolla-lobes; filaments very short; anthers narrow-ellipsoid. Style short. Stigma dilated. Ovulary ten-celled, with one ovule in each cell. Disk deeply lobed. Fruit indehiscent; endocarp separating into ten pyrenaceous divisions.

A genus, distinct from Trochocarpa and Decaspora in the important characteristic of not valvular prefloresence of the corolla; from Brachyloma significantly in not consolidated putaminous endocarp. This genus therefore stands precisely in the same position to Trochocarpa (in wider sense) as Brachyloma to Styphelia.

Decatoca Spencerii.

On Mount Knutsford and on others of the highest elevations of the Owen Stanley's Ranges.

A shrubby plant, in some places dwarfed to a few inches height and sometimes procumbent. Branchlets beset with very short spreading hairlets. Leaves crowded, of rather thin texture, conspicuously stalked, somewhat spreading, from orbicular-to lanceolar-ovate, broadish towards the base, slightly curved inwards, mostly one-quarter to one-third of an inch long, at the margin flat and faintly ciliolar-rough, beneath pale green and there showing three to five longitudinal somewhat prominent and many thinner divergent venules, at the apex simply acute. Flowers terminal, sessile, usually but few crowded together. Bracts one to each flower, as well as the bracteoles rhomboid-orbicular, about twice shorter than the calyx, broadish and hardly acute. Sepals orbicular-ovate, streaked, subtle-ciliolated. Corolla nearly twice as long as the calyx, probably white, hardly one-quarter of an inch long; its tube much longer than the lobes, considerably narrowed only near the base, inside bearing closely crisped hairlets; its lobes rounded, glabrous or imperfectly beset inside with hairlets. Anthers pendent, without appendicle or protraction. Style extremely short, stoutish, always glabrous. Stigma truncate. Disk blunt-lobed. Fruit globular, half exceeding the calyx, hardly measuring more than one-sixth of an inch, glabrous, but not seen in a perfectly matured state, the exocarp probably getting succucent; fruit-cells, so far as can be judged from the available material, secedent.

Unexpectedly this new Epacrid shows an approach to Trochocarpa thymifolia, which hardy plant particularly on account of its crimson flowers ought to become an inmate of gardens also of the cool zone. The leaves of this solely Tasmanian plant are in form exactly like those of the new Papuan member of the order, but they are smaller, more divergent, somewhat recurved at the margin and of thicker texture, with venules hardly perceptible beneath, the spikes are longer and at first decurved, the colour of the flowers is different, the sepals are less streaked, the hairlets on the inner side of the corolla are mainly descending, and are aiding in conveying the pollen to the stigma, the corolla-lobes are acute, the filaments are well developed and bend downward during fecundation, so as to place the anthers then close to the stigma, further the fruit is much larger, outside very succulent and proportionately more depressed, irrespective of the generic difference derived from the valvular æstivation of the corolla-lobes.

In its leaves this new epacrideous plant is singularly similar to Styphelia Macraei, so also in the disposition of the flowers and in the shape of the calyx as well as that of the bracteoles and fruit. Incidentally it should be noted in connection with the latter plant, that Cyathodes Macraena from the Hawaian Mountains has been reduced by Asa Gray and subsquently also by Wilhelm Hillebrand, as a variety with glabrous corolla-lobes, to C. Tameiameiæ, so that without clashing of specific appellations it can pass under the latter specific name into Styphelia.

This taxonoically and phyto-geographically remarkable plant is specifically named in honour of Professor Baldwin Spencer, B.Sc., of the Melbourne-University, who with enthusiastic zeal now carries on the onerous duties here as local Secretary of the Australian Association for the Advancement of Science, and who as one of the Hon. Secretaries of the Royal Society of Victoria promoted the publication of this essay.

Gentiana Ettingshauseni.

Dwarf; stems very thin, leafy, laxe, near the base somewhat creeping, beset with very minute hairlets; leaves very small, simply opposite, rigidulous, from ovate-to narrow-lanceolar, mucronulate-pointed, equally green and shining on both sides, thickly pale-margined and also along the keel transparently pale-edged, subtle-ciliolate towards the base otherwise glabrous, without any externally visible venules, the lowest leaves the smallest; flowers singly terminal on a very short stalk; calyx to near the middle four-or five-cleft, its lobes linear-semilanceolar, gradually much pointed, conspicuously margined and carinulated; corolla glabrous, by about one third longer than the calyx; its tube cylindric, downward narrowed; its lobes four or five, semilanceolar-deltoid and finely acuminated, fringeless, about three times shorter than the tube; semilanceolar membranous appendages between the lobes; stamens emanating from near the middle of the corolla-tube; anthers dorsifixed, disconnected, narrow-ellipsoid; free part of filaments hardly longer than the anthers; style very short; stigmas soon recurved; ovulary on a short stipes, narrow-ellipsoid; ovules very numerous along the hardly perceptible placentaries; ovules dark, almost ellipsoid, slightly pointed at their extremities.

Crest of the Owen Stanley's Ranges.

Aspect, so far as the foliage is concerned, almost that of some small caryophyllous plant. Leaves from often only one-sixth of an inch length on the lower portion of the stem enlarging on the upper to nearly half an inch. Calyx also about half an inch long. Colour of the dried corolla no longer well discernible, but seemingly yellowish towards the middle and bluish towards the summit; narrow membranous folds decurrent from between the lobes; stamens enclosed. Ripe fruit not available.

After an extensive search I have been unable to identify this remarkably delicate Gentian with any of the numerous Himalayan or other species. It belongs however to the series of specific forms, in which G. quadrifaria is prominent; but that plant is distinguished by broader leaves, those near the root enlarged, by usually smaller flowers, by less pointed and less carinulate calyx-lobes, by the corolla-lobes being less acuminated, by seemingly shorter stamens and perhaps also by carpologic characteristics, those of our new plant not being yet ascertainable. G. decemfida has stem-leaves much like those of the Papuan species; but its basal leaves are much larger, whereby the plant obtains a very different aspect, its flowers are considerably smaller, and have bifid appendages.

Baron Constantin von Ettingshausen, the renowned palæontologist in Gratz, having done me the honour of giving my name to a fossil undubitable species of Alder, discovered by Mr. Johnston in Tasmania, I avail myself of this opportunity for reciprocating by connecting his name now with the only Gentian as yet known from New Guinea, of which that distinguished investigator may often be reminded by the several beautiful Gentians surrounding him in Styria.

Alyxia semipallescens.

Branchlets beset with a thin vestiture consisting of somewhat papillular hairlets; leaves rather small, ternately whorled, on very short stalks, lanceolar-obovate, nearly blunt, glabrous, entire, slightly wrinked and shining above, very pale and quite smooth beneath, almost flat; pedicels often solitary, quite short, angular; calyx minute, its lobes cymbiform-semilanceolar; tube of the corolla nearly thrice as long as the lobes, in its upper part turgid, inside slightly beset with hairlets; stamens inserted near the middle of the corolla-tube; filaments nearly as long as the anthers, very thin; anthers gradually attenuated upwards; style capillary, glabrous; stigma turgid towards the summit; ovulary glabrous.

Summits of Mount Musgrave.

Leaves very firm, two-thirds to one and a third inches long, almost whitish on the underside and there no veinlets visible except the carinular one. Corolla only a quarter of an inch long, slender. Fruit not obtained, and only one flower here seen. The difference of the colouration of the upper and lower side of the leaves is in this species greater than in any other; it seems also to adscend higher elevations, than those attained by any congeners.

A. buxifolia is allied, but that is a coast-species, reaching besides litoral deserts only, extending however the limits of the genus far beyond the tropics, indeed to Tasmania; its leaves are often simply opposite, its flowers more numerous and considerably larger, its anthers almost sessile.

A. obtusifolia has somewhat larger leaves of less firmness, much more copious flowers with proportionately shorter corolla-tube.

A. Sinensis has the edge of the leaves more recurved, a different inflorescence with shorter corollas, but is nearest in affinity to the Papuan plant; the fruit of the three species, here compared, may also be different.

Veronica Lendenfeldii.

Somewhat woody, erect or ascending, much ramified, extensively beset with very short spreading hairlets ; leaves copious, comparatively small, on very short stalks, of rather thick texture, flat, lanceolar-or orbicular-ovate, from above the base or from the middle bluntly serrulated ; racemes axillar, particularly near the summit of branchlets, few-flowered, much longer than the leaves ; bracts from lanceolar-to linear-elliptical ; pedicels generally about as long as the bracts and calyx ; segments of the calyx four, nearly lanceolar ; corolla fully twice as long as the calyx, outside beset with scattered hairlets, broadly tubular to near the middle, its lobes rounded ; stamens shorter than the corolla ; free part of the filaments about as long as the anthers ; style glabrous ; ovulary beset with hairlets ; fruit about as long as the calyx, ovate-or roundish-ellipsoid, rather turgid, at last septicidally dehiscent almost to the base, loculicidally dehiscent to about the middle ; seeds several in each cell, nearly orbicular, slightly concave.

Summit of Mount Victoria.

Height of plant about one and a half feet or variously less. Leaves one-third to two-thirds of an inch long, without much lustre, their denticles ending into a slight glandular enlargement. Racemes seldom reaching more than two inches in length. Corolla about one-third of an inch long ; its colour not ascertainable here. This species is cognate to V. Hookeriana, which however is of dwarf or even prostrate habit, has the peduncles longer and as well as the calyx beset with glandule-bearing hairlets, has the flowers more crowded, the lower lobe of the corolla slightly bifid, the tube shorter. The name of that species in the icones plantarum is V. nivea, not V. nivalis. Our plant has received the name of Dr. R. von Lendenfeld, now of the University of Innsbruck, who during several years' stay in South-Eastern Australia and New Zealand, carried on extensive zoologic particularly spongiologic researches, with the earning of just fame, and who may be reminded of the Papuan Highlands, which he longed to ascend, whenever he meets the lovely Veronicas at his present Tyrolese home.

A second Veronica was brought from the same locality by Sir William MacGregor, differing in leaves narrowly elliptic-lanceolar with lesser vestiture, in racemes fewer flowered or reduced to two flowers or even one, in pedicels of less length and fruits of rather smaller size ; but as otherwise all organs show no structural differences from those of the broader-leaved plant, it would be injustifiable, to separate it as a genuine species, at least until the two can be further observed in their living state. What is assumed here to be a mere variety, comes in some respects near V. linifolia, but that is a much weaker species with a different inflorescence.

Euphrasia Brownii. F. v. M., Fragmenta Phytographiæ Australiæ, V. 88 (1865).

Mount Victoria.

The specimens respond to the rather dwarf form with short leaves, abbreviated spike, merely ciliolated anthers and minute stigma, which variety constitutes the E. striata, and is almost restricted in Australia to alpine regions. The corolla of the Papuan plant is much beset with very short hairlets, and has a narrow-cylindric tube; but these characteristics can also be observed in Australian individual plants.

Trigonotis Haackei.

Ascendant or erect; leaves copious, from linear-to elongate-lanceolar or the lower more ovate, broadly sessile, slightly recurved at the margin, the upper side as well as the branches and inflorescence extensively beset with rigid closely appressed hairlets, the lower side almost glabrous; racemes terminal, corymbiform; pedicels about as long as the calyx or soon somewhat longer; segments of the calyx almost lanceolar; corolla glabrous, its tube equalling in length the calyx, cylindric, its lobes nearly orbicular, about as long as the tube, its orificial scalelets closely beset with subtle hairlets and at the margin incurved; anthers ellipsoid; style very short, stoutish, as well as the ovulary glabrous; stigma truncate; fruitlets disjointed, erect, basifixed, thinly margined, black, almost smooth, somewhat shining, posteriorly compressed.

Mount Victoria.

Root perennial. Stems several, a foot or less long, sometimes much shortened, as well as the branches rather robust. Leaves usually from three-quarters to one and a half inches long, mostly crowded. Racemes one to two inches long, devoid of bracts, short-pedunculate. Pedicels close to each other. Calyx about one-sixth of an inch long. Colour of corolla here unascertainable, its lobes overlapping before expansion without any contortion. Stamens enclosed, inserted near the middle of the corolla-tube; filaments extremely short; anthers glabrous, above the base fixed. Disk depressed, almost entire, glabrous. Fruitlets nearly one-tenth of an inch long, trigonous, somewhat longer than broad. This Papuan species is more robust than T. ovalifolia, T. multicaulis, T. microcarpa and T. rotundifolia, differing also widely in foliage from these and indeed also the few other congeners. The specific name of this Myosotis-like plant, emblematic of remembrance, is chosen in honour of Dr. Wilhelm Haacke, who for some years was engaged in zoologic researches on our shores, who was Naturalist to the Expedition sent to Southern New Guinea by the Royal Geographic Society of Australia four years ago, and who now co-operates with Dr. A. E. Brehm in elaborating a new and enlarged edition of the "Illustrirte Thier-Leben" of that distinguished author.

Trigonotis inoblita.

Stems short, erect or ascending, as well as the inflorescence densely beset with rigid spreading hairlets; lower leaves long-stalked, the most upper sessile, from orbicular-to elliptic-ovate, above nearly glabrous, beneath rather sparsely beset with rigidulous hairlets; racemes terminal or from the upper axils, rather slender; flowers quite small, on pedicels of finally somewhat greater length; segments of the calyx lanceolar-ovate; corolla nearly glabrous, its tube about as long as the lobes and calyx; lobes of the corolla roundish, simply overlapping, scalelets of the orifice closely beset with very minute hairlets; stamens inserted near the middle of the corolla-tube; filaments extremely short; anthers cylindric-ellipsoid; style very short, capillary, glabrous; stigma minute, depressed-globular; fruitlets nearly as long as the calyx, tetrahedrous-pyramidal, dull-brownish, smooth, towards the base constricted.

Crest of the Owen Stanley's Ranges.

Few to several inches high. Lower leaves attaining a length of one and a half inches; upper gradually shorter. Calyx hardly one-twelfth of an inch long. Colour of corolla unascertainable here.

Comparable as regards resemblance to T. ovalifolia, which however has a less conspicuous indument, smaller leaves, longer thinner and partly axillary pedicels, somewhat larger flowers, distinctly margined outwards broader and not quite glabrous fruitlets, the latter being more like those of T. Haackei, while the fruitlets of T. inoblita come nearer those of T. micracarpa.

Myosotis Australis; R. Brown, prodromus floræ Novæ Hollandiæ 494 (1810).

Dwarf, much beset with rigidulous somewhat appressed hairlets; leaves small, except at the base of the stem distant, from obovate-to elliptic-cuneate, almost or quite sessile; raceme short, nearly spicate; pedicels also finally shorter than the calyx; segments of the calyx lanceolar, bearing hooked-pointed hairlets; tube of the corolla downward thinly cylindric, lobes extremely small several times shorter than the tube; scalelets at the orifice very minute; stamens enclosed in the upper part of the tube, anthers ellipsoid; style as long as the corolla-tube; stigma almost globular; fruitlets nearly as long as the calyx, trigonous-ovate, somewhat pointed, shining, quite smooth, brownish.

Summit of the Owen Stanley's Ranges among Drapetes.

Description from a single specimen-plant almost out of flower.

Stem weak, few inches long. Leaves one-third to half of an inch long, absent from the upper part of the stem. Calyx hardly one-tenth of an inch long. Corolla-tube proportionately very slender, lobes twisted before unfolding. Myosotis antarctica differs in more robust stature, in absence of peduncles, in some of the flowers being singly axillar, in seemingly straight hairlets on the calyx, and particularly in shorter corolla-tube. Description from the Papuan specimen.

Possibly this species may yet become identified with some already known, when fuller material is obtained, but the writer did not like passing this opportunity of giving at least a preliminary account of a plant geographically so interesting, as only one Myosotis is known as peculiar to the Himalayas and none from the Sunda Islands. The remarkable elongation of the corolla-tube in proportion to the lobes is shared by this species with M. variabilis, irrespective of some of the section Exarrhena.

The recent restoration of Waldstein and Kitaibel's Myosotis suaveolens has led to the change of the name of Labillardiere's plant into M. exarrhena, as effected in the "Second Census of Australian Plants" instituted in 1889 and just published.

Phyllocladus hypophylla; J. Hooker, icones plantarum 889 (1852).

Mount Musgrave.

Of this "fern-leaved pine" only the foliage is available; but as others of the Kini-Balu plants have now been traced to the highlands of New Guinea, we have good reason for supposing, that it is the Borneo-species, to which our present one should be referred. The pseudo-phyllodes of the Papuan species are longer and more acuminated, than those delineated by Fitch, but seemingly other differences do not exist, so far as the branches and frondlike dilatations, the latter formed by connate leaves (not leaflets) are concerned, as viewed by Sir Joseph Hooker and as thus far comparable to those of Gingko also.

Libocedrus Papuana.

Branchlets much compressed, broadish; leafy internodes from nearly twice to finally rather more than thrice longer than broad; lateral leaves several times shorter than the marginal leaves, almost rhomboid; marginal leaves much connate, rather acute, sometimes partially glaucous; staminate amentaceous spikes very small, several crowded together at and near the summit of branchlets, almost ellipsoid and sessile; rhacheoles minute, glabrous, nearly rhomboid and sessile; anthers generally four occasionally three or rarely two to each rhacheole, almost globular.

On Mount Victoria and on others of the highest elevations of the Owen Stanley's Ranges. Breadth of leafy internodes to one quarter of an inch. Marginal leaves somewhat keeled, their length from one-eighth to fully one-third of an inch. Staminate spikes about one-quarter of an inch long, mostly opposite; rhacheoles spirally arranged in a few rows. Pollen-grains yellowish, smooth, ovate-globular. Ovulary and fruit unknown.

Considering, that all the other Conifers, hitherto known from New Guinea, are of mainly or entirely southern type, I have ventured, to assign accordingly a generic position to this plant; but it is quite possible that it will become transferable to Thuya or some other allied genus, when the fruit will have been secured, though the

Papuan plant would belong rather to the Libocedrus-region. The characteristics of the staminate spikes are, as we all know, the same in Libocedrus, in Thuya and in Biotia. Among species of Libocedrus this Papuan one approaches through the great disparity of its lateral and its marginal leaves nearest to L. decurrens; but it is separated at once by the marked broadness of its leaves, and is likely different also as regards fruits, irrespective of geographic considerations.

The collection contains furthermore branchlets of what will likely prove a Nageia, the leaves of which resemble those of N. ferruginea, but are larger and more pointed; they may however only exhibit the young state of foliage in the manner of N. cupressina, so that no clear idea about this tree can as yet be gained. In later less perilous and then not necessarily so hurried expeditions we shall doubtless learn also more about this.

Branchlets of another so-called Conifer came also from the very summit of the Owen Stanley's Ranges; but until the staminate flowers and the fruit will be discovered, this plant can neither be placed even yet into a generic position. Leafy branchlets of it are quite lycopodinous in appearance; they may represent a Dacrydium, and remind of D. cupressinum, but the foliage is much more rigid; they might also be likened to those of Pherosphæra Fitzgeraldii, but the leaves are more spreading and more pungent, so that the resemblance is still less with the foliage of D. araucarioides. Araucaria Cunninghamii appears to reach in New Guinea very high elevations. Mr. Sayer noticed it on a mountain, next to Mount Obree, up to 8000 feet, but its utmost altitudinal position has not yet been determined. Incidentally it may here be added, that for the name-giving of this Araucaria the authority is claimed by Steudel, in the Nomenclator Botanicus, edit. sec. 118, probably from the first edition of that work, issued in 1821.

It seems to me preferable, to leave the Coniferæ systematically at the end of the Dicotyledoneæ, instead of placing them next to the Lycopods, because however much they may approach the latter in some respects of anatomic structure and in peculiarities of some of their organs, yet the preponderance of their characteristics seems clearly to be with dicotyledonous plants, notwithstanding their alliance to the still more aberrant Cycadeæ. Remarkable instances of some analogies in particulars of organisation are exhibited also by other orders of plants, without thereby any close mutual affinity being indicated; thus the pluri-cotyledonous embryo of many Coniferæ is repeated by the otherwise very distant Nuytsia and by several species of the equally remote genus Persoonia, while from the similarity of the staminal apparatus of Asclepiadeæ to that of numerous Orchideæ an actual affinity of value for taxonomy could not well be demonstrated.

Dendrobium psychrophilum.

Very dwarf, tufty, glabrous; pseudobulbs consisting of a single piece, mostly truncate-ovate, much wrinkled; leaves solitary, very small, linear-lanceolar, somewhat channelled, its very short petiole enclosed in a cylindric membrane; peduncles singly from the base of pseudobulbs, thinly filiform, at the base bearing a cylindric membraneous bract and also at the middle; floral bract membraneous, almost lanceolar; calyx-tube slender and as well as the pedicel during anthesis quite short; calyx-lobes membraneous, broadly lanceolar, somewhat acuminated, the upper rather shorter, the two lower slightly protruding at the base anteriorly, lateral petals hardly of more than one third the length of the calyx-lobes, pellucidly membraneous, ovate-lanceolar, at the base blunt; labellar petal almost equalling the calyx-lobes in length, to near the summit tender-membraneous and ovate, but longitudinally concurved, ending in a short somewhat carnulent narrowly elliptic-lanceolar smooth lobe; gynostemium very short, quite adnate; anther upwards gradually narrowed.

Near the summits of the Owen Stanley's Ranges, imbedded in moss.

Fibrills copious, thinly filiform, tortuous. Pseudobulbs one-third to two-thirds of an inch long. Leaves (an only one seen) about three-quarters of an inch long. Peduncles one and a half to two and a half inches long, probably always one-flowered. Floral bract nearly a quarter of an inch long. Length of calyx-lobes about half an inch, likely as well as the petals white. Some allowance must be made for any shortcomings in the description of the floral structure, as its elaboration is based on two almost shrivelled flowers; hence the pollinia had dropped, so that the generic position needs even yet to be confirmed, the basal protuberance being also unusually small. The plant might almost as well be placed in Bulbophyllum, on the supposition of nothing contrary as regards pollinia. Some species of the epiphytal genera Dendrobium and Bulbophyllum are likely also ascending to subalpine elevations in the Himalayas, as some few congeners reach to far southern latitudes in New Zealand. This Dendrobium would likely find an apt systematic position near D. reptans.

Sisyrinchium pulchellum; R. Brown, prodromus floræ Novæ Hollandiæ 305 (1810).

Crest of the Owen Stanley's Ranges.

The specimens obtained are in incipient state of fruiting; so far they precisely agree with our southern plant. Here it is often consociated with Oxalis Magellanica, which therefore may also perhaps exist in the Highlands of New Guinea.

Korthalsia Zippelii; Blume, Rumphia II. 171 t. 130 (1836).

Owen Stanley's Ranges.

This seems to have been collected in the upper regions, to which it is however elsewhere not restricted. If it advances to high elevations, it would be one of the hardiest of all palms.

Astelia alpina; R. Brown, prodromus floræ Novæ Hollandiæ 291 (1810).

Mount Knutsford.

From tufts of other plants some few leaves of this were disentangled, and as they are very characteristic, there can hardly be any doubt about the identification; those of the narrowest variety of Aster celmisia certainly are also similar, but have not the many longitudinal venules, nor does the almost scarious indument disintegrate into straightish and flattened but into lanuginous hairlets.

Carpha alpina; R. Brown, prodromus floræ Novæ Hollandiæ 230 (1810).

Summits of the Owen Stanley's Ranges, particularly on Mount Knutsford.

A true representative of an alpine flora, as the specific name implies. The stigmas soon wear away.

Scirpus caespitosus; Linné, species plantarum 48 (1753).

Summits of the Owen Stanley's Ranges.

The few specimens from thence have the two lowest bracts hardly larger than any of the floral bracts, and the fruits nearly thrice longer than broad. Otherwise the Papuan plant does not differ from the ordinary state of this in the northern hemisphere so widely distributed species. Moreover, in some Swedish specimens I find the spikelet fully of double the length of the lowest bract, and bearing also more numerous flowers than usual, while in dwarf states, for instance from Corsica, when the spikelet is much reduced in size, the outer bracts become also quite small, whereas furthermore in specimens, collected in the Dukedom of Schleswig by myself nearly 50 years ago, the fruit is almost as elongated as that of the New Guinea plant. Should nevertheless this plant, as a variety or perhaps even as a species, require separation from the genuine S. caespitosus, then the name heleocharoides would be an apt one. In the last monography of Cyperaceæ, that by Bœckeler, the varied characteristics of this plant are still not fully met. See Garcke's Linnæa XXXVIII, 434 (1874). I find exceptionally a second spikelet developed from the basal bracts. Another Scirpus is contained in the collections, as gathered on Mount Knutsford and Mount Musgrave; it is an aged state of fructification, and may perhaps belong to the variety fluviatilis of S. maritimus.

Gahnia Javanica; Zollinger's systematisches Verzeichniss der im Indischen Archipel gesammelten Pflanzen 98 (1854).

On the crest of the Owen Stanley's Ranges.

The plant agrees fairly well with the descriptions, furnished by Hasskarl, Steudel, Miquel and Bœckler of the Java-and Sumatra-species, which ascends there already to 9000 feet. It approaches among Australian congeners closely to G. erythrocarpa.

Schoenus curvulus.

Stems thinly filiform, laxe, variously curved, streaked; leaves extremely narrow, somewhat channelled and curved or even twisted, slightly rough towards the summit, most of the lower leaves about as long as the stems, the floral leaves also elongated but gradually shorter; petioles glabrous, the lower slit, rather dilated, the upper closely cylindric, slender and nearly black; spikelets often in three somewhat distant fascicles or short panicles, but the inflorescence occasionally much reduced; peduncles very thin, some elongated; spikelets almost black, seldom brownish, linear-ellipsoid; bracts usually five, the lower shorter and acute, the upper longer and almost blunt; rudimentary sepals thin-capillary, slightly rough, surpassing the fruit; stigmas three, longer than the style; fruit trigonous-ellipsoid, the angles rather prominently margined.

Mount Victoria and other summits of the Owen Stanley's Ranges.

The species is of near alliance to the South-American Schoenus laxus, but its stems and leaves are still thinner and weaker, the spikelets are narrower and still darker in colour, the rudimentary sepals are usually numbering less, and the fruit is proportionately less broad. The very wide geographic isolation of the two speaks against their being conspecifically united.

Carex fissilis; Boott, illustrations of the genus Carex II, 86 t. 245 (1860).

On the Owen Stanley's Ranges at an elevation of about 9000 feet.

The Papuan plant agrees in all essential characteristics with specimens at low evels collected in Queensland, but has the fruits more distinctly ciliolated.

Sir William Macgregor collected a second Carex, but in incipient inflorescence only. Most likely the genus will be found rather extensively represented in New Guinea at elevations still higher than those of the Owen Stanley's Ranges.

Uncinia riparia; R. Brown prodromus floræ Novæ Hollandiæ 241 (1810).

Mount Knutsford.

The species accords perfectly with the typical plant.

Uncinia Hookerii; Boott in J. Hooker, flora Antarctica I, 91, pl. II (1844).

Mount Knutsford.

The only specimen obtained has still narrower leaves than those of the plant, illustrated in the work above quoted, and the spike is scarcely one inch long; but these differences would represent merely a small state, and there are no other discrepancies observable.

Agrostis montana; R. Brown, prodromus floræ Novæ Hollandiæ 171 (1810).

Highest region of the Owen Stanley's Ranges.

The spikelets are rather larger than in the generality of Australian specimens. The relation of this grass to A. Magellanica and A. setifolia has to be yet further studied. Steudel's description of the first mentioned agrees fairly well with our plant, in which the accessory rhacheole is not always developed. Mr. John Buchanan in his work on the "Indigenous Grasses of New Zealand" offered some very appropriate remarks about the undesirability of removing the species of the section Deyeuxia as a genus from Agrostis.

Aira caespitosa; Linné, species plantarum 64 (1753).

Mount Knutsford, at and close to the summit.

The leaves are there much oftener compressed-filiform and slightly channelled only, than flat, but otherwise the characteristics are not those of A. flexuosa. The spikelets attain there fully one-third of an inch in length; terminal membrane of the clasping-cylindric petioles is usually much pointed. Small forms of this grass resemble Catabrosa antarctica.

Danthonia penicillata; F. v. M. Fragmenta phytographiæ Australiæ VIII, 135 (1873).

At the highest elevations of the Owen Stanley's Ranges.

There from one-half to one and a-half feet high. The bulk of the obtained specimens belongs to that form, which comprises D. semiannularis, D. Unarede and D. gracilis, but some of the individual plants seem to pass gradually into D. bromoides and D. flavescens.

The separation of the hairlets into tufts on the bracts, supporting the flowers, is more or less marked, and the twisting of the main-awn is also one of degree. The collective name, here again adopted for the species, is adduced already by Palisot de Buauvois (Essai d'une nouvelle Agrostographie 29) from the Arundo penicillata of Labillardière as a distinct designation, but limited only to one form, just as Roemer and Schultes comprehended merely some varieties of the polymorphous Agrostis Solandri under the specific name A. Forsteri. Passingly the appellation D. penicillata (in the wide sense) was used in the "Vegetation of the Chatham-Islands" at p. 60 as early as 1864.

Festuca ovina ; Linné, species plantarum 73 (1753).

In the highest region of the Owen Stanley's Ranges.

This grass varies there from some few inches to nearly two feet in height, according to the situations, which it occupies. From the copious supply of specimens it may be assumed, that it is frequent there. What Mr. Buchanan figured as F. scoparia, seems to approach closely to F. ovina. Some forms from this new locality come near F. erecta. The species is particularly well given in Stebler and Schroeter's " Futter Pflanzen " p. 21-26 t. 20 (1884). Prof. Hackel has devoted in his admirable " Monographia festucarum Europæarum " p. 82-118 to the elucidation of F. ovina in its European forms, to which still other varieties might be added from extra-European countries.

Festuca pusilla ; Banks and Solander according to J. Hooker, Flor Antarctica I, 380 (1847).

Culminations of the Owen Stanley's Ranges.

Inasmuch as some other far southern plants of the Western Hemisphere have been found now also in the Papuan Highlands, I less hesitate in referring one of the small tufted grasses from there to the above-named species and to what appears to be a still dwarfer state of it, namely Poa (or Triodia) Kerguelensis. Sir Joseph Hooker's description and Mr. W. Fitch's drawing are well applicable also to our plant, unless the fruit-supporting bracts are (Poa-like) more compressed, more carinated and devoid of denticles. Further notes on it occur in the extra-volume of the Philos. Transact. of the Royal Soc. for 1879, where also, as concerning us on this occasion, is alluded to Agrostis Magellanica. In the Handbook of the New Zealand Flora I, 341, an opinion however is expressed, that the American plant may be a small form of Festuca scoparia. At the least sheltered spots ours is reduced to a height of about two inches, forming particularly compact patches. The spikelets are frequently one-flowered, when this species may be easily mistaken for an Agrostis, just as in the case of Poa uniflora. Sometimes the leaves are placed so distichously, as to give to the plant the appearance of an Oreobolus. The taller form of this grass resembles some states of Festuca ovina. A monstrous state occurs, in which the fruit-supporting bract becomes elongated pointed and uncinated, somewhat in the manner of an often similar abnormal growth in Poa alpina, and particularly like the hooked end of bracts not infrequent in Hemarthria compressa.

Another Festuca grows on the highest tops of the Owen Stanley's Ranges, where it forms small cushion-like patches ; its leaves are very short and narrow, rigid, shining, often pale and somewhat arched, longitudinally involute and almost pungently acute ; the spikelets are quite small, two or three-flowered, singly terminating very short stalks, and thus much concealed among the leaves ; the outer bracts are blunt and as well as the pointed fruit-supporting bracts neither compressed nor prominently streaked; the latter are towards the base beset with hairlets. I have not been able to identify this species with any one described, and named it *F. oreoboloides*. For want of ripe fruit the generic position cannot yet be fully affirmed, but some approach to Triodia seems also indicated.

Equisetum debile; Roxburgh according to Vaucher in Mémoires de la Société de physique et d' histoire naturelle, Genève, I, 387 (1822).

Mount Knutsford.

The specimens are devoid of fruit, but accord otherwise fully with some from Ceylon, available here. Indeed the species was recorded from New Guinea before, but is now shown to reach very high altitudes there, though in some parts of India it is even a coast-plant.

Lycopodium clavatum; Linné, species plantarum 1101 (1753).

Highest regions of the Owen Stanley's Ranges.

Lycopodium Selago; Linné, species plantarum 1102 (1753).

Near the summits of the Owen Stanley's Ranges and of Mount Musgrave.

A laxely rampant form, verging towards L. varium. Brief notes on the variability of this species are also given in the "Vegetation of the Chatham Islands," p. 62.

Lycopodium scariosum; G. Forster, florulæ insularum Australium prodromus 87 (1786).

Mount Knutsford.

The typic form. The collection contains from Mt. Knutsford also specimens (without fruit) of a plant, similar in aspect to L. scariosum, but the branches are not flattened; it may possibly be referable to L. alpinum.

Lycopodium volubile; G. Forster, florulæ insularum Australium prodromus 86 (1786).

Mount Musgrave.

Recorded from New Guinea before. In these specimens the rows of minor leaf-like organs are much less developed than usual; fruit not seen from this place.

Gleichenia dicarpa; R. Brown prodromus floræ Novæ Hollandiæ 161 (1810).

Mt. Knutsford.

There also the var. alpina.

This fern, though of a tropical type, would endure the clime of Middle-Europe and other regions in the cool temperate zone, as in the Australian Alps it fringes often the rivulets of valleys, which are covered annually during several months with snow.

Gleicheinia flagellaris; Sprengel, systema vegetabilium IV, 25 (1827).

Mt. Knutsford and Mt. Musgrave.

Evidently a comparatively hardy fern.

Specimens from Java and Mauritius, here compared, fully accord with the Papuan plant. The G. pubescens and G. pedalis of the Western Hemisphere are closely allied to this fern. Among the upland-ferns, now received from New Guinea, is also G. Hermannii, but it came not likely from the highest elevations.

Schizæa dichotoma; Smith in Mémoires de l' Academie de Turin V., 149 (1791).

Mt. Musgrave.

The plant, illustrated under the above name in Guillemin's icones lithographicæ plantarum Australasiæ rariorum 20, is a much ramified form of S. bifida, which species, unlike the genuine S. dichotoma, extends to far extra-tropic latitudes.

Hymenophyllum Tunbridgense. Smith in Roemer's Archiv fuer die Botanik I. 56 (1797).

At and near the summits of the Owen Stanley's Ranges, also on Mt. Musgrave.

Cyathea Macgregorii.

Trunk dwarf; fronds bipinnate; rachis beset with a brownish somewhat lanuginous early desiduous vestiture and at first also with paleaceous somewhat lanceolar long-acuminated membranes; pinnæ in outline elongate-lanceolar, rather rigid; pinnules narrow, quite blunt; rhacheoles imperfectly invested with crisp flattened hairlets; segments of the pinnules very small, tumid, broadly recurved at the margin, the lower mostly semielliptic and distinctly separated, the upper more roundish or almost semiorbicular and sometimes confluent, but in some instances all segments roundish; sorus-fruits two to each segment or oftener only one; indusium at first globular and almost closed, at last in its upper portion irregularly ruptured; receptacle somewhat longer than broad; sporangia from dimidiate-ovate to oblique-cuneate, narrowed gradually into a short stalk-like base or almost sessile, at the summit and along the greater part of one side annulated.

Mount Knutsford, with Ranunculus amerophyllus and Decatoca Spencerii.

What here has been regarded as the typic form of this species differs from all other congeners in the segments of the pinnules being quite turgid and their aperture only being formed gradually beneath; thus they are in structure somewhat like the ultimate frond-segments of Gleichenia dicarpa, or like the fertile segments of Onoclea sensibilis. The sorus-fruits, whether one or two, occupy the whole cavity thus formed, beyond which they partially protrude in age. This one seems unique among tree-ferns as ascending actually to frosty subalpine heights within the tropics. In this instance the effect of cold on the plant is shown by the manner, in which sometimes its fronds become curled up.

Another Cyathea occurs among these highland-plants, but at lower levels; it is of the more usual type, with flat frond-segments and more shallow indusium.

Polypodium punctatum; Thimberg, Flora Japonica, 337 (1784).

Mount Victoria.

Polypodium trichopodum.

Dwarf; fibrils very thin; rhizome creeping, closely beset with pale-brown broadish membranous scalelets; stalks longer than the fronds, capillary-thin, bearing scattered spreading rather long delicate hairlets; fronds very small, of thinly chartaceous texture, from elliptic-to narrow-lanceolar, undivided, somewhat copiously beset with very thin spreading brownish hairlets; venules concealed, free, two-branched, thickened at the end, and ceasing at a slight distance from the margin of the frond; masses of sporangia several or some few, roundish, closely approximated near the median line of the frond, occasionally reduced to two only; sporangia on conspicuous stalklets, many of them terminated by from one to four minute bristlets.

Mount Victoria.

Stalks attaining a length of four inches. Well developed fronds one to two inches long, one-sixth to one-third of an inch broad. Sorus-fruitmasses proportionately large. Bristlets of the sporangia somewhat antenna-or horn-like, rather longer than the latter.

This unexpected characteristic of sporangia bearing hairlets may perhaps become of diagnostic value in pteridography; the microscopic objects, thus presented, are remarkable and beautiful; these hairlets are accessory and superficial organs. A similar occurrence was noted by Bauer in Polypodium crenatum, and Presl seems to have observed it in several species of the section Goniopteris. Systematically this plant should be placed in the vicinity of P. setigerum and P. Hookerii.

Aspidium aculeatum; Swartz in Schrader's Journal fuer die Botanik II, 37 (1800).

Mount Musgrave and Mount Knutsford.

There were also gathered small specimens of what may be Lomaria Capensis; they are without fructification.

Taenitis blechnoides; Swartz, synopsis filicum 24 et 220 (1806).

Mount Knutsford, but perhaps not in the highest regions. It was mentioned as indigenous to New Guinea before; see "Papuan plants," II, 22.

Vittaria elongata; Swartz, synopsis filicum, 109 et 302 (1806).

Mount Musgrave, up to high altitudes.

Fully half a hundred ferns, irrespective of Lycopodiaceæ, were brought by Sir William MacGregor from the uplands of the Owen Stanley's Ranges. But as many of these may belong to the constantly misty region much below the terminal portions of these mountains, I have left most of these ferns phytographically untouched. Indeed I have, while just pressed with multifarious engagements, assigned the detail-examination of the ferns to Mr. J. G. Baker, who as a leading specialist in Pteridography since the last 25 years, aided by the princely recourses of Kew-gardens, continued in this particular direction there the previous extensive fern-studies of Sir William Hooker. As regards the two species, now described by me, Mr. Baker concurs in my view, that they should be considered as hitherto unknown. Named specimens of many of these plants, especially the new kinds, were submitted at the Royal Society's Meeting, held on the 13th September, 1889; the descriptions passed through the press in September, October and November 1889, and the whole was issued towards the end of the latter month.

Dawsonia superba; Greville in the Annals of Natural History xv. 226 t. 12 (1847).

Owen Stanley's Ranges.

This tall moss was in a sterile state brought from the less elevated ranges of New Guinea before, as mentioned already in my "Papuan Plants," II. 22. Sir William MacGregor succeeded in getting a fruit-bearing specimen now from this new region.

II. General Considerations.

The memorable expedition, so valiantly and circumspectly carried out by His Excellency Sir William MacGregor, the Governor of British New Guinea, for the ascent and exploration of the Owen Stanley's Ranges, has for the first time brought also the flora of the temperate and the sub-alpine zone of that great island within the reach of elucidation. In a brief preliminary report, written in July last, attention was drawn to the extraordinary commigration, by which plants of Asiatic, of far southern and even of sub-antarctic types had mingled together in the Papuan highlands. From the material, thus brought together, only a commencement could be made, to study the vegetation of the higher mountains regarding geographic points of view; in order to obtain a full insight into the Papuan alpine flora, it would require, to explore the hitherto inaccessible more central culminations in the island, where on tiers still some few or perhaps several thousand feet higher in yonder latitudes, according to varied physical conditions, a glacier-flora would be more fully reached. To form extensive conclusions on the nature of the Papuan alpine flora would at present be premature;

but from what we have now seen, it promises to be eminently interesting. On this occasion I shall merely group these highland-plants on geographic principles, with a hope that it may yet fall to my own share, to carry on these comparisons more amply at some future time from fuller material, the total subalpine and alpine flora of New Guinea in all likelihood comprising several hundred species of vascular plants. Such future researches will be to myself all the more fascinating, as from 1853 to 1855 the whole flora of the Australian Alps became elucidated by field-work of my own, it being utterly unknown before. In these pages is alluded only to those plants, which Sir William MacGregor gathered in altitudes between 8000 and 13,000 feet, therefore in the region above the mountain-zone, involved in almost permanent clouds.

Of the 80 plants, specifically and distinctly recorded in these pages as emanating from the most elevated regions, nearly half the number seems endemic, so far as hitherto can be judged, while not yet all the highlands of South-eastern Asia are explored, and while we yet remain in uncertainty about the constancy of some of the characteristics, on which the adopted new specific forms are systematically established. Of these restricted Papuan plants two, namely Ischnea elachoglossa and Decatoca Spencerii, represent new genera, the one allied to the exclusively Italian Nananthea, the other to the Australian and chiefly alpine Trochocarpa. Of the other endemic plants 17 are of Himalayan tpyes, namely Hypericum Macgregorii, Sagina donatioides, Rubus Macgregorii, Anaphalis Mariae, Myriactis bellidiformis, Vaccinium parvulifolium, V. amblyandrum, V. Helenae, V. Macbainii, Gaultiera mundula, Rhododendron gracilentum, R. spondylophyllum, R. culminicolum, R. phaeochiton, Gentiana Ettinghausenii, Trigonotis Haackei and T. oblita, though some of these show also a touch of the Sundaic vegetative element; and here at once may be alluded to the extensive display of ericaceous (inclusive of vacciniaceous) plants, which forms of vegetation are in Australia so very scantily developed, and then only in alpine regions. Contrarily however we now perceive otherwise almost a preponderance of upland Australian or New Zealandian or sub-antarctic types in the highlands vegetation of New Guinea, so far as already revealed; this is demonstrated by the endemic occurrence of Ranunculus amerophyllus, Metrosideros Regelii, Rubus diclinis, Olearia Kernotii, Vittadinia Alinae, V. macra, Veronica Lendenfeldii, Libocedrus Papuana, Phyllocladus hypophyllus, Schoenus curvulus and Festuca oreobaloides; furthermore this repetition of the features of the southern flora so far north is rendered still more expressive and significant by the occurrence of numerous plants absolutely identical with our southern species, namely: Epilobium pedunculare, Galium australe, Lagenophora Billardièrii, Styphelia montana, Euphrasia Brownii, Myosotis australis, Sisyrinchium pulchellum, Astelia alpina, Carpha alpina, Carex fissilis, Uncinia riparia, U. Hookerii, Agrostis montana, Danthonia, penicillata, Festuca pusilla, Lycopodium scariosum, Gleichenia dicarpa and Dawsonia superba—most of these being now shown for the first time to approach so near to the equator. Four Borneo-plants, hitherto only known from lofty altitudes of Kini-Balu, have now been traced to the Papuan highlands also, viz.: Drimys piperita, Drapetes ericoides, Rhododendron Lowii, Phyllocladus hypophyllus, three being of far southern type. Even a few of such British plants, not almost universally cosmopolitan, have now come like messengers from home before us from New Guinea as there also indigenous, thus: Taraxacum officinale and Seirpus caespitosus, these being wanting even in the Malayan islands and in continental Australia, irrespective of the widely distributed Aira caespitosa, Festuca ovina, Lycopodium clavatum, L. Selago and perhaps L. alpinum as well as Hymenophyllum Tunbridgense and Aspidium aculeatum. For the familiar northern genus Potentilla a truly indigenous position in the southern hemisphere has been gained now for phyto-geography, as well as for Myriactis and Trigonotis, while Astelia, Uncinia and Dawsonia are now seen to enter equinoctial regions in the eastern hemisphere. The Styphelia montana, the Astelia and the Carpha mentioned indicate the commencement of a truly alpine flora.

On the Finisterre-range, the ascent of which was accomplished by Mr. Zoeller and his party during 1888 (this enterprise being inspired by myself in a lengthened interview with the leader) tree-vegetation exists to the summit, therefore up to 11,000 feet, as indeed already telescopically ascertained by M. Mikluho Maclay. I can however furnish no data, which might assist our present purpose, on the nature of the vegetation there, as—against my expectation—no botanic specimens whatever, resulting from that courageous exploit, came to me as one, who since many years has been engaged occasionally on connected elucidations of the Papuan flora. Sir William Macgregor found the arboreous vegetation to cease on the Owen Stanley's ranges at 11,500 feet (despatch, July 1889, p. 10), and this cessation was not due to a change of geologic formation. The limits of tree-vegetation may however on some other Papuan culminations under altered physical conditions be somewhat higher so near to the equator, in comparison to zones of vegetation in the Himalayas at and near the verge of the tropics.

As regards prospective utilitarian gain from the world of plants, likely to emanate from this expedition, we may look forward to the acquisition of the "Cypress" (Libocedrus Papuana), which constitutes the principal forests on the summit of Mount Douglas and Winter's Height, for arboreta even of countries of the cool temperate zone, and with this cypress-like tree could doubtless be associated in parks far outside of the tropics also the tall "Bamboo" (See Sir William MacGregor's despatch, p. 8), with which the dry region above the nebular zone begins at (about 8500 feet). The several hardy and gaudy Rhododendrons could aptly be consociated by dissemination with the many Sikkin-species, now so frequent as garden-favourites. The dwarf Raspberry would give us an additional table-fruit. How far the Korthalsia-Palm would bear actual frigour, remains to be ascertained. The species of Papuan highland-grasses are rather gregarious than numerous.

Why so many plants from cold southern latitudes suddenly reappear on the Papuan and perhaps also on the Borneon highlands in evidently coeval forms of common origin; why the highest regions and these almost only should like in New Zealand reiterate plant-life, otherwise typical of Tasmania, of continental Australia, of islands in the Southern Ocean and also of Fuegia and Patagonia; whether this indicates a continuity of portions of the Papuan Island with a once vastly extending southern land, now mostly submerged; what clues can be obtained for all this from the study of glacial drifts occurring during former enormous telluric changes, such as geologic science endeavours to explain; what part possibly could have been taken by any migratory birds in effecting so wide a dispersion of some of these plants even into so exceptional isolations; all this and other momentous considerations, involved in these questions, must be reserved for future discussions and generalisations in a special essay, perhaps under the advantage of access to ampler working material, and at not too distant a day.

ARTICLE II.

The Preparation of Alkyl-Sulphine, Selenine, and Phosphonium Salts, by Orme Masson, M.A., D.Sc., and J. B. Kirkland, F.C.S.

(Read Thursday, Dec. 13, 1888.)

The usual method of preparing the salts of triethyl-sulphine (which may be taken as the type of the sulphine radicles) consists in mixing ethyl sulphide and ethyl iodide, purifying the resulting solid triethyl-sulphine iodide by crystallisation, converting this into the hydroxide by the action of silver oxide, and finally neutralising the solution of the hydroxide with the appropriate acid. The method is simple and gives a good yield. It is open, however, to one somewhat important objection, viz., that it involves, as a preliminary process, the preparation of ethyl sulphide—a liquid of such a poisonous character and possessed of such a penetrating and disagreeable odour that chemists are not generally willing to work with it.

Triethyl-selenine salts are prepared by a perfectly analogous series of operations. A similar objection holds to an even greater extent, as ethyl selenide is of more disagreeable character than ethyl sulphide. Moreover, the loss of selenium, which necessarily occurs in the preliminary process of converting it into ethyl selenide, is here a fault of considerable importance.

The salts of tetraethyl-phosphonium have been obtained by several methods, but none of them can be called wholly satisfactory. They were discussed at length by Professor Letts in a paper published in the Transactions of the Royal Society of Edinburgh (1881); and the difficulty of the problem may be judged from the fact that this investigator rejected all known methods as practically unworkable and sought for a new method to supplant them. By far the best and easiest of all hitherto known methods is that devised by Hofmann, and which consists in heating phosphonium iodide with absolute alcohol in sealed tubes to 180° for some hours. The following reactions occur:—

$$PH_4\,I + 4\,C_2H_5\,OH = P\,(C_2H_5)_4\,I + 4\,H_2O,$$
$$PH_4\,I + 3\,C_2H_5\,OH = P\,(C_2H_5)_3\,H\,I + 3\,H_2O;$$

and these two iodides are separated by addition of potash, which precipitates the former unchanged and converts the latter into the volatile free base triethyl phosphine. There are two objections to this process, however. The first is that the preliminary preparation of the phosphonium iodide is a troublesome operation if any large quantity be required; and the second is that a very great pressure is always developed in the tubes in which the alcohol and phosphonium iodide are heated, so that a considerable risk is run of losing one's time and labour and material by violent explosions. Letts, indeed, found that it was impossible to avoid losing the large majority of his tubes; and, though we have not found this to be the case when all precautions are taken, we agree with him in considering this objection as a serious one.

It is obvious that a general method of preparing such compounds as the iodides of triethyl-sulphine, triethyl-selenine, and tetraethyl-phosphonium, which gives good yields, which does not involve the use of any poisonous or troublesome compounds of sulphur, selenium, or phosphorous, and which avoids loss of material by explosions, is one that should be acceptable to chemists.

We have found the following method work well. Its most important features are the use of the elements themselves (sulphur, selenium, or phosphorus), the conversion of these direct into polyiodides by heating with ethyl iodide, and the decomposition of these polyiodides by means of water and hydrogen sulphide. The following equations illustrate the formation of sulphine salts by this method:—

(1) $S + 3\,C_2H_5\,I = S\,(C_2H_5)_3\,I_3$

(2) $S\,(C_2H_5)_3\,I_3 + H_2\,S = S\,(C_2H_5)_3\,I + 2\,H\,I + S$

(1) Powdered roll sulphur and ethyl iodide are mixed in the proportions indicated in the equation, and are heated in sealed tubes for 24 hours at 180° C. There is but slight pressure developed (due to the formation of a combustible gas by a secondary reaction), and no special precautions are necessary in making the tubes. When cold they are seen to contain a quantity of a semi-liquid black substance, easily recognised as a polyiodide by anyone accustomed to work with such bodies. The sulphur is seen to have entirely disappeared.

(2) The tarry polyiodide is washed into a tall cylinder, and covered with water to the depth of a few inches; and a current of hydrogen sulphide is then passed in until all the polyiodide has disappeared, leaving a deposit of sulphur and a clear acid solution.

(3) This solution, decanted from the sulphur, cannot be evaporated direct, as the free hydriodic acid present reacts with the triethyl-sulphine iodide. It may be treated with excess of moist silver oxide, so as to precipitate all the iodine as silver iodide, and leave a solution containing only the free base, $S\,(C_2H_5)_3\,OH$; and from this any desired salt may of course be obtained by neutralisation with the proper acid.

It is necessary to use excess of silver oxide, *i.e.*, more than enough to react with all the hydriodic acid and all the sulphine iodide present in the solution. In our first experiment we added silver oxide cautiously till the acid reaction disappeared, and then attempted to obtain the sulphine iodide by evaporation of the filtered neutral solution. Very little of the salt was obtained, although the residue of silver iodide was washed with hot water till the washings no longer gave an iodide reaction. On mixing this residue, however, with more silver oxide and water, we obtained a solution rich in the sulphine iodide; and it was found that the whole of the salt could be recovered in this way. This points to the fact that the iodides of such bases as triethyl-sulphine form *insoluble* double salts with silver iodide; and we were able to confirm this by separate experiments. These double salts differ in appearance from silver iodide itself, inasmuch as they are white in colour instead of yellow. An explanation is thus afforded of the change of colour from white to yellow, which the precipitate undergoes when silver nitrate solution is gradually added to a solution of any of these iodides of organic bases.

Quantitative experiments have been made which verify the above equations. The yield obtained in one experiment, after finally converting the base into iodide and crystallising the salt out, was more that five-sixths of that indicated by theory. The identity of the salt was established by its general properties, and by an iodine estimation (found, 51.60 per cent. of iodine; calculated, 51.62 per cent.) The method has been tried and found to work when selenium is substituted for sulphur.

In the case of phosphorus, the change which takes place during the heating is not quite so simple, though in appearance it is closely similar. Either yellow or (preferably) red phosphorus may be used, and the ethyl iodide must be taken in somewhat large excess of the proportion of 7 C_2H_5I to 2 P. The tubes are heated, as in the case of sulphur, to 180° C for about 24 hours. All the phosphorus disappears, and a liquid or semi-solid mass of black polyiodide remains. That this cannot consist wholly of $P(C_2H_5)_4I_3$ is evident if one try to construct an equation, and our experiments proved that only half of the phosphorus employed is converted into this substance and recoverable as $P(C_2H_5)_4I$ by the method already described, while the other half goes to form a compound that is converted into triethyl phosphine oxide by the action of the hydrogen sulphide and water. The theory of the reaction which is represented by the following equations is in accordance with the quantitative results of our experiments:—

$$(1) \qquad 2\,P + 7\,C_2H_5I = P(C_2H_5)_4I_3 + P(C_2H_5)_3I_4$$

$$(2) \qquad \begin{cases} P(C_2H_5)_4I_3 + H_2S = P(C_2H_5)_4I + 2\,HI + S \\ P(C_2H_5)_3I_4 + H_2S + H_2O = P(C_2H_5)_3O + 4\,HI + S \end{cases}$$

According to this theory, 3.1 grams of phosphorus should yield 13.7 grams of $P(C_2H_5)_4I$, and the weight of the precipitated sulphur should be 3.2 grams. We obtained 13.45 grams of the iodide and 3.4 grams of precipitated sulphur. The salt obtained was identified by its properties and by two iodine estimations. It was found to contain 45.98 and 45.90 per cent. of iodine (calculated, 46.35).

An alternative method of procedure, which we have found to work extremely well in this case, instead of using silver oxide, is to saturate the solution obtained after the hydrogen sulphide reaction with potash. The tetraethyl-phosphonium iodide (as in Hofmann's process) separates out, on warming, as a light oily layer; and this can be then purified completely and easily by crystallisation from alcohol. This alternative method also works when applied to the preparation of triethyl sulphine iodide; but we are not able to state whether it gives as good a yield as the silver oxide treatment.

ARTICLE III.

The Anatomy of an Australian Land Planarian, by Arthur Dendy, M.Sc., F.L.S., Demonstrator and Assistant Lecturer in Biology, in the University of Melbourne. (With plates vii, viii, ix, x.)

(Read Thursday, August 8th, 1889.)

CONTENTS.

(N.B.—The numbers inserted in brackets throughout the letterpress refer to the "List of Literature Referred to.")

Introduction.

During the Easter vacation of 1888 Professor W. Baldwin Spencer obtained a few specimens of a fine land Planarian, remarkable from the intense blue colour of the ventral surface, in the neighbourhood of McMahon's Creek on the Upper Yarra, Victoria. These specimens he kindly placed at my disposal for minute investigation, and for this, and for much help and advice during the progress of my work, I desire to record my indebtedness to him.

As the original supply of material proved insufficient for the elucidation of all the questions connected with the anatomy and histology of the animal in question, I made an expedition myself, about the end of August, 1888, to McMahon's Creek, to search for more specimens. I succeeded in obtaining about half a dozen of the worms on this occasion, and later on, in December, I obtained yet more specimens at Warburton, also on the Upper Yarra. I was thus enabled to study the animal in its living condition, and to investigate its habits, which proved very advantageous in my subsequent work.

So far as I am aware, no Australian land Planarian has hitherto been anatomically investigated, although Professor Moseley (1) and Messrs. Fletcher and Hamilton (2) have described the external characters of a number of species. Moseley, in the work referred to, observes: "I have been able to find no published description of these forms, for the reception of which I have made the new genus *Cœnoplana* . . . . Their anatomy I have not yet worked out, but a few transverse sections made show that they closely resemble *Rhynchodemus* in the structure of their lateral organs, whilst in the arrangement of their muscles they are intermediate between *Geoplana* and *Dolichoplana*, from which latter they differ principally in having many small eye-spots instead of a single pair of larger eyes." The genus *Cœnoplana* is defined as follows:—"Body long and worm-like, much rounded on the back, flattened on the under surface, without an ambulacral line. External longitudinal muscular bundles largely and evenly developed over both dorsal and ventral regions. Lateral organs* distinct and isolated as in *Rhynchodemus*, and, as in it, connected by a transverse commissure Eyes absent from the front of the anterior extremity, but present in two lateral elongate crowded patches placed just behind the anterior extremity and scattered sparsely on the lateral margins of the body for its entire extent. Mouth nearly central, pharynx cylindrical."

Messrs. Fletcher and Hamilton (2) ably criticise the new genus. "If our supposition be correct that Professor Moseley from the examination of indifferent spirit material overlooked the presence of eyes on the anterior extremity of the Australian land Planarians examined by him, it seems unnecessary, in the present state of our knowledge, to separate these forms as a distinct genus *Cœnoplana* on purely anatomical grounds (the arrangement of the muscles, and of the lateral organs). No doubt eventually it will be found necessary to take anatomical characters into account in defining the genera, and in establishing his two new genera *Cœnoplana* and *Dolichoplana* Mr. Moseley did so. But we cannot find such definitions of *Geoplana* and *Rhynchodemus* . . . . Under these circumstances, therefore, and as all the many-eyed Australian species we have met with may be referred to the genus *Geoplana* as at present defined, we venture to express the opinion that the retention of *Cœnoplana* is unnecessary."

These remarks are very much to the point, and I can heartily endorse them. So far as I am aware, only one species of *Geoplana* has been anatomically described, viz., *Geoplana traversii*, from New Zealand (1) and the description of that species is by no means complete.

At present, therefore, I consider that we are justified in distinguishing only two genera of Australian land Planarians, viz., *Geoplana*, with many eyes, and *Rhynchodemus*, with only two eyes.† That these two genera will subsequently

* Longitudinal nerve cords. A. D.

† I would here refer the reader to my subsequent observations on the eyes of land Planarians, in the present paper.

need sub-dividing is eminently probable, but this cannot be done until we have further anatomical details at our command. In the meantime I have contented myself with pointing out, during the course of my descriptions, the points of difference and resemblance between the species under consideration and those which have previously been worked out. Probably the form and arrangement of the genital organs will prove of great value to the systematist, and it will be seen that *Geoplana spenceri* differs markedly in this respect from all previously described land Planarians.

The progress of my work has been greatly impeded by the scarcity of literature. When I first commenced it I had no idea how much was known about the anatomy of land Planarians, and I had therefore the mortification of subsequently finding that some of my most interesting results, which I believed to be new, had been forestalled. Nevertheless I determined to publish my results in full, as I believe it to be of the greatest importance for Australian naturalists, and especially for students, to have a complete series of Australian types fully described.

I wish to express my very hearty thanks to Mr. J. J. Fletcher, of Sydney, for sending me copies of his own papers, and also for lending me von Kennel's very important paper on the subject (3) which I could not elsewhere obtain. I have also to thank the authorities of the Melbourne Public Library for kind permission to remove such books as I required from the Library.

I have named the species, which is new to science, *Geoplana spenceri*, in honour of its original discoverer.

Habits.

Geoplana spenceri, like other land Planarians, is found in damp situations, frequently under rotten logs. When the log under which it lies is first lifted, the animal is found more or less tightly coiled up, and as the dorsal surface is then alone visible it appears as a dark, slimy mass, almost black. Soon after being exposed to the light and air, however, the animal stretches itself out very considerably and begins to crawl about with an even, gliding motion. When crawling the animal exhibits great activity, and the narrow anterior extremity (*vide* Figs. 1 and 2), on which the eyes are situated, is uplifted as if to gain a more extended view. The course of the animal is marked by a slimy track, precisely resembling the track of a snail. One of my specimens escaped from the bottle in which it was confined, and I only succeeded in finding it again by following up the slimy track.

The slimy coating on the surface of the animal is caused, as I shall show later on, by an abundant secretion of mucous, containing numerous rod-like bodies ejected from the skin. With a view to determining whether these rod-like bodies might be any protection to the animal against being eaten by any of the numerous devourers of worms, I tried the plan of licking the surface of the animal. At first no peculiar sensation was experienced, but on applying the tongue to the roof of the mouth the result was very unpleasant, and a feeling experienced something like that caused by putting a piece of velvet in the mouth, or sucking a lump of alum. This sensation may, I think, very probably be attributed to the presence of the innumerable rod-like bodies, which may perhaps thus render the animal inedible. The function of these bodies has hitherto been a perfect mystery, and I only offer the above explanation as a possible one.* I tried the same experiment, and with the same result, upon another common Australian species of land Planarian.

The pharynx during the life of the animal is usually completely retracted and hidden within the peripharyngeal chamber (*vide* Figs. 8 and 9), and I have no observations of my own to record with regard to the food or method of obtaining it.† I must, however, quote a very interesting observation on this point, recently published by Mr. Charles C. Brittlebank in a letter to the Editor of the "Victorian Naturalist" (4) :—"During one of my night rambles I found one of those banded, leech-like worms. I think they are called Planarian worms, or terrestrial Planariæ. In Darwin's 'Voyage of a Naturalist,' p. 27, he mentions keeping some of these worms and feeding them on rotten wood. If these terrestrial Planariæ are the striped leech-like worms we find here, I think they feed on animal food as well as vegetable. The worm I found captured one of those *insects* known as wood-lice or slaters. It caught this insect by means of the mucous coating with which these worms are covered, and, after crawling over it a short time, it protruded an organ from the under side of the body, and, after some time, inserted it between the segments on the under side of the slater. In a short time I noticed the worm had increased in size; also that it had become a much darker colour, from the contents of the slater flowing into its body, and it was not long before the empty shell was all that remained of what had once been a slater or wood-louse. I found one of these worms devouring the larva of a ground beetle, but, as I did not see the worm kill the larva, I took no further notice, although the worm had the same organ buried in the larva. I mention this, as Darwin speaks of rotten wood as the food on which he fed those kept by him." These valuable observations concerning the animal nature of the food of Australian land Planarians are quite in accordance with Professor Moseley's conclusions on the subject.(6)

In two of the specimens of *Geoplana spenceri* of which I cut sections I found, embedded in the tissue beneath the alimentary canal, numerous small Nematode worms living as parasites. It is interesting to find a Nematode parasitic upon a land Planarian, and I am not aware that such a case has hitherto been recorded. Hallez, however (5) records the frequent occurrence of a small parasitic Nematode

* The rod-like bodies may possibly also serve to increase the stickiness of the mucous and thus enable the worm to hold its prey more securely.

† *Vide*, however, my subsequent paper "Zoological notes on a trip to Walhalla" ("Victorian Naturalist," Vol. vi., No. 8, December 1889).

enclosed in a cyst "au milieu des fibres musculaires rayonnantes du pharynx de la *Planaria nigra* et du *Dendrocoelum lacteum*," so that it appears that both terrestrial and aquatic Planarians are subject to these parasites.

External Characters.

The worm under consideration is a fine, handsome Planarian, some idea of the size and general appearance of which may be gathered from figures 1 and 2, which were drawn by myself from the living animal. Well-grown specimens, after preservation in alcohol (Fig. 3) measure about two inches in length, and are rather broad in proportion to their length as compared with many species. When crawling about, however, the worm elongates itself greatly, and the body becomes correspondingly slenderer.*

The dorsal and ventral surfaces of the body are very distinctly marked off from one another, the dorsal surface in the living worm being of a uniform, very dark olive green colour, almost black, and the ventral surface a beautiful cobalt blue. The colour of the dorsal surface is continued ventrally so as to form a narrow edge of dark olive green all round the ventral surface, which is much flattened.

The extreme anterior tip of the animal has a distinct brownish pink colour; it tapers off considerably in front and, as I have already pointed out, is uplifted from the ground when the animal is moving about, as would seem to be the case in all land Planarians.

The minute aperture which leads into the peripharyngeal chamber is placed nearly in the centre of the body in the mid-ventral line. The pharynx (Fig. 3, *ph.*) is a large organ of a creamy or white colour. When protruded it is seen to be cylindrical, terminating in an expanded, disk-like sucker, which has a small perforation—the true mouth—in its centre.

The common genital opening is situated about half-way between the opening into the peripharyngeal chamber and the posterior end of the body, also in the mid-ventral line.

The eyes are distinctly visible with a pocket lens, as small dark specks, at the anterior end of the body. Their exact position was determined by means of sections, and will be described subsequently.

Internal Anatomy and Histology.

A.—*The Epidermis.*—In ordinary microscopical sections of material preserved simply in alcohol it is, as already noticed by Moseley (6), very difficult, if not impossible, to make out satisfactorily the structure of the epidermis. Sections taken from an animal killed with hot corrosive sublimate, and cut by the paraffin method, are

* During my visit to Walhalla I found a number of very large specimens, some of which must have been fully six inches in length when crawling.

also very unsatisfactory for this purpose, although they show plainly enough the cilia on the ventral surface, which are difficult to make out in sections similarly prepared from ordinary spirit-preserved material. I have obtained by far the most satisfactory results in this respect from variously prepared transverse sections of a small specimen which I killed with osmic acid. Some of these sections were cut with the freezing microtome and stained, some with borax carmine and others with Kleinenberg's haematoxylin, after being cut. The difficulty in using the freezing microtome is to get the sections thin enough. Those stained with Kleinenberg's haematoxylin proved to be the best, and they demonstrated at once the very important fact of the existence of a perfectly distinct row of nuclei in the deeper portion of the epidermic layer, both on the dorsal and ventral surfaces. These nuclei had hitherto entirely escaped my notice, nor had they been previously observed by Moseley. Von Kennel (3), however, has noticed their occurrence in the German land Planarians investigated by him, and Jijima (7) describes and figures them in the fresh-water Tricladians.

In order to obtain thinner sections I resorted to the ordinary paraffin method, after staining with borax carmine, and figures 5 and 6 are based upon one of these preparations. Owing doubtless to the heat employed in melting the paraffin, the cellular constituents of the epidermis appear somewhat shrivelled up in these preparations, but this is not altogether a disadvantage as it is of some assistance in determining the boundaries between adjacent cells.

I shall now describe the structure of the epidermis in *Geoplana spenceri*, and it must be borne in mind that in this, as in other cases, my description and figures are the result of the examination of a very large number of sections prepared in a variety of ways.

The epidermis, as is well known in other forms, is not of the same thickness all over the body, being very much thicker on the lateral and dorsal than on the ventral surface. I have observed cilia on the ventral surface only. Moseley (6) concludes that in *Bipalium* and *Rhynchodemus* cilia are present all over the body, although he did not succeed in making them out on the dorsal surface. He further adds "Max Schultze, though he did not see cilia in *Geoplana*, yet concludes that it must be covered all over with them from the experiments of Fr. Müller, who covered the body of one of these Planarians with arrowroot, and observed a motion of the particles which served to show the presence of cilia. Darwin came to the same result from the observation of the motion of air-globules in the slime of *Geoplana*. Mecznikow found the skin of *Geodesmus bilineatus* covered with cilia."

In a later paper (1) the same author states that in a transverse section of a fresh animal *(Geoplana flava)*, examined in saliva, cilia were present over the entire dorsal surface, where, however, they are very short and difficult to see, whereas they are very long and strong on the ventral surface. In *Geoplana traversii*, however, described in the same article, Moseley could not detect cilia on the dorsal surface, either by direct observation or experiment.

I must consider the presence of cilia on the dorsal surface of *Geoplana spenceri* as a point still requiring demonstration. It seems hardly probable that they can have escaped detection in my specimens, preserved as they were with the utmost care. Nevertheless it is possible, as observed by von Kennel (3), that their presence might be hidden by the numerous ejected rod-like bodies.

I also repeated the experiments of Fritz Müller, following Moseley's example in using small pieces of paper instead of arrowroot, but with no very definite results, and I am inclined to think that the observed motion of particles on the dorsal surface may perhaps, at any rate in some cases, be accounted for by the muscular action of crawling, and by the natural flowing off of slime from the surface.

Epidermis of the Dorsal and Lateral Surfaces.—According to Moseley (6), "the entire substance of the epidermis is probably made up, in the living condition, of cells resembling the gland-cells described, but of various dimensions, and of cells containing rod-like bodies." If there existed an epidermis of this structure it would be a very curious fact, as no mention is made of any ordinary, nucleated cellular elements. Moseley, however, was evidently led astray in his conclusions by the unsatisfactory condition of his material. As a matter of fact, the constituents of the epidermis mentioned by him are no part of the epidermis proper at all, but are simply wanderers on their way to the surface from the deeper layers of the body.

The epidermis on the dorsal and lateral surfaces of *Geoplana spenceri* is made up of closely packed, elongated columnar cells, each with an oval or rounded nucleus at its base (Fig. 6). The bodies of these cells are very delicate, and they very readily shrivel up. Wedged in between them are found numerous other structures, which are so abundant as very greatly to obscure the epidermic cells, and which Professor Moseley mistook for the true epidermic structures. They are of two kinds—(*A*) *Masses of mucous* (Fig. 6, *mu.*) on their way to the surface from the deep-lying glandular cells (slime-glands). These masses of mucous are characterised by staining very deeply with borax carmine; sometimes they appear almost homogeneous, and sometimes coarsely granular, but I have no doubt they are all one and the same thing. In some cases they are seen to be continued by narrow stalks for some distance below the epidermis (Fig. 10), and they are obviously blocks of mucous, hardened by the action of the reagents employed whilst in process of extrusion. Moseley describes and figures similar bodies in the forms investigated by him (6); he speaks of them as "irregular elongated masses of finely granular material which stain deeply with carmine, and as they are often seen to be in connection with the glands beneath the skin, are probably masses of slime hardened by the spirit in the act of their extrusion by these glands." The same author, however, also speaks of certain "gland-cells," which he describes as large, oval sacs, filled with granular contents; these, I believe, to be also simply masses of hardened mucous, derived, as before, from the glands beneath the skin. I do not know that there is any evidence, unless it be the supposed presence of an investing membrane, for regarding them as cells, and the appearance of such a membrane may readily be accounted for by supposing it to be the remains of some of the true columnar cells shrunk on to the mass of mucous. (*B.*) *Rod-like bodies* (Fig. 6, *r.*) These are narrow, cylindrical rods, commonly found in groups of several together, and very often more or less curved. They appear very dark in colour, partly because they take the stain well, and partly because they are naturally of a very dark colour, owing to the pigment contained in them. They are seen in vertical sections in various positions on their way out from the special zone of rod-like bodies to the outside of the body, where they occur in great abundance in the layer of mucous which immediately clothes the epidermis. I shall give a fuller account of these bodies in the proper place; meantime I may observe that they are doubtless homologous with the rod-like bodies described by Moseley in *Bipalium*, although presenting certain points of difference which will be best understood by referring to his original paper. (6)

Epidermis of the Ventral Surface.—The transition between the epidermis of the lateral and ventral surfaces takes place quite suddenly, on each side of the body, along the line of junction between the dark olive green colour of the dorsal surface with the bright cobalt blue of the ventral.

The epidermis on the ventral surface, as has been already indicated, does not form nearly such a thick layer as it does on the dorsal and lateral surfaces. It is composed of closely packed, nucleated, rather short columnar cells, each bearing a large number of short cilia on its outer surface. Three of these cells are represented in figure 5, where it will be seen that the delicate bodies of the cells have shrunk away from one another in the preparation, so as to leave wide gaps between. Deeply staining blocks of mucous are frequently met with, wedged in between the cells, but rod-like bodies are not nearly so abundant as on the dorsal surface, though I believe they occur in small numbers, and their presence may naturally be inferred from the fact that the special zone of rod-like bodies, as I shall show subsequently, is continued ventrally.

Thus it appears that the epidermis of the land Planarians consists of a layer of nucleated columnar cells, which, on the ventral surface at any rate, are abundantly ciliated. The true structure of the epidermis is, however, greatly obscured by the presence of numerous rod-like bodies and blocks of mucous wedged in between the cells, and especially abundant on the dorsal surface. Moseley (6) appears to have mistaken these two kinds of bodies for the real epidermal elements, and to have overlooked the columnar cells. He states, however, that "Max Schultze found cuticular cells present in *Geoplana*." Von Kennel (3) describes briefly, but without figures, the structure of the epidermis in the German land Planarians, and recognises its true nature. Jijima (7), in the case of the fresh-water Tricladians, comes to much the same conclusions as those arrived at by von Kennel and myself in the case of the terrestrial forms. He observes, "Einzelne Drüsen, wie sie Moseley beshreibt, sind niemals in dem Epithel vorhanden und ich muss deren Annahme mit Kennel für eine durch die unvollkommene Behandlung hervorgerufene Täuschung erklären." The structure of the epidermis, as described and figured by Jijima in *Planaria polychroa*, bears considerable resemblance to what occurs in *Geoplana spenceri*. I would refer especially to his figures 4 and 5 (Taf. xx.). He describes and figures the nucleus, however, as occurring in about the middle of the cell, and von Kennel makes a similar observation with regard to the nucleus in the ventral epidermic cells of the forms examined by him, while in *Geoplana spenceri* it occurs at the base of the cell. Jijima also describes the rod-like bodies as occurring *within* the individual cells of the epidermis, instead of *between* them, as in *Geoplana spenceri*. I am inclined to think that he must be mistaken in this respect, for it is hardly conceivable that the rods, which originate in deep-lying mother cells, should, after leaving the latter, again enter another kind of cell. Jijima's description of the nuclei themselves, as roundish bodies containing a great number of strongly stained granules, agrees precisely with my own observations. He also notices a fact with which I have been repeatedly struck in the case of *Geoplana*, and which may be best stated in his own words, "Kerne von solcher Beschaffenheit treffen wir auch in allen übrigen Geweben des Körpers mit Ausnahme der Eier und gewisser Drüsenzellen."

Special Modification of the Epidermis in the Peripharyngeal Cavity.—When the pharynx is retracted it lies in a very definite cavity, which opens on to the ventral surface of the body by a minute rounded aperture, as shown in figures 8 and 9. The outer surface of the pharynx itself is lined by a richly ciliated epithelium, which is continued for a short distance all around the insertion of the pharynx, as far as the points marked *a* and *c* in the figures. Also, the ordinary epidermis of the ventral surface of the body appears to be continued for a short distance inside the opening of the cavity, as far as the points marked *b* and *d* in the figures. Over the remainder of the wall of the peripharyngeal cavity the epidermis becomes peculiarly modified to form a glandular organ, which appears to have been hitherto unnoticed. The epidermic cells increase greatly in size and lose their cilia, and in their most highly developed condition they assume an inverted flask-shaped form. These flask-shaped cells are shown in figure 7. They lie with their narrow ends resting on a thin basement membrane, and their broad rounded ends directed towards the lumen of the cavity. Each cell is differentiated into two tolerably distinct regions—*(a)* the neck, which is comparatively hyaline, and contains the granular nucleus; and *(b)* the body of the cell, which is coarsely granular, and stains very deeply indeed with borax carmine.

At the point marked *c* in figures 8 and 9 the transition between the ciliated and glandular epithelium is very abrupt indeed, as shown in figure 7. This was observed in two distinct series of sections. In other places it is not so easy to make out the boundary line between the two kinds of cells, but it appears to be generally better marked along the dorsal margin of the glandular epithelium than along the ventral. In some parts also the glandular cells are not nearly so distinctly flask-shaped as in the portion figured, being more irregularly massive and often also of smaller size. This is especially the case towards the ventral border of the glandular zone, and perhaps we have here a more or less gradual transition between the two kinds of epithelium.

I have spoken of the peculiarly modified epidermic cells as glandular without being able to offer any absolute proof that they are so; still I think there can be little doubt of the correctness of the view I have taken. They probably secrete a fluid which fills the peripharyngeal cavity, and may be of service as a lubricant in the protrusion and retraction of the pharynx through the very narrow opening of the cavity in which it lies. The coagulated remains of such a fluid are visible in my preparations. These cells are not, however, the only structures from which such a fluid may have been derived, for in the angle where the pharynx joins the wall of the cavity the ordinary glandular tissue (to be described later on) appears strongly developed beneath the epidermis. This tissue by itself, however, would scarcely be sufficient to secrete all the fluid necessary to fill the cavity.

Perhaps stronger arguments in favour of the glandular nature of the modified epidermic cells are to be found in their peculiar structure, and in the difficulty of assigning to them any other function. They appear to be merely modifications of the ordinary columnar cells of the epidermis, and to be the only true gland cells existing in that layer. They probably discharge their contents by rupture of the cell-wall at its outer extremity.

B.—The Basement Membrane.—This is distinctly visible in some preparations as a very thin, structureless layer, immediately underlying the epidermic cells, just as described by Moseley (6); but very often it cannot be made out as a distinct layer.

C.—The Muscular System.—With regard to the muscular system of *Geoplana spenceri*, the first feature which strikes the observer is its close correspondence in arrangement with what Moseley (6) has described in *Bipalium* and *Rhynchodemus*, and later (1) in *Geoplana traversii*. So close is this agreement that were it not for the fact that I wish to give as complete an account as possible of the minute anatomy of *Geoplana*, which may be of use especially to Australian students, and also to enunciate certain views, which I believe to be new, regarding the homologies of the muscular systems in the land and fresh-water Tricladians, it would scarcely be necessary to do more than refer to Moseley's descriptions and figures. Von Kennel (3) could find no external circular muscle sheath in the forms examined by him, and I believe he has more or less misunderstood the entire arrangement; it is, therefore, not necessary to discuss his observations on the subject.

In the first instance, I propose to describe the different muscular systems in detail, following the arrangement proposed by Moseley in his admirable memoir already cited. (6)

This author distinguishes between two principal systems of muscles, superficial and deep. Together with these he describes the special arrangement met with in the "ambulacral line" (where such exists), but the special muscles of the generative and digestive organs are described together with the other parts of these systems. The lateral muscular organs described by Moseley under the designation of "ambulacral lines" do not exist in *Geoplana traversii* nor in *Geoplana spenceri*, and hence the arrangement of the muscular system is to some extent simplified.

Superficial Muscular System.—This consists of two well-marked, perfectly distinct muscular coats, the only two really definite and distinct coats which it is possible to recognise throughout the body. The outermost lies immediately beneath the basement membrane of the epidermis, and forms but a very thin layer. This corresponds to and is homologous with the external circular layer of Moseley. It is composed of two distinct sets of muscles, and, as far as I can make out, only two. The muscular bands of each set run approximately parallel to one another, but cross those of the other set obliquely, so as to leave a series of diamond-shaped interspaces (Fig. 19). This arrangement agrees precisely with that of the "decussating" fibres described and figured by Moseley (6) as occurring in the external circular layer. Moseley, however, states that some fibres take a directly transverse or circular course, a remark which I am unable to confirm in the case of *Geoplana*. He also observes that this layer of muscles is thickest in the dorsal region, and inferiorly on each side of the ambulacral line. In *Geoplana spenceri* it also seems to be somewhat thicker on the dorsal than on the ventral surface, but there is no great variation. Each muscle band is made up—at any rate usually—of two or more delicate fibres.

The inner of the two coats constituting the superficial muscular system is a layer of very well marked and strongly developed longitudinal muscles—the external longitudinal layer. This layer is rather more strongly developed on the ventral than on the dorsal surface of the animal, doubtless in relation to the crawling movements; but the difference is not so great as described by Moseley (1) in the case of *Geoplana traversii*. It is composed of a series of muscular bands, each made up of a number of separate fibres. These bands run, as a rule, approximately parallel to one another, but they not infrequently branch and anastomose, as represented in figure 19. They are separated from one another by considerable intervals, about twice as wide as the bands themselves, or perhaps sometimes wider, and it is through these spaces between the muscles that the rod-like bodies pass on their way out to the surface (Fig. 19). The muscular bands forming this layer are much stouter than those of the external circular (or more properly oblique) layer.

The external circular (or oblique) and external longitudinal layers of muscles are immediately contiguous, and it is a remarkable fact that the two together are not quite so thick as the epidermis of the dorsal surface (*vide* Figs. 4 and 15).

Deep Muscular System.—The deep muscular system is separated, as in *Bipalium* and *Rhynchodemus*, from the superficial muscular system by a broad zone of tissue. Moseley (6) states that this intervening zone is occupied by loose radiating fibres and various skin organs. In *Geoplana spenceri* the radiating fibres (Fig. 15, *r.f.*) are poorly developed.

The deep muscular system itself (Fig. 15, *y.*) forms a layer around the alimentary canal considerably thicker than the last-named intervening zone, and very much thicker than the entire superficial system. It consists principally of two distinct sets of fibres, which are not arranged in definite layers but occur intermingled in the same mass. The fibres of the one set are arranged longitudinally, as shown in the figure, while those of the second set run round the body, sometimes almost or quite circularly, so that their cut ends only (Fig. 15, *c.f.*) appear in longitudinal sections, but very often obliquely in two main directions, crossing one another at various angles. Between the various fibres of the deep muscular system we find glandular structures and a few nuclei. In the same layer are also found the radiating ends of the bolting muscles (Fig. 15, *d.v.*), whose main direction is dorso-ventral, but which run at various angles between the diverticula of the alimentary canal (*vide* Fig. 4).

Moseley (6) mentions that specially stout muscular fibres, which he regards as derived from the circular portion of the deep layer, pass transversely immediately beneath the digestive tract. Very distinct fibres, which evidently correspond to these, are plainly visible in my transverse sections of *Geoplana spenceri*, running across above the longitudinal nerve cords, as shown in figure 4. This system of fibres, which is of very constant occurrence, may be conveniently termed "supra-neural."

Thus the general musculature of the body agrees closely with that which Moseley has made known in other land Planarians. If, however, we try to draw any comparison with the muscular system of the fresh-water Tricladians, as described by Jijima (7), we find ourselves face to face with a somewhat difficult question. It is necessary first to remember that the only really distinct and well defined muscle layers—indeed, the only muscle layers at all—which can be considered as belonging to the superficial or "skin" system in *Geoplana*, are the external circular (or oblique) and external longitudinal layers, which are evidently the homologues of the external circular and external longitudinal layers of Moseley.

Jijima, in his very important work on the fresh-water Tricladians, already referred to, distinguishes between "Hautmuskulatur" and "Körpermuskulatur." In the first he includes the different layers of muscles lying beneath the skin at the periphery of the body, and in the second the dorso-ventral and transverse muscles. The homologues of the two constituents of the "Körpermuskulatur" are evidently to be found in the dorso-ventral (or bolting) and transverse (or supra-neural) muscles of *Geoplana*. The question arises, "Is the superficial muscular system of Moseley the equivalent of the "Hautmuskulatur" of Jijima, or does the latter include also the longitudinal and more or less circular fibres of Moseley's deep system?" According to my view of the case the "Hautmuskulatur" of Jijima is the equivalent of the superficial muscular system of Moseley, and the longitudinal and more or less circular fibres of Moseley's deep system are an extra development, either wanting or poorly developed, and not yet recognised in the fresh-water forms. An examination of Jijima's figures 3 and 4 (Taf. xx.), and comparison of the same with my own figures, seem to me to establish the truth of this view. It will be seen from these figures that the whole of the "Hautmuskulatur" in *Planaria polychroa* forms a thin layer lying immediately beneath the basement membrane of the epidermis, and occupying a thickness much less than that of the epidermis itself. Moreover, Jijima's figures show it lying entirely outside the special zone of rod-like bodies and the nerve sheath, exactly as is the case in *Geoplana*. In short, the internal longitudinal muscles of *Planaria polychroa*, which form the deepest layer of the "Hautmuskulatur," correspond precisely in position to the external longitudinal muscles of *Geoplana* and other land Planarians, and the two layers are, I believe, homologous.

This longitudinal layer of muscles appears to be constant in both terrestrial and fresh-water Tricladians, while all the other layers are subject to more or less variation in the different forms. This constancy of the one layer only appears to me to indicate that this layer alone is homologous throughout the terrestrial and fresh-water *Tricladians*.

Jijima gives the following tabular scheme of the arrangement of the muscle layers in the forms examined by him:—

	Planaria polychroa.	*Dendrocoelum lacteum.*	*Polycelis tenuis.*
Superficial System. (Hautmuskulatur.)	Circular fibres.	Circular fibres.	Circular fibres.
	External longitudinal fibres.	———	External longitudinal fibres.
	Oblique fibres.	Oblique fibres.	———
	Internal longitudinal fibres.	Longitudinal fibres.	Longitudinal fibres.
Deep System. (Körpermuskulatur.)	Transverse fibres.	Transverse fibres.	———
	Dorso-ventral fibres.	Dorso-ventral fibres.	Dorso-ventral fibres.

This may be compared, in what I believe to be the correct manner, with the musculature of the terrestrial forms as follows:—

	Bipalium and Rhynchodemus.	*Geoplana spenceri.*
Superficial System.	External circular & oblique fibres.	External oblique fibres.
	External longitudinal fibres.	External longitudinal fibres.
Deep System.	Internal longitudinal and more or less circular fibres.	Internal longitudinal and more or less circular fibres.
	Transverse fibres (supra-neural).	Transverse fibres (supra-neural).
	Dorso-ventral fibres.	Dorso-ventral fibres.

Thus it appears that in the fresh-water Tricladians the superficial muscular system is, usually at any rate, more highly developed, and contains more layers than in the terrestrial forms, and that *the internal longitudinal layer of the fresh-water forms is the homologue of the external longitudinal layer of the terrestrial forms.* On the other hand, the terrestrial forms have developed a much more extensive body, or deep muscular system than the fresh-water forms, and this is doubtless correlated with the changed habitat and the thickened form of the body as opposed to the thin flattened form of the latter.

Perhaps the strongest argument in favour of the views here advanced with regard to the homologies of the muscle layers in the terrestrial and fresh-water Tricladians is the relative position of the nerve sheath. This, as I shall show later on, is situated in *Geoplana* just beneath the external longitudinal layer of muscles. In the fresh-water Tricladians, according to Jijima, the nerve plexus (or sheath) occurs immediately beneath the *inner* longitudinal fibres of the skin musculature. Now, if these two layers of muscles, called outer in one case and inner in the other, are really homologues, as I believe, then the position of the nerve sheath in the land and fresh-water Tricladians is the same, as might be expected on purely *à priori* grounds.

D.—The Alimentary Canal.—The alimentary canal of *Geoplana spenceri* has the typical Tricladian form, consisting of a pharynx and three main branches, one of which runs anteriorly in the middle line while the other two run posteriorly, one on each side of the genital aperture.

The Pharynx and Peripharyngeal Cavity.—The pharynx is large, and when protruded somewhat trumpet-shaped, consisting of a short cylindrical tube, terminating in a flattened, disk-like expansion at its free end. In the centre of the flattened disk is a small aperture, the mouth. During the life of the animal the pharynx is usually completely hidden within a large cavity, which I have called the peripharyngeal cavity, but it is sometimes protruded when the animal is preserved in spirit (Fig. 3). Figure 9 shows the pharynx lying within the peripharyngeal cavity in the retracted state; it will be seen that it is attached to the dorso-anterior wall of the cavity, with its free end pointing backwards; while the terminal, disk-like portion is closely folded together. Figure 8 shows the pharynx when about half protruded through the opening of the cavity; the terminal, disk-like portion is becoming expanded. Von Kennel (3) has aptly compared the protrusion of the pharynx in land Planarians to that of the human tongue.

Although the peripharyngeal cavity itself cannot be considered as forming any portion of the alimentary canal, yet it will be convenient to say a few words about it in this place. Its general form, as seen in longitudinal section, may be gathered by reference to figures 8 and 9; it is wide in front, and narrows gradually posteriorly, so as to run out into a sharp angle, which appears in transverse section in figure 4. It communicates with the exterior by an aperture whose position has already been described. When the pharynx is completely retracted this aperture is very minute, though distinct, and transversely oval in form, with its margins flush with the general surface of the body. When, on the other hand, the pharynx is protruded the aperture is necessarily greatly distended in order to admit of its passage. I have already described, when speaking of the epidermis, the peculiar glandular tissue which lines the greater part of the peripharyngeal cavity. The cavity itself appears to me to be simply an invagination from the exterior, and its opening has, I believe, nothing to do with the true mouth of the animal, which is situated in the centre of the disk-like termination of the pharynx. A precisely similar condition obtains in such forms as *Leptoplana* and *Cestoplana*, and is admirably shown in the diagrammatic figures given by Lang in his work* on the Polycladia of the Gulf of Naples. (8)

Histological Structure of the Pharynx.—In transverse or longitudinal sections the outermost layer of the pharynx wall is seen to be made up of a single layer of very small, richly ciliated, columnar cells. Von Kennel (3) regards this layer as "Eine feine homogene Schicht, die sich mit Picrocarmin gut färbt, und die sehr zahlreiche, aber kurze Cilien trägt; Kerne sind darin nicht zu erkennen, ebensowenig Zellgrenzen; dennoch darf man annehmen, dass diese Lage aus vershmolzenen Plattenzellen gebildet ist." This view must have been based upon unsatisfactory preparations; certainly the cells are very minute, and by no means easy to make out satisfactorily. Near to the insertion of the pharynx these epidermic cells are completely obscured by numbers of closely packed blocks of mucous wedged in between them. These blocks themselves simulate a columnar epithelium, but their homogeneous, deeply stained

* Unfortunately, I have been unable to obtain access to this valuable monograph during the progress of the present work, and have only been able to refer to copies of a few of the figures made before I left England.

appearance, and their evident connection with irregular masses of mucous lying beneath the epidermis, at once reveal their true nature. Although the true columnar cells are thus completely hidden by the masses of mucous, their cilia are still plainly visible on the surface, as will be seen by reference to figure 29.

Immediately beneath the epidermis there appears a thin layer of longitudinal muscle fibres, and beneath this again a thin layer of circular muscles, exactly as described by von Kennel (3) in the forms examined by him. Thus it appears that the relative position of the longitudinal and circular layers of muscles is here exactly the reverse of what it is in the integument generally. The thin layer of circular muscles is followed, after an interval in which glandular tissue and nuclei, with only a few fibres, occur, by a very thick layer of longitudinal muscles, which demand special attention on account of certain peculiarities in their component fibres. These are much thicker and stain much more deeply than the ordinary muscle fibres, and they are also granular. They are very conspicuous in longitudinal sections of the pharynx, and in general appearance resemble glandular tissue, but instead of running towards the surface of the pharynx, as would be the case were they glandular structures, they run parallel with it. Beneath this layer of longitudinal fibres comes a thick layer of circular fibres, exhibiting the ordinary histological characters and immediately surrounding the lumen of the pharynx.

In addition to the muscle layers thus enumerated there occur a number of radial fibres, running from the inner circular layer towards the outside, so that the agreement of the muscles of the pharynx in their arrangement with those described by von Kennel in the German land Planarians is complete.

The lumen of the pharynx is lined by a single layer of rather large, irregular, columnar cells. These in section appear shrivelled and very much vacuolated; they stain very lightly indeed, but each one has a very distinct oval nucleus which is coarsely granular and stains readily. The free surface of this epithelium is not smooth and even, but wavy and indented. I have not succeeded in detecting the line where it meets the ciliated epithelium of the outside of the pharynx, but the latter appears to be continued over the lip of the pharynx for some little distance.

The three main Branches of the Alimentary Canal.—The lumen of the pharynx leads upwards and forwards into that of the great anterior branch of the alimentary canal, and from the region where the two unite spring the two posterior lateral branches, running backwards, one on each side of the middle line. All three main branches are themselves very narrow and laterally compressed, but they give off on each side numerous blind diverticula, placed close together throughout the length of the alimentary canal. These diverticula are frequently branched, and, so far as I can make out, they are quite irregularly arranged. They are compressed from before backwards, perhaps owing to the state of contraction caused by preservation, so that in a vertical longitudinal section of the entire animal they appear elongatedly oval in outline (Fig. 10. *al. c.*)

In *Geoplana traversii* Moseley (1) describes and figures a remarkably regular arrangement of the openings of the lateral diverticula into the main canals. He says: "The arrangement of the openings of the diverticula into the main canals is shown in Pl. XX. Fig. 6. The mouths of the diverticula appear as vertically directed, irregularly oval slits which are arranged in a line on the outer walls of the main canals and are of two sizes, smaller ones alternating with larger. A narrow longitudinally directed groove or depression connects the middle of the mouths of the diverticula with one another." According to von Kennel, Mecznikow also (whose original paper I have not seen) appears to have figured a regular arrangement of the diverticula in *Geoplana*. Von Kennel, however *(loc. cit.)*, denies their regularity, and observes, "wie er es angestellt hat, solche Bilder zu erhaltes, ist mir räthselhaft."

Moseley (6) records the interesting fact that no diverticula are present on the inner side of the two posterior main branches in *Bipalium* and *Rhynchodemus*, but in *Geoplana traversii* he states (1) that they occur in the position named, as also is the case in *Geoplana spenceri*.

At the extreme anterior end of the animal the alimentary canal diminishes in size, and finally terminates in a small chamber above the nerve ganglion, as shown in figure 10.

Histological Structure of the main Branches of the Alimentary Canal and their Diverticula.—Before describing the histology of the digestive epithelium in *Geoplana spenceri*, it will be well to notice the very concise observations of von Kennel (3) upon the subject. Von Kennel found everywhere a simple, high, cylindrical epithelium, the cells of which were placed very close together, and usually resting, not perpendicularly, but obliquely, on the surrounding tissue. Between the ordinary homogeneous and pale-coloured cells were found more or less numerous isolated, spherical cells, which appeared highly granular or reticulated, and which the author regards as unicellular glands. All the cells had oval nuclei in their basal portions, and in many larger or smaller brownish concretions occurred at the central end of the cell, but these were not found in the so-called unicellular glands. In the adult animals the nuclei were so numerous and the cells so small that they were difficult to distinguish, and therefore not figured, but the author convinced himself that the epithelium always remained one cell thick, and he nowhere observed cilia. It was found that very often the alimentary epithelium was completely destroyed by the action of the re-agents employed, especially when these penetrated slowly, and in such cases the lumen of the canal was found clothed by irregular heaps of granules, such as had been previously figured by Moseley. (6) Outside of the epithelium no firm canal wall was found, but the cells were placed immediately upon the surrounding connective tissue, or at most there were a few muscle fibres in the neighbourhood of the canal and its diverticula.

The histological structure of the alimentary epithelium in *Geoplana spenceri* agrees fairly well with what is here described by von Kennel for the German land Planarians. The cells are usually more or less columnar in outline, with oval, granular nuclei and great numbers of highly refractive granules, which are probably identical with the concretions mentioned by von Kennel and the granules figured by Moseley. Sometimes, however, owing possibly to scarcity of food, the large granules are absent, and the protoplasm of the cells appears much more abundant, finely granular, and vacuolated. Figure 16 is drawn from a section cut with the freezing microtome from the anterior end of a young specimen killed with osmic acid and stained with borax carmine before cutting. From this figure it will be seen that the epithelial cells are not always arranged in a single layer, as described by von Kennel, though such is frequently the case. The cells here figured resemble those lining the lumen of the pharynx excepting in the presence of the abundant granules, which is doubtless due to the exercise of a digestive function not possessed by the latter. Digestion is obviously intracellular.

A slight, but highly interesting modification of the digestive cells occurs in the main canal just before its anterior termination, as observed in a specimen killed with corrosive sublimate and cut by the ordinary paraffin method. The wall of the alimentary canal is here made up of a single layer of closely packed, very much elongated cells, each with an oval, granular nucleus in its basal portion. The base of the cell, containing the nucleus, is slightly expanded, and is followed by a very long and narrow neck, projecting into the lumen of the canal and terminating in a large, swollen head of irregular shape. The difference in the nature of the cell-contents in the different portions of one and the same cell is very striking. The part containing the nucleus, and also the neck of the cell, are uniformly but finely granular, and stain moderately, the granules being placed close together. The irregular free termination of the cell, however, is in itself quite hyaline and transparent, and does not stain at all, but it contains a considerable number of large granules scattered irregularly through it, and these stain very deeply. The *Amœba*-like irregularity in the form of this portion of the cell leaves little doubt in my mind that during life it exhibited more or less active amœboid movements, feeding like an *Amœba*, and passing the digested food alone through the narrow neck to the deeper part of the cell, and thence to the tissues beneath. That only the digested food is passed down the neck may be gathered from the fact that no large granules occur in the deeper part of the cell. Figure 18 represents a group of these cells drawn from the specimen referred to.

Figure 17 shows another modification of the digestive cells, found in a diverticulum a short distance behind the pharynx of another specimen. The animal in this case was simply preserved in alcohol, and the sections cut by the paraffin method. The cells in question are globular, and considerably smaller than the ordinary digestive cells described at first. Each contains a nucleus, a very small quantity of protoplasm, greatly vacuolated, and a number of large, highly refractive granules. I have not found them arranged in a definite layer, but scattered about in the lumen of the diverticulum amongst quantities of large and small granules. They are very possibly cells which have completed their digestive functions and are undergoing dissolution.

I can fully confirm von Kennel's observations with regard to the heaps of granules of which, in most sections, the wall of the alimentary canal appears to be composed; they are doubtless derived from the breaking down of cells filled with granules, such as those which I have been describing. The breaking down of these cells is probably partly, but not entirely, due to the action of the re-agents, for I believe the granules to be mostly excretory products which are sooner or later naturally set free by the breaking down of the cells, and then discharged through the mouth.

In short, the following appears to me to be the most correct view concerning the nature of the lining epithelium of the alimentary canal. It consists primitively of a single layer of amœboid cells, which take in and digest food particles. At the anterior end of the alimentary canal, where we may suppose that only a little food can find its way, these cells retain their amœboid character, and remain in a single layer. Nearer the mouth, however, where there is more food to be digested, the cells become so numerous that there is no longer room for them in a single layer, and we consequently find them in irregular heaps. Even these cells are probably amœboid, at any rate in the earlier stages of their existence; they soon, however, become densely charged with granules (excretory products), and their protoplasm at the same time seems to dwindle away, so that ultimately we have mere thin-walled bags full of granules, which, sometimes at any rate, become rounded off and no longer form a definite layer. Finally the cell wall ruptures, and the granules are discharged into the lumen of the alimentary canal, thence to be ejected through the mouth.

A somewhat similar condition of affairs has been described by Hallez (5), in the case of *Mesostomum ehrenbergii*. In this species the walls of the intestine are formed of tabular cells. During digestion these cells swell considerably, until they attain ten times their original volume; their contents become more transparent, and sometimes fatty drops appear in the interior. At the same time the nucleus disappears, after having become reticulate. Soon the cell, considerably distended, appears as a perfectly transparent sphere, without proper walls, apparently formed of a very thick liquid, and enclosing in its centre a refractive globule, resembling a concretion. At this stage the sphere detaches itself from the wall of the intestine, and forms a veritable *deliquium*. The refractive globules, or concretions, are finally discharged through the mouth.

Hallez also observes, " ces sphères transparentes, avec leur concrétion centrale, qui remplissent l' intestin de tous les Turbellariés (Rhabdocœles et Dendrocœles), et qui parfois se fusionnent plusieurs ensemble, ont certainement été vues par tous les naturalistes qui ont observés de ces animaux, mais jusqu'à prèsent personne, à ma connaissance, n'avait déterminé ni leur origine ni leur nature, ni leur rôle.

" Le rôle de cette sécrétion doit consister très-vraisemblablement à modefier la nature chimique des aliments, de manière à permettre la diffusion de ceux-ci à travers la paroi intestinale."

It appears to me, however, that these refractive particles are not to be regarded as a secretion at all, but as excretory products ; considering that digestion is almost certainly intra-cellular, we should scarcely expect to find a special digestive secretion, while the fact, observed by Hallez himself, that the particles are ultimately discharged through the mouth, argues strongly in favour of their excretionary nature.

Judging from Hallez' figure (Plate VI., Fig. 21), the tabular cells which form the walls of the alimentary canal appear to be amœboid. A layer of similar flattened cells occurs in the anterior portion of the small chamber (Fig. 10.) which terminates the alimentary canal in front in *Geoplana spenceri*.

I have not observed any of the unicellular glands described by von Kennel as occurring between the ordinary digestive cells, and it seems to me possible that the supposed glands are merely stages in the life-history of the latter. My own observations also do not tend to confirm his statement that the nuclei in the adult animals are so numerous, and the cells so small, that it is difficult to distinguish them. It is certainly a very difficult matter to make out the cell boundaries, owing to the great number of granules which usually occur, but the nuclei, where visible, always appeared to me to be rather small in comparison with the size of the whole cell, as von Kennel himself figures in the young *Planaria lugubris*.

Like von Kennel, I have nowhere observed cilia on the digestive epithelium of the alimentary canal, nor does it seem in any way probable that they exist in this position. In the case of *Geoplana flava,* however, from Brazil, Moseley (1) records the very remarkable fact that "the free surface of the gastric lining of the digestive canals was ciliated." This statement is to me quite inexplicable, and I cannot help thinking that there must have been some error of observation.

The lining epithelium of the alimentary canal rests upon no special layer of tissue, but frequently muscle fibres occur immediately beneath the epithelial cells, as shown in figure 16, and exactly as described by von Kennel.

E.—The General Connective Tissue of the Body.—Under this head I propose to speak of the tissue which fills all the interspaces between the muscles and the various internal organs. This tissue has been described by Hallez (5) under the name *Reticulum conjonctif*, by von Kennel (3) under the name *Körperparenchym*, by von Graff (9) under the name *Parenchymgewebe*, and by Jijima (7) under the name *Mesenchymbindegewebe.*

Before passing on to notice the condition exhibited by *Geoplana spenceri,* we must consider as briefly as may be the views which have been set forth by previous writers concerning this somewhat enigmatical tissue, and firstly it must be pointed out that the terms given above as used by various authors are not exactly co-extensive, some including more structures than others.

Hallez (5) says, "Je désigne sous le nom de tissu conjonctif, le tissu qui constitue la majeure partie du corps des Planaires, et que les anciens naturalistes appelaient pulpe ou parenchyme . . . . . Il comble, comme on peut le voir, tous les intervalles existant entre les divers organes."

His subsequent description of this tissue makes it tolerably certain that he has confounded a large portion of the less definitely arranged muscular fibres with the connective tissue under the same appellation, which accounts for his statement "c'est chez les Planaires terrestres que ce tissu présente son plus grand développement."

Von Kennel's observations (3) on this head are very brief:—"Ueber die histologische Structur des 'Körperparenchyms' habe ich keine detaillirten Untersuchungen angestellt; auf Schnitten sieht man eine feinkörnige Grundsubstanz, in der zahlreiche Kerne, feine Fasern, und die 'Bildungszellen' oder Stäbchen, letztere in einer Zone am Rücken und besonders an beiden Seiten nahe unter der oberflächlichen Muskulatur liegen. Die Structur des genannten Gewebes stimmt völlig mit der bei unsern Süsswasserplanarien zu findenden überein."

Von Graff, in his monograph on the *Rhabdocœlida* (9), enters into considerable detail with regard to the "Parenchymgewebe." In the *Rhabdocœla* it is, according to this author, composed of three elements—(1) "Sagittalmuskelfasern," (2) "Bindegewebsbalken," and (3) "Bindegewebszellen." With the first of these structures we have nothing to do here. "Die Bindegewebsbalken sind gebildet von feinkörniger Substanz, so dass sie wie betäubt erscheinen. Sie sind sehr blass und zart und färben sich nicht in Carmin und Hämatoxylin. Bald verbreiten sie sich zu breiteren Platten . . . . . bald bleiben sie äusserst dünne Fasern, die nur da, wo sie mit anderen anastomosiren Verbreiterungen zeigen . . . . stets aber bilden sie ein reichverzweigtes Maschenwerk, das ganz passend den Namen 'Reticulum' führen könnte, wenn man denselben ausschliesslich auf die Bindegewebsbalken beshränken würde, statt die Gesammtheit der Gewebselemente des Parenchyms damit zu bezeichnen. In der Regel enthält das Bindegewebe reichlich Kerne, runde oder ovale, eingestreut."

Von Graff found it difficult to distinguish between the sagittal muscles and the true connective tissue. The same author describes the existence, apparently in all *Rhabdocœlida*, of a perivisceral fluid *(periviscerale Flüssigkeit)*. "Doch ist die relative Menge derselben schwer zu bestimmen, da sie meist farblos ist und dann beim lebenden Thiere nur dadurch erschlossen werden kann, dass sie die freien Bindegewebszellen mitreisst, wenn durch Contraction des Körpers eine Verschiebung derselben erfolgt. In Querschnitten conservirter Thiere wird, da ihr Wasserantheil durch die eingedrungenen Conservirungsflüssigkeiten Verdrängt worden ist, wohl meist nur ein spärliches Erinnungsproduct ihre vorherige Anwesenheit verrathen können." These observations appear to me to be of very great importance in elucidating the true nature of the connective tissue.

Jijima, in his paper on the fresh-water Tricladians, discusses the observations of Hallez and von Graff, and states that the observations of the latter author upon the *Rhabdocœlida* closely agree with his own upon the Tricladians. He differs from von Graff, however, in one important respect, namely, in regarding the "Bindegewebsbalken" and "Bindegewebszellen," not as two distinct elements of the connective tissue, but as one, so that his term "Bindegewebszellen" includes both the elements of von Graff. "Die Bindegewebszellen verästeln sich mehr oder minder deutlich und die Aeste stehen in Zusammenhang mit einander, wodurch das Reticulum oder die Bindegewebsbalken gebildet werden."

Obviously the tissues figured by von Graff (*loc. cit.*, Taf. XII., Fig. 4) and by Jijima (*loc. cit.*, Taf. XXI., Fig. 13) are the same thing, and there can be no doubt as to the accuracy of their drawings, though it seems to me possible that they have misinterpreted the facts of the case. I find precisely similar appearances, of which it is unnecessary to give any further description or figures, in my sections of *Geoplana* *spenceri*, but it is doubtful whether they are not principally a *post-mortem* effect, due to the action of re-agents upon a very delicate, gelatinous, or possibly fluid material. In sections of sponges very similar appearances are of common occurrence, and are undoubtedly due to shrinkage. In considering this question, von Graff's observations on the perivisceral fluid, quoted above, are of great moment. In the *Rhabdocœlida*, at any rate, we know that in the living animal there is a fluid containing floating cells, and probably itself more or less albuminous. The effects of ordinary preservative re-agents upon such a fluid would be to cause it to contract and then harden in the form of a network of strands, in which the floating cells would be entangled. Then we have a complete explanation of the appearances often seen in sections. It appears to me that the published observations of Hallez, Jijima and von Graff, point to the correctness of this conclusion. Certainly cells exist in the ground substance of the connective tissue. Their nuclei are plainly visible in considerable numbers in all preparations, and not infrequently the protoplasmic body of the cell, sometimes more or less stellate in form, is visible around the nucleus. The existence of connective tissue fibres is, it appears to me, entirely unproved, and the connective tissue probably consists of a more or less fluid, finely granular ground substance, with nucleated cells imbedded in it. Possibly, as in the case of the sponges, such for example as *Stelospongos flabelliformis* (10), the connective tissue cells may in some forms be connected by long processes, thus forming a network of cells, but the network usually seen in sections resembles rather a *post-mortem* effect. In the land Planarians the amount of connective tissue is very small, owing to the great development of the muscular fibres.

F.—The Mucous Glands.—In the deep muscular layer, around the alimentary canal, there is an irregular zone of scattered glandular tissue (Figs. 4 and 15, *sl.g.*), which is at once recognised by its highly granular appearance and its deep staining with borax carmine. This tissue is composed of irregularly scattered, large, nucleated cells of irregular outline, three of which are represented in figure 27. The cells are often seen, as shown in the figure, to be connected with threads or rods of mucous on its way to the surface. The mucous rods are long and slender, and can be traced, as shown in figure 15, through all the overlying tissues to the epidermis, where they are connected with the blocks of mucous lying between the epidermic cells as already described. Histologically the mucous rods partake of the characters of the unicellular glands which gave them origin, being very granular and staining very deeply with borax carmine.

Thus it appears that the slime with which the body of the land Planarians is so abundantly covered, and which is left behind like the trail of a snail wherever the animal crawls, is the secretion of a number of unicellular glands lying deep down below the epidermis.

In sections of an unstained animal certain irregular masses lying in the zone of mucous glands, and probably themselves mucous glands, were observed to have a blue colour. I am unable to say whether or not this colouration is constant for the mucous glands, but I shall show presently that the blue pigment which forms so conspicuous a feature of the living animal is lodged principally in the rod-like bodies.

G.—The Rod-like Bodies (Rhabdites).—The nature of these remarkable organs has given rise to a good deal of discussion, and no very satisfactory conclusion has as yet been arrived at concerning them.

Moseley (6) describes the existence of the rod-like bodies in the epidermis and their origin in parent cells "beneath the external longitudinal muscle layer." According to him these parent cells are, in spirit specimens, of an elongated oval form, with the upper extremity drawn out into a point or long filament; when cut transversely they are seen to be divided into two or three compartments, and they have a very stout, horny-looking cell-wall. "In vertical sections they are usually seen to contain more than one rod-like body, often three, in apparently different stages of development. The cells have usually a nucleus-like body at their inferior extremity." Moseley concludes that these peculiar structures are homologous in all Planarians, but he wisely leaves the much vexed question as to their relation to the thread-cells of the *Cœlenterata* alone.

In the main this account agrees with the state of things in *Geoplana spenceri*, but I must call in question the statement that the parent cells are divided into two or three compartments and have a very stout, horny-loooking cell-wall. These appearances are, in all probability, due to the action of re-agents.

Hallez (5) also describes the formation of rod-like bodies within parent cells, but his views concerning the position and origin of the latter are certainly incorrect if applied to land Planarians. I need not quote them here, but refer the student to his monograph.

Von Kennel's account (3) of the rod-like bodies in the German land Planarians requires more consideration, because his observations were made upon forms closely allied to those studied by Moseley and myself. He describes them as existing in the epidermis of the dorsal surface, between the epidermic cells, and in very large numbers. This also holds good for *Geoplana spenceri*. He states, however, that in *Rhynchodemus* there exist two kinds of rod-like bodies—(1) larger, egg-shaped, elliptical, or spindle-shaped bodies; (2) smaller, thread-like, sharp at both ends, usually curved at one or both ends so as often to form a circle, always of quite homogeneous substance. The smaller ones are much less numerous than the larger and placed between them; both kinds originate in mother cells. In *Geodesmus* von Kennel found the rods much smaller and more of one form, spindle-shaped, with pointed ends.

Jijima (7) denies the existence of two forms of rod-like bodies, as described by von Kennel, but it does not appear whether or not he examined the species studied by the latter author. He also describes and figures the rod-like bodies in the epidermis as lying *within* the epidermic cells, instead of between them, although he admits their origin in "gewissen dem Mesenchym eingelagerten Zellen." It seems highly improbable that the rods should originate within one cell and then migrate into another, and I must conclude that Jijima is mistaken in this respect, and that the rod-like bodies lie between the epidermic cells in the fresh-water Planarians exactly as in the terrestrial forms. Finally, this author comes to the conclusion that the rod-like bodies *(Rhabditen)* are not discharged from the body, a conclusion directly opposed to what I believe to be the usually accepted opinion, and to my own observations on *Geoplana*.

Von Graff (9) gives a very full account of the rod-like bodies, or rhabdites, in the *Rhabdocœlida*, for which I must refer the reader to his monograph. He comes to the conclusion that in all *Rhabdocœlida* the rod-like bodies, where such occur, originate in parent cells in the connective tissue of the body, a view now generally held, and in all probability true for all the remaining groups of Planarians.

I propose now to give an account of my own observations in the case of *Geoplana spenceri*.

In microscopical sections the dorsal surface of the animal, outside the epidermic cells, is seen to be covered with a layer of granular, hardened mucous, in which large numbers of ejected rod-like bodies, or rhabdites, are imbedded. It is here that the structure and form of the isolated rods may best be studied. Figure 24 represents three of them as they appear in a tangential section of a specimen preserved in alcohol and stained with borax carmine. In this position the rods always appear more or less curved or vermiform, a fact which suggests that they possess but little rigidity when first ejected; they sometimes also appear to be very greatly elongated. They are slender, cylindrical, and pointed gradually at each end; they are homogeneous in texture and stain very deeply with borax carmine.

In the epidermis itself the rods are found in large numbers wedged in between the component cells on the dorsal and lateral surfaces of the animal, while on the ventral surface, if they occur at all, they are very scarce. In the epidermis on the lateral surfaces of the animal the rods are frequently so numerous as entirely to conceal the true structure of the epidermis, and make it appear as though the latter were composed solely of closely packed rods.

Beneath the epidermis the rods are concentrated in a special zone lying just below the nerve sheath, and hence also below the external longitudinal layer of muscles, as described by Moseley. This zone is a very conspicuous feature in all vertical sections of the animal, as shown in figures 4, 10, and 15. It is best developed on the dorsal surface and well on the lateral surfaces, but on the ventral surface the rods become much fewer in number and smaller in size. In this special zone the rods are arranged in faggot-like groups or bundles. Each bundle is usually spindle-shaped, but the inner ends of the rods composing it are more closely packed than the outer ends, which tend to separate. Figure 23 represents such a bundle, in which the outer ends of the rods are more separated than usual. The form, structure, and mode of staining of the individual rods in this position agree so exactly with what has been just described for the ejected rods on the surface of the animal as to leave no doubt as to the identity of the two. In figure 23 the ends of the rods are blunter than is usually the case; possibly the extreme tips have been cut off in the section. In the fully-developed groups of rods, occurring in the special zone of rod-like bodies, it is no longer possible to discover traces of the original mother-cell in which they were developed; it seems to have entirely disappeared, though its previous existence is still indicated by the grouping of the rods. Between the special zone and the epidermis, rod-like bodies, still assembled in groups, are frequently met with at different levels on their way to the surface, as I have represented in figure 15, but there are no traces of any special ducts through which they pass. In figure 19, again, groups of rod-like bodies, in transverse section, are seen on their way to the surface, between the longitudinal muscle bands.

The young mother cells of the rod-like bodies, still recognisable as distinct cells, occur scattered about just beneath the special zone. They are not so numerous as one would be naturally led to expect from the great numbers of rods occurring in the special zone and epidermis. They are very small, and when first recognisable already elongated so as to be spindled-shaped (Figs. 20, 21). Each contains a large, granular nucleus, and the protoplasmic body of the cell is very small and difficult to make out. Around the nucleus the rods appear as shown in the figures; first of all as a few slender, darkly staining streaks. They soon, however, increase so greatly in size and numbers as to obscure everything else, though still tightly enclosed in the delicate, extended mother cell (Fig. 22). In the special zone, as already stated, no trace of the mother cell remains visible, and the rods frequently tend to become separated at their outer ends, indicating that the wall of the mother cell has been ruptured in this position.

In brief, the life-history of the rod-like bodies appears to be as follows:—They originate as condensations of the protoplasmic body of small, nucleated, spindle-shaped mother cells which lie beneath the special zone. As they increase in size and numbers they destroy the mother cell and themselves accumulate, still arranged in bundles, in the special zone. Hence they gradually pass outwards towards the surface of the animal, and again accumulate between the cells of the epidermis. Finally they are discharged and come to lie freely in the slimy covering of the animal.

The most remarkable feature of the rod-like bodies in *Geoplana spenceri* still remains to be noticed. Moseley (1) has already observed, when speaking of the Australian land Planarians, that "The remarkable Prussian blue-coloured *Cœnoplana cœrulea* has its intense pigment contained to a large extent in the rod-cells, which stand out thus in relief in the vertical sections of the animal." If for "rod-cells" we read "rods" the same remark applies exactly to *Geoplana spenceri;* the rod-like bodies, in unstained sections, appearing of an intense blue colour, so that the special zone containing them stands out brilliantly. The colouring matter appears to be evenly dispersed through the rods, and it makes its appearance while the latter are still very minute and lying beneath the special zone.

With regard to the function of the rod-like bodies, various hypotheses, none of which are at all satisfactory, have been suggested. I do not propose to discuss the question here, and it will probably have to be decided by careful experiment on the living animals. In an earlier portion of this paper I have suggested, however, that they may possibly, by making the animal extremely unpalatable, serve as a protection against being eaten.*

H.—The Nervous System.—Previously to the year 1879, the greatest doubt and uncertainty prevailed with regard to the nervous system of land Planarians. The existence of two longitudinal cords was admitted, though not by all naturalists, but their nature was greatly misunderstood. In 1879, however, a flood of light was thrown upon this much vexed question by von Kennel's researches on the German land Planarians. (3) It is no longer necessary to discuss the various views entertained prior to this date ; I will simply take up the question where von Kennel left it. This author recognised the existence of an anterior ganglionic mass ("Gehirn"), composed of two symmetrical halves and containing nerve cells. He also recognised the connection of this ganglion with the two longitudinal nerve cords, which run parallel beneath the alimentary canal to the posterior end of the body, and are connected with one another by numerous transverse commissures, at the same time giving off numerous branches.

I had convinced myself that this was the true state of the case before I saw von Kennel's paper, in which he so completely forestalled me. All that I can now add

* They may also serve to increase the stickiness of the slime, and thus enable the animal to hold its prey more firmly. (*Vide* p. 53.)

to his observations is that there is also a nerve sheath surrounding the body and connected with the two longitudinal cords by branches of the latter, so that the essential agreement of the nervous system of the terrestrial Planarians with that of other Tricladians is complete. [Since this was written I learn from Jijima's paper (7) on the fresh-water Tricladians that Lang has discovered a nerve sheath in *Rhynchodemus*. Unfortunately I have not been able to see Lang's paper.]

I will now describe the nervous system as I found it in *Geoplana spenceri*.

The Ganglion.—This is a bilobed organ, situate at the extreme anterior end of the body, just beneath the skin, and below the anterior termination of the alimentary canal. Its position is best seen in figures 10 and 11. The ganglion (Fig. 12) consists of a very finely granular, non-staining ground substance, in which great numbers of small nerve-cells are imbedded. These cells are scattered irregularly through the ground substance, but are more numerous towards the periphery than in the centre of the ganglion. As von Kennel has already remarked, there is no special membrane around the ganglion, so that the latter is not sharply differentiated from the general connective tissue of the body, and in the case of some of the peripherally placed cells it is impossible to say precisely which belong to the ganglion and which to the connective tissue. Thus, on the ventral aspect of the ganglion there is a dense mass of cells which agree in appearance with the nerve cells, but seem to be outside the ganglion, although touching it. These cells may, nevertheless, be nerve cells, for I shall show presently that nerve cells are not confined to the ganglion and nerve cords.

The nerve cells are very small, with relatively very large and distinct nuclei. It is difficult to distinguish the protoplasmic body of the cell, but sometimes delicate processes are distinctly visible which resemble on a small scale the radiating processes of typical multipolar ganglion cells.

The Longitudinal Nerve Cords.—Each half of the ganglion is continuous posteriorly with one of the longitudinal nerve cords. The cords themselves are relatively thick, and are recognisable at once in all transverse sections taken behind the ganglion as two very faintly stained or unstained oval areas lying beneath the alimentary canal, one on each side of the middle line.

Von Kennel (3) affirms that the two nerve cords do not unite posteriorly:—"Dies sind dann die Anfänge der beiden Längsnerven, der bisher sogen. Balkenstränge, die dann parallel bis ans hintere Körperende verlaufen, wo sie allmählig dünner werden und, ohne sich miteinander zu verbinden, aufhören." My sections of *Geoplana spenceri* show that in this species at any rate the contrary is the case. The two cords gradually approach one another posteriorly until in transverse sections only a single cord is visible, lying in the middle line beneath the alimentary canal. This cord then gradually thins out, breaking up into several fine branches.

Throughout their entire course, until they unite at the posterior end of the body, the two longitudinal nerve cords are connected by very numerous stout transverse commissures. So abundant are these commissures that they are visible in almost every transverse section (Fig. 4, *t.c.*) They are, however, best shown in horizontal sections (Fig. 13), in which they are seen frequently to anastamose with one another, instead of running straight across.

From the outer sides of the nerve cords numerous fine branches are given off towards the nerve sheath or plexus. In the region where the testes occur there is usually one such branch visible between each two adjacent testes (Fig. 13).

In transverse section the longitudinal nerve cords usually present the characteristic spongy or finely reticulate appearance, which has been so fully described and discussed by previous authors that I need say nothing more about it here. The figures given by Jijima (7) for his fresh-water Tricladians might almost have been drawn from my own sections of *Geoplana.* Numerous small nerve cells occur scattered in the substance of the cords.

The Nerve Sheath or Plexus.—This consists of a close network of fine fibres, lying between the outer longitudinal layer of muscles and the special zone of rod-like bodies, and hence only a short distance beneath the epidermis (*vide* Figs. 4, 10, 13, 15, *n.s.*). It extends completely round the body, and though most easily seen in tangential sections is also plainly visible in vertical ones. The meshes of the plexus are remarkable in that they are usually more or less rectangular in form. Histologically the fibres of the plexus agree with the main nerve cord. It is only rarely that nerve cells are found actually within the fibres, but they are very plentifully scattered in the spaces between them. Figure 14 illustrates all these points. The separation existing between the fibres and the nerve cells is somewhat remarkable. I have already noted the tendency of the nerve cells to become aggregated at the periphery and immediately outside of the ganglion (beneath it), and a similar state of things is perhaps recognisable in the longitudinal cords. This state of things perhaps indicates that the nerve cells and fibres originate separately and independently and come together only secondarily.

In the fresh-water Tricladians, according to Jijima (7), the nerve plexus forms an irregular network, spread over the whole dorsal surface, but apparently he has not found it on the ventral surface. He also states that it lies immediately below the inner longitudinal fibres of the skin musculature. This, as I have already pointed out, is a very strong argument in favour of the view that the internal longitudinal muscle layer of the aquatic Tricladians is the homologue of the external longitudinal layer of the terrestrial forms.

I.—The Eyes.—The only special sense organs which I have found in *Geoplana spenceri* are the eyes. These are very abundantly present as numerous minute black specks placed ventro-laterally, in an elongated patch at each side of the extreme anterior end, and extending all round the horseshoe-shaped anterior margin. In the living worm the eyes are a good deal obscured by the dark pigment of the body. The eyes are not absolutely confined to the front end of the body, for I have found a few at the extreme hinder extremity, recalling the condition described by Moseley (6) in *Bipalium*, where the eye-spots are numerous at the anterior end, and also sparingly present over the entire length of the body to the very tail. In *Geoplana spenceri*, however, I have only found eyes at the two extremities, but in *Geoplana traversii* Moseley (1) records the fact that eye-spots are scattered more sparsely on the lateral margins of the body, along its entire length posterior to the principal patches.

The position of the eyes with regard to the different layers of the body is shown in figures 10 and 11. They are placed just outside the special zone of rod-like bodies along the line where the latter begin to thin out towards the ventral surface, and *they lie imbedded in the nerve sheath.*

The structure of the eyes is very simple. In longitudinal section (Fig. 25) the outline of the whole eye is more or less elliptical, the longer axis of the ellipse, which measures about 0·06 mm., being placed at right angles to the surface of the animal.

The eye consists of two parts—*(a)* a pigment cup, *(b)* a lens (*vide* Figs. 25, 26). The pigment cup is widely open at its outer end and surrounds the lower two-thirds of the lens. It does not form a perfectly continuous layer around the lens, but is made up of some four or five elongated segments, which meet at their edges and call to mind the petals of a flower. The divisions between the segments are most obvious at the margin of the cup, but can be traced right down to the bottom. The pigment is deposited in the segments of the cup in the form of very minute, closely packed, spherical granules, of a brown colour. The lens is a somewhat elongated, faintly staining, very slightly granular body lying in the pigment cup. Its outer extremity projects for a short distance beyond the margin of the pigment cup, and presents a convex, almost hemispherical surface towards the outside of the animal. At its inner, somewhat narrower end, the lens contains a nucleus (Fig. 26, *n*). Between the lens and the pigment cup, and also just in front of the outer surface of the lens, small spaces are visible, doubtless caused by shrinkage of the tissues.

The eyes of *Geoplana spenceri* appear to be unicellular bodies, and their position and structure suggest what seems to me a very probable theory as to their origin. They lie always immediately outside the special zone of rod-like bodies, and they are not confined to any one region of the body, but make their appearance more or less sporadically, although naturally chiefly at the anterior end, which, it will be remembered, is uplifted and constantly moving about when the animal crawls.

I have pointed out, on a previous page, that the groups of rod-like bodies originate each in a single cell, and that the rods appear as small streaks around the nucleus, which afterwards, as the mother cell passes outwards, increase in size and numbers, so as ultimately completely to conceal the original cell and nucleus, and then separate at their outer ends. I believe that each eye is probably merely a special modification of a group of rod-like bodies and their mother cell, the segments of which the pigment cup is formed being homologous with the rods and the nucleated lens representing the original mother cell. To obtain such an eye from a group of rod-like bodies we have only to imagine the original mother cell increasing in size instead of dwindling away, and the rods developing around the outside of the cell only, in fewer numbers and of larger size. The eye is, it is true, considerably larger than an ordinary group of rod-like bodies, being about twice the size, but there is no reason why growth should not continue beyond the ordinary limit if the mother cell retains, as seems probable, its activity for a slightly longer period than usual. The colour of the pigment in the eyes and its deposition in definite granules is perhaps a more serious objection, but cannot, I think, be held to invalidate the theory. The colour of different species of land Planarians varies enormously, and probably (though this remains to be proved) the pigment in differently coloured species will be found to be lodged in the rods, as in *Geoplana spenceri*. If different colours may be developed in the rods in different species there is no reason why the rods of any one species may not differ in colour.

So far as can be judged from Moseley's account (6) the eyes of *Bipalium* agree very closely in structure with those of *Geoplana spenceri*. Moseley states that the eye is a simple sac or cell, the anterior part transparent and lens-like, the posterior and larger portion darker and opaque, owing to the presence of brown pigment granules imbedded thickly in its wall. An unpigmented dot often present in the posterior part seems to show that the eye spots are modifications of single nucleated cells. In the interior of the eye spots a lens-like body is visible in sections, but very little differentiated from the general cell contents, and hard to see. Between the lens-like body and the interior of the pigmented back of the eye spot is a highly refracting substance. The position of the eyes in *Bipalium* also agrees with that in *Geoplana*. In *Geoplana* I can detect, however, no "highly refracting substance," and the position of the nucleus (if the structure described by Moseley be a nucleus) is also different. Still the fundamental agreement of the eyes in the two cases is obvious.

Amongst land Planarians we meet with two very different types of eyes, which we may call the *unicellular* and the *multicellular*. The unicellular eyes are met with, for example, in the genera *Geoplana* and *Bipalium*, and they always appear to be very numerous. In the forms with multicellular eyes, such as *Rhynchodemus*, there appears to be usually only a single pair.

Von Kennel (3) states that in *Rhynchodemus* the eyes are two little pigment cups filled with small cells, whose nuclei stain pretty distinctly. Black pigment is irregularly heaped around the contents. Similar eyes appear to occur in *Geodesmus*, according to Mecznikow and von Kennel; they are larger than those of *Rhynchodemus*.

The fresh-water *Tricladians* have also multicellular eyes, whose structure is probably fundamentally the same as in *Rhynchodemus*. There is usually only a single pair, but they may be numerous. The latest account of these organs, so far as I am aware, is that given by Jijima. This author (7) states that the eye of *Planaria polychroa* consists of three parts—(1) a pigment cup, (2) the visual rods ("Sehkolben"), (3) the ganglion opticum. The pigment cup is formed of compact pigment granules, and has its opening directed outwards and upwards. In front of the opening is a collection of nervous substance, viz., granular substance and fibres surrounded by numerous nuclei, apparently belonging to ganglion cells. These form the ganglion opticum or retina, which lies only a little below the basal membrane. The boundary between the ganglion opticum and the cavity of the pigment cup is pretty sharp, but specially thick fibres pass over it into the cavity of the cup, where they increase in thickness, and end each in a swelling. Carrière considers the swellings as unaltered nuclei, but according to Hertwig nuclei are present within them, which, however, Jijima could not discern. The fibres in connection with the swellings can be traced into the optic nerves, which originate from the lower part of the ganglion opticum, and run obliquely backwards and downwards. How the optic nerves come off from the brain, Jijima was unable to determine.

The aquatic *Tricladians* then, and some of the terrestrial forms, have multicellular eyes, usually two in number, and probably innervated from the anterior ganglion. The remainder of the terrestrial forms have unicellular eyes, occurring in great numbers, with no special nerves, but lying in the nerve sheath, from which doubtless they are innervated.

According to Moseley, Mecznikow considered that the great complexity of the eye in *Geodesmus* had been caused by terrestrial habits, but Moseley points out (and it will be readily seen from the above description) that the eye of the aquatic forms is as complex as in *Geodesmus*.

It appears to me, on the other hand, that the unicellular eyes of such forms as *Geoplana* are of much later development than the multicellular type, and that they have arisen as a result of terrestrial habits by special modification of groups of rod-like bodies. Certain terrestrial genera, which we may suppose have taken to land at a later date, still retain the multicellular type of eye which they inherited from their aquatic ancestors. Probably future research will show that terrestrial forms exist in which both types of eye occur.

K.—The Reproductive Organs.—Geoplana spenceri, is, as might be expected, hermaphrodite, and provided with only a single genital opening, situate about half way between the pharynx and the posterior extremity of the body. Indeed, the reproductive organs agree essentially in structure with what Moseley and von Kennel have already described in the genera examined by them, and I shall therefore make my description as short as possible, enlarging only upon doubtful questions and such points of difference as exist.

The Female Organs.—These consist of four principal portions—*(a)* The ovaries; *(b)* the oviducts; *(c)* the uterus and vagina; *(d)* the yolk glands.

(a) The *Ovaries.*—There is a single pair of ovaries, situate near the anterior end of the body, one on either side just inside the nerve cord.

Each ovary, as shown in figure 42, is a small, pear-shaped sac, with the narrow end pointing backwards. Its length is about 0·4 mm. It has no distinct investment, but the cavity of the sac is lined by an irregular layer of epithelial cells, more or less polygonal from mutual pressure and with very large nuclei. Figure 44 shows a portion of this lining epithelium, in which the polygonal outline of the cells is unusually well marked. Amongst the epithelial cells, and perhaps forming a very loose and irregular investment to the ovary, a few delicate, nucleated, spindle-shaped cells may also be detected; these are especially numerous about the point of entrance of the oviduct. In the interior of the ovary, ova in various stages of development are met with. As the development of the ova within the ovary does not appear as yet to have been very fully followed, I propose to describe it here in some detail (*vide* Figs. 44-49).

Each ovum originates as an epithelial cell, at the periphery of the ovary (Fig. 44). The nucleus is already very large and highly granular, and in one instance I detected what looks like a small food granule, already deposited in the protoplasm (Fig. 44, *f.g.*). The ovum next separates from the lining epithelium and becomes amœboid (Fig. 45). At this stage spindle-shaped cells *(sp. c.)* begin to make their appearance, closely adherent to the surface of the ovum, and the protoplasm of the ovum contains very distinct globular food particles *(f. g.)*. Figure 46 shows a somewhat older ovum, with four spindle-shaped cells adhering to its surface. Sometimes, as in figure 47, the nucleus at this stage shows a very distinct nuclear network. The spindle-shaped cells next disappear and the ovum rounds off and appears more or less in the middle of the ovary as a mature ovum. The form and structure of the mature ovum is exceedingly characteristic. There is a large nucleus, which has lost its granular appearance and assumed a transparent, vesicular aspect, and in the protoplasm around it there are always several large food granules (perhaps better called oil-globules by Moseley). Moseley (6) describes the mature ovum in *Bipalium* as invested by a distinct external capsule derived from the stroma of the ovary. Such a capsule does not occur in my sections of *Geoplana*. Possibly, however, it may be represented by the spindle-shaped cells seen at an earlier stage of development. It is, however, curious, if so, that these should subsequently disappear, and it appears to me not improbable that they may be nutrient cells from which the ovum derives its very abundant supply of food particles or oil-globules. Moseley does not describe these nutrient cells, but it is not impossible that he has overlooked them, and the capsule observed by him in the adult ovum may be derived from their remains. Altogether the ovary of *Geoplana* agrees very closely in structure with that of *Bipalium*.

The mode in which the oviduct opens into the ovary is remarkable. A very evident papilla projects into the cavity of the ovary on its outer side and a little behind the middle of its length (Fig. 42). At the apex of this papilla is the opening of the oviduct.

(*b*) The *Oviducts*.—The oviduct, on reaching the base of the papilla on which its intra-ovarian opening is placed, first of all makes a sharp and very short turn dorsally, and then runs straight towards the posterior end of the animal, keeping, for almost its entire length, close along the top of the longitudinal nerve cord, where it is always to be found in transverse sections (Fig. 4, *od.*)

In *Geoplana traversii* also, according to Moseley (1), the oviduct leaves the ovary on its outer side, and the same is true of *Bipalium*; while in *Rhynchodemus* it leaves the ovary on the inner side.

Moseley has fully described the histological structure of the oviduct in the two latter genera, and in *Geoplana spenceri* we find exactly the same structure, viz., a thin basement membrane supporting a layer of distinctly nucleated columnar cells, with strongly developed cilia projecting into the lumen of the duct (Fig. 34).

At brief intervals along its course, branches are given off from the dorsal aspect of the oviduct, which run upwards for a short distance (Fig. 34). These, as I shall presently show, lead to the yolk glands. Moseley (6) describes similar branches in *Bipalium*, but states that in *Rhynchodemus* they are absent. He regards them as the rudiments of the branched ovary possessed by lower Planarians. Von Kennel (3) found them to exist also in *Rhynchodemus terrestris.*

A short distance behind the external genital aperture the two oviducts turn inwards and unite together (Fig. 43, *odd.*) The united oviducts then open into a small dilated chamber (Fig. 43, *a.*), and this latter communicates with the posterior end of the uterus by means of a short, narrow duct, which runs upwards and forwards, as shown in the figure. The small chamber and the duct leading thence to the uterus are lined by very narrow, elongated, columnar, ciliated cells. Lying around the dilated chamber and converging towards it is a quantity of feathery-looking tissue, the structure of which is difficult to make out and requires further elucidation. This tissue is characterised by a very distinct, yellowish-brown colour, which it retains even in deeply stained sections. It probably forms an accessory gland of some description opening into the chamber by numerous very fine ducts. Moseley (6) figures accessory glands somewhat similar in appearance opening into the uterus in *Bipalium*.

(c.) The *Uterus* and *Vagina.*—These organs are enclosed in a dense muscular mass of the shape shown in figure 32, which is easily dissected out as a distinct structure and may be called the female copulatory organ. The broader and more posterior part of this structure is the uterus, which gradually tapers off in front to form the vagina, which curves forwards and downwards to the external aperture. The muscle fibres around the uterus and vagina are principally disposed in a circular direction, but numerous longitudinal fibres also occur. The longitudinal fibres occur principally in a fairly well-defined layer on the inside, surrounded by the much thicker layer of circular fibres. Imbedded amongst the muscle fibres, chiefly around the uterus, numerous darkly staining granular bodies appear, closely resembling the mucous glands. They are probably accessory glands which secrete the mucous which is always found within the cavity of the uterus.

The cavity of the uterus is lined by a very peculiar epithelium, which is shown in figure 33. This epithelium is composed of richly ciliated columnar cells, and its peculiarity consists in the presence of innumerable slender, elongated villi, composed entirely of the ciliated columnar cells and projecting into the cavity of the uterus.

Anteriorly the lumen of the uterus gradually diminishes in diameter to form that of the vagina, and at the same time the villi disappear and give place to a smooth lining epithelium composed of a single layer of richly ciliated columnar cells.

The vagina opens into the common *atrium genitale*, which, as I shall show later on, is so small and rudimentary that it is often hard to distinguish at all.

The form and relations of the female copulatory organs, the mode of opening into them of the oviducts, and the histological structure of the uterus differ very markedly in *Geoplana spenceri* from what has been described by Moseley and von Kennel in the forms examined by them, as will readily be seen by comparing the works of those authors.

Geoplana traversii probably agrees more closely in these respects with *G. spenceri* than any other form that has been examined, and this might naturally be expected. Moseley, however, does not describe (1) the uterus and vagina and the opening of the oviducts in any detail, and gives only a small figure of the external appearance of these parts when dissected out. In this figure the oviduct is made to open straight into the posterior end of the uterus.

(*d*).—The *Yolk Glands*.—These consist of irregularly ramified masses of cells lying between the diverticula of the alimentary canal, and communicating with the oviducts by means of the short branches of the latter already described and shown in figure 34. The yolk glands occur abundantly also behind the uterus and therefore behind the oviducts. How they here communicate with the oviducts I have not been able to determine. The yolk glands consist of closely packed, large cells with enormous, highly granular nuclei and very small protoplasmic bodies, as shown in figures 34 and 35. They are doubtless homologous with what von Kennel (3) describes and figures in *Rhynchodemus*, but the nuclei are much larger and more granular, and the protoplasmic bodies of the cells much smaller than they appear to be in that form. There are no special ducts, but the masses of cells just come into contact at certain points with the branches of the oviduct, as shown in figure 34. Von Kennel figures precisely the same mode of communication between yolk glands and oviduct. Probably at the time when the ova are passing down the cells of the yolk gland simply break down and empty themselves into the oviduct.

Hence it would appear that the ova receive two distinct supplies of food—*(a)* In the ovary, deposited in the protoplasm around the nucleus and probably received from the spindle-shaped cells investing the immature ova; *(b)* in the oviduct, from the yolk glands. The food-material supplied by the yolk glands is probably simply enclosed in the cocoon together with the ova. The cocoon itself may be secreted by the brown glands discharging into the chamber into which the oviducts first open.

It is interesting to observe that the yolk glands in *Geoplana spenceri* are not present in all specimens, or if they be present it is in so rudimentary a condition that it is difficult, if not impossible, to identify them.

Thus in specimens obtained at Easter by Professor Spencer I found no yolk glands, and had it not been for a specimen which I afterwards obtained at the same locality about the end of August of the same year, I might have entirely overlooked their presence. This difference may possibly be due to the time of the year, or it may simply depend upon the age of the animal.

The Male Organs.—These consist of *(a)* the testes, *(b)* the vasa deferentia, and *(c)* the penis.

(a) The *Testes.*—The testes are exceedingly numerous, and arranged in a single long row down each side of the body, just outside of the longitudinal nerve cord (Figs. 4 and 13, *t.*), the consecutive testes being very close together, but not, at any rate as a rule, actually touching. The row commences on each side a short distance in front of the ovary, and extends backwards to a point about half way between the pharynx and the external genital aperture. Owing to the impossibility of obtaining any one section to pass through the whole row of testes it is difficult to count their exact number, but I estimate that there must be at least fifty on each side of the body.

Each testis (Fig. 30) is a simple, pear-shaped sac, about 0.34 mm. in length, with the broad end directed towards the ventral and the narrow end towards the dorsal surface of the animal.

The cavity of the testis is lined by an epithelium resting upon a very thin membrane. At the broad end the epithelium is very thin, composed apparently of a single layer of flattened cells, but at the sides and especially at the apex of the sac the epithelium gradually increases in thickness, and is seen to be composed of numbers of large cells of the form shown in figure 36. These cells have very large, deeply staining, highly granular nuclei, and they are the mother cells of the spermatozoa.

In the centre of the testis, and separated from the layer of mother cells always by a very distinct interval (which may be in part due to shrinkage, but which certainly indicates a well defined separation), lies a compact mass of developing spermatozoa of the general form shown in figure 30. This mass is connected with the epithelial lining of the testes at the broad (ventral) end by a narrow neck (Fig. 30, *x.*) which indicates the point where the developed spermatozoa pass into a branch of the vas deferens. Moseley (6) has already insisted upon this separation of the testis into two distinct regions in the case of *Bipalium*, although in that form the inner mass of developing spermatozoa appears to be in contact with the layer of mother cells all round. He states that the two regions are so well defined that it would almost appear as if a thin membrane were reflected back from the point of union of the vas deferens with the testicular sac-wall and separated the two regions. He could not, however, make sure of the existence of any such membrane. Indeed, it seems highly improbable that such a membrane should exist, and I can find no trace of it in my preparations.

Figures 37 to 39 show three stages in the development of the spermatozoa, found in the central part of the testis. The interpretation of these appearances is perhaps a little doubtful. Figure 37 represents the earliest of the three stages, which I take to be equivalent to a spermatosphere in such a form as the earth-worm, and which is probably derived directly from a single mother cell (*spermatospore*) such as is shown in figure 36. In giving rise to the spermatosphere the mother cell has become swollen and vesicular, the nucleus has disappeared, having probably divided into a great number of parts, which are, however, not recognisable, and on the surface of the swollen vesicle numerous buds have made their appearance. The central part of the spermatosphere is to be regarded as the blastophore, and each of the buds on the surface as a spermatoblast.

Figure 38 represents what I take to be three spermatoblasts, or young spermatozoa, in a further stage of development, and now separate from the blastophore. In the broad end of each a distinct, deeply staining spot, doubtless part of the original nucleus, is visible.

Figure 39 shows three detached spermatozoa from the testis, obviously derived from such forms as those represented in the previous figure, the nucleus forming the head, and the protoplasm having greatly stretched out and elongated itself into a thin thread to form the tail of the spermatozoon.

It will be noticed in these figures that the spermatoblasts seem to separate from the blastophore at a very early stage, but it is questionable whether this early separation is normal, and may not have been induced by the action of re-agents. Moseley figures the blastophores in *Bipalium* with numerous spermatozoa, of about the stage represented in figure 39, still attached, and there are indications, though less distinct, of a similar state of things in my sections of *Geoplana*.

Moseley observes that in the mature spermatozoa which crowd the vas deferens the heads are absent, and states that Max Schultze has observed the same thing in other Planarians. In *Geoplana spenceri*, also, the spermatozoa found in the vas deferens appear to have no heads. If the head of the spermatozoon, which represents the nucleus, be really lost in the fully developed stage, it is, of course, a very remarkable circumstance, but that the nucleus should really disappear seems scarcely credible, and it is more probable, as Professor Spencer has pointed out to me, that the nucleus simply undergoes some change as regards its staining properties. This latter hypothesis is supported by the fact that no nuclei are visible in the spermatosphere stage shown in figure 37, although they are very distinct in the mother cells and appear again very distinctly in the young spermatozoa (spermatoblasts) as shown in figures 38 and 39.

(*b*.) The *Vasa Deferentia*.—These organs differ somewhat strikingly in form and position from what Moseley and von Kennel have described in the case of *Bipalium*, *Geodesmus* and *Rhynchodemus*. In the two former genera it appears that the vas deferens of each side runs close along the inner sides of the testes, which discharge their contents directly into it. It hence lies just on the outside of the nerve cord. In

Rhynchodemus, according to von Kennel (whose observations are supported by the earlier ones of Moseley on the same genus) the vas deferens springs from the last testis. In *Geoplana traversii*, again, Moseley states that a wide vas deferens leads from the hinder end of the testes transversely inwards to the vesicula seminalis.

In *Geoplana spenceri*, on the other hand, the vas deferens commences near the anterior end of the body, probably at the level of the first pair of testes, and it lies just inside, instead of outside of the nerve cord of its side and just below the transverse commissures between the two cords, as shown in figure 4, *v.d.* From this position it follows that the testes cannot communicate directly with the main vas deferens, and as a matter of fact each testis communicates with the vas deferens of its side by means of a narrow and rather long branch which starts from the broad ventral aspect of the testis and runs transversely beneath the nerve cord to enter the vas deferens at right angles. This arrangement is best seen in horizontal sections, when the vas deferens with its branches appears as shown in figure 31.

It seems to me not improbable that a condition similar to that which I have described may be found to exist in *Rynchodemus* and *Geoplana traversii*.

On nearing the penis each vas deferens becomes dilated to form a thin-walled, tortuous vesicula seminalis; they then contract again and unite at the base of the penis to form the convoluted duct which leads through the penis to the genital orifice (Fig. 43, *d.*). The vasa deferentia and their branches are lined by a very thin, flattened epithelium of nucleated cells (Fig. 31), but in the vesiculæ seminales the cells forming this epithelium become more or less cubical.

(c) The *Penis.*—This is an ovoid, muscular mass, tapering towards the posterior end, which is directed downwards towards the genital aperture. It lies immediately in front of the vagina, and can be readily dissected out, together with the female copulatory organ, as a definite structure, when it appears as shown in figure 32. It is pierced throughout its length by the duct, convoluted at the anterior end, through which the spermatozoa are discharged (Fig. 43, *d.).* The muscle fibres of which the penis is composed are arranged in two principal sets, circular and longitudinal, the fibres of the two sets occurring intermingled with one another. The duct of the penis is lined by a layer of small, deeply staining, columnar, ciliated cells.

The penis of *Geoplana spenceri* is remarkable for the fact that it does not lie for the most part free in a surrounding cavity, as for example in *Bipalium* (6), but is closely surrounded by the general tissues of the body almost up to its termination near the genital aperture. The capability of protrusion of the penis under these circumstances must depend upon the great elasticity of the surrounding tissues.

The Atrium genitale.—The common atrium genitale, into which the male and female organs open, is rudimentary and scarcely, perhaps sometimes not at all, recognisable, so that at first sight the male and female openings appear to be separate although very close together. Careful examination, however, shows that there is really only a single external opening.

I have endeavoured to represent the peculiar condition of the copulatory organs in figures 32 and 43. The actual appearances presented by these parts depend somewhat upon the state of contraction of the specimen under examination, but I think there can be little doubt as to the general correctness of the above account, which is based upon the examination of horizontal and transverse serial sections and upon careful dissection.

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DESCRIPTION OF PLATES.

Plate 7.

Fig. 1.—Living specimen of *Geoplana spenceri* lying almost still. Nat. size.

Fig. 2.—Living specimen actively crawling. Nat. size. (The animal is represented slightly twisted, so as to show the blue colour of the ventral surface.)

Fig. 3.—Specimen after preservation for a few days in alcohol, ventral surface. *ph.* pharynx; *g. a.* genital aperture. x2. (The colour is somewhat altered already by the action of the spirit.)

Fig. 4.—Transverse section through the region of the posterior prolongation of the peripharyngeal cavity (compare Figs. 8 and 9). *ep.* epidermis; *n. s.* nerve sheath; *s. z.* special zone of rod-like bodies; *sl. g.* slime glands; *al. c.* alimentary canal; *n. c.* nerve cords; *t. c.* transverse commissure between nerve cords; *t.* testis; *v. d.* vas deferens; *od.* oviduct; *p. ph.* peripharyngeal cavity.

Fig. 5.—Group of three ciliated epidermic cells from the ventral surface of a specimen killed with osmic acid, stained with borax carmine and cut by the paraffin method. *n.* nucleus; *ci.* cilia. Drawn under Zeiss F. oc. 2.

Fig. 6.—Epidermis from dorsal surface of same section. Zeiss F. oc. 2. *ep. c.* epidermic cell; *n.* nucleus; *r.* rod-like bodies; *mu.* mass of hardened mucous.

Fig. 7.—Epidermis from peripharyngeal cavity (compare Figs. 8 and 9), showing the sudden transition from ciliated to glandular cells. Zeiss F. oc. 2. *g. c.* glandular cells; *ci. e.* ciliated epidermis; *x.* junction between the two; *n.* nucleus.

Fig. 8.—Diagrammatic longitudinal section through the region of the pharynx, the pharynx being protruded. *al. c.* alimentary canal; *m.* true mouth; *ph.* pharynx; *p. ph.* peripharyngeal cavity. The black outline from *a* to *b*, and from *c* to *d*, represents the extent of the glandular epidermis.

Fig. 9.—Similar section with the pharynx retracted. *e. m.* external mouth or opening of peripharyngeal chamber; other lettering as in figure 8.

Plate 8.

Fig. 10.—Longitudinal section through the anterior end of the body, a little to one side of the middle line. *ep.* epidermis; *n. s.* nerve sheath; *s. z.* special zone of rod-like bodies; *n. c.* nerve cord; *al. c.* diverticula of alimentary canal; *gang.* bilobed ganglion; *e.* eye.

Fig. 11.—Section along the line *x. y.* in the preceding figure. *d. m.* layer of diagonal (oblique) muscles immediately beneath the epidermis; *e. l. m.* external layer of longitudinal muscles; other lettering as in the preceding figure.

Fig. 12.—Bilobed ganglion, more highly magnified, showing the finely granular ground substance and the numerous small ganglion cells, of which the nuclei alone are usually visible.

Fig. 13.—Portion of a horizontal section through the two nerve cords near the anterior end of the body, showing the arrangement of the nervous system, which is coloured blue. (Compare Fig. 4.) *n. c.* nerve cords; *t. c.* transverse commissures; *n.* nerves running out from the main cords to the nerve sheath; *n. s.* nerve sheath; *ep.* epidermis; *s. z.* special zone of rod-like bodies; *t:* testes.

Fig. 14.—Portion of the nerve sheath from the ventral surface, as seen in horizontal section. Zeiss D and F oc. 2. *n. f.* nerve fibres, arranged so as to form more or less rectangular meshes; *g. c.* ganglion cells, occurring between the nerve fibres.

Fig. 15.—Small portion of a longitudinal section through the anterior part of the animal; the section extends from above the alimentary canal to the epidermis on the dorsal surface of the animal. *ep.* epidermis; *r.* rod-like bodies; *mu.* masses of hardened mucous; *d.m.* layer of diagonal (oblique) muscle fibres immediately beneath the epidermis; *e. l. m.* external layer of longitudinal muscles (compare Fig. 19); *n. s.* nerve sheath; *g. c.* ganglion cells (compare Fig. 14); *r. f.* radiating muscle fibres; *s. z.* special zone of rod-like bodies; *x.* layer of tissue containing irregularly arranged muscle fibres, nuclei, and hardened rods of mucous (*mu.*) on their way to the surface; *y.* layer containing the deep muscular system; *l. f.* longitudinal fibres; *c. f.* circular or more or less oblique fibres seen in section; *d. v.* dorso-ventral fibres; *sl. g.* unicellular slime glands from which the rods of hardened mucous in the outer layers originate; probably in a young stage of development (compare Fig. 27).

Plate 9.

Fig. 16.—Portion of the lining epithelium of the alimentary canal, from a specimen killed with osmic acid, cut frozen, and stained with borax carmine before

cutting. Zeiss F. oc. 2. *al. ep.* alimentary epithelium ; *gr.* granules in the epithelial cells ; *n.* nucleus ; *m. f.* muscle fibres on which the epithelium rests.

Fig. 17.—Globular cells from the alimentary canal. Zeiss F. oc. 2. *n.* nucleus ; *gr.* granules.

Fig. 18.—Epithelium from the anterior end of the alimentary canal, from specimen killed with corrosive sublimate and cut by the paraffin method. Zeiss F. oc. 2. *am.* amœboid bodies of the cells projecting into the lumen of the alimentary canal ; *nk.* elongated neck of the cell ; *n.* nucleus ; *gr.* granules.

Fig. 19.—Portion of a vertical tangential section, showing the arrangement of the two superficial muscle layers. Zeiss D. oc. 2. *d. m. f.* layer of diagonal muscle fibres (corresponding to the external circular layer of Moseley) ; *e. l. f.* external longitudinal fibres, lying immediately beneath the preceding ; *r.* groups of rod-like bodies on their way to the surface between the bands of longitudinal fibres.

Figs. 20, 21.—Young mother cells with rod-like bodies developing in them. Zeiss F. oc. 2. *n.* nucleus ; *r.* rod-like bodies.

Fig. 22.—Older mother cell with the rods so far developed as to hide the nucleus, but still showing the outline of the unbroken mother cell. Zeiss F. oc. 2.

Fig. 23.—Group of rod-like bodies, the product of a single mother cell, from the special zone of rod-like bodies. From a specimen killed with osmic acid and cut frozen without staining (the rods appeared of a deep blue colour). The mother cell has apparently been ruptured and the rods are separating at their outer ends. Zeiss F. oc. 4. (The ends of the rods are blunter than usual.)

Fig. 24.—Three ejected rod-like bodies found lying in the mucous on the surface of the animal. Zeiss F. oc. 2.

Fig. 25.—Longitudinal section of an eye. Zeiss F. oc. 2. *l. c.* lens slightly shrunk so as to leave a space around it. *p. c.* pigment cup, seen to be composed of several more or less separate elongated portions, three of which are shown in the section. The pigment is deposited in the form of fine granules.

Fig. 26.—Transverse section across the inner portion of an eye, showing the nucleus (*n*). Zeiss F. oc. 2. *l. c.* and *p. c.* as in the preceding figure.

Fig. 27.—Three unicellular slime glands, from beneath the alimentary canal, showing the hardened rods of mucous in connection with them. Zeiss F. oc. 2. *sl. g.* slime gland ; *n.* nucleus ; *mu. r.* mucous rod.

Fig. 28.—Small portion of a horizontal section through the region marked *x* in figure 15, only from the ventral surface. Zeiss F. oc. 2. *m. f.* irregularly arranged bands of muscle fibres ; *n.* transverse section of a nerve.

Fig. 29.—Portion of vertical section through the extreme outside of the pharynx ; showing the cilia of the epidermic cells, the masses of mucous beneath the epidermis, and the rod-like masses of mucous lying in the epidermis itself and completely obscuring the cells of which it is composed. *ci.* cilia ; *mu.* masses of hardened mucous.

Plate 10.

Fig. 30.—Longitudinal section of testis, showing the central mass of spermatozoa in various stages of development, separated by a cavity, probably chiefly due to shrinkage, from the lining epithelium of mother cells. At *x* the central mass of spermatozoa is connected by a short neck with a branch of the vas deferens, which is not shown in this figure. *m. c.* mother cells of the spermatozoa ; *c. m.* central mass of developing spermatozoa.

Fig. 31.—Part of vas deferens, with branches to the testes, as seen in horizontal section. Zeiss D. oc. 2 (compare Fig. 4, *v. d.*). *v. d.* vas deferens ; *t. b.* branches to testes ; *n.* nuclei of epithelial cells lining the vas deferens.

Fig. 32.—Male and female muscular copulatory organs, dissected out from the ventral surface (compare Fig. 43). *fe.* female ; *ma.* male ; *g.a.* genital aperture.

Fig. 33.—Portion of lining epithelium of uterus, showing the ciliated projections. Zeiss Immersion 2.0 mm. oc. 4.45 mm. *ci.* cilia ; *n.* nuclei.

Fig. 34.—Part of yolk gland, showing its connection with a branch (yolk duct) of the oviduct. Zeiss D. oc. 2. *ylk.* yolk gland ; *ylk. d.* yolk duct ; *od.* oviduct ; *ep.* columnar ciliated epithelium of oviduct ; *i. m.* investing membrane of oviduct.

Fig. 35.—Two yolk gland cells, showing the enormous size of the nucleus *(n.)*. Zeiss F. oc. 2.

Fig. 36.—Mother cells of spermatozoa from epithelial lining of testis. Zeiss F. oc. 2. *n.* nucleus.

Figs. 37-39.—Three stages in the development of the spermatozoa, from the central mass of testis.

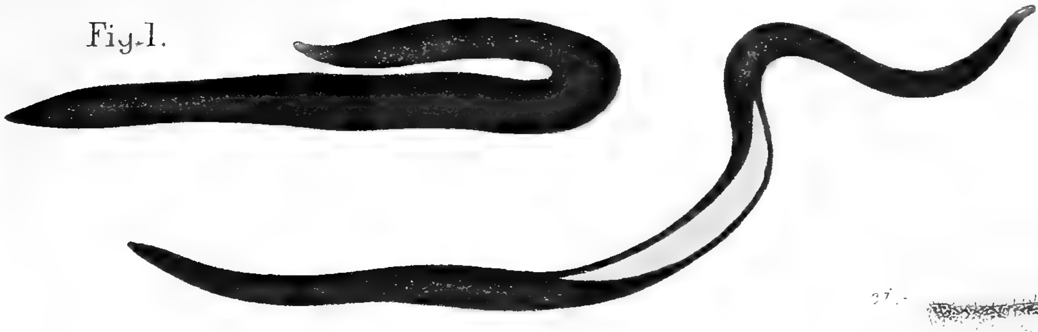
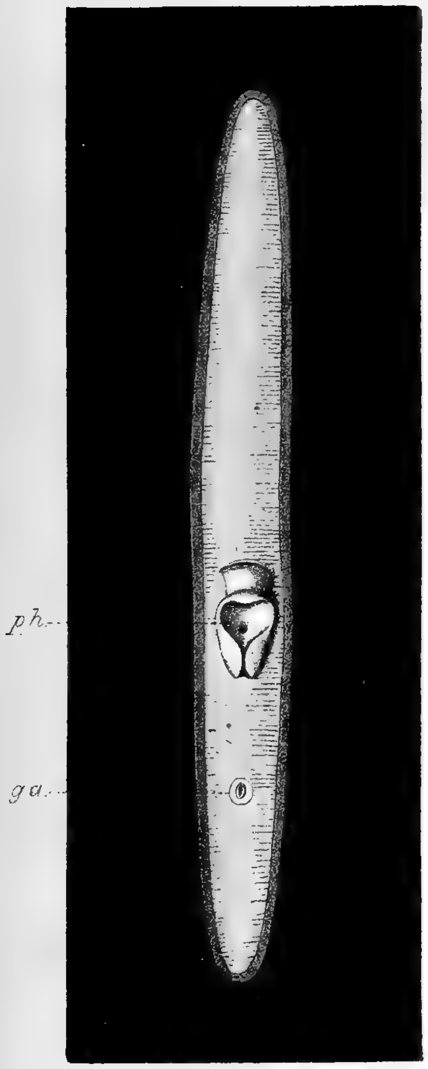


Fig. 1.

Fig. 2.



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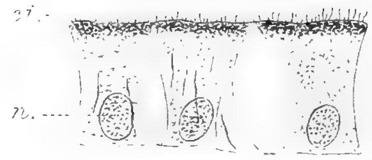

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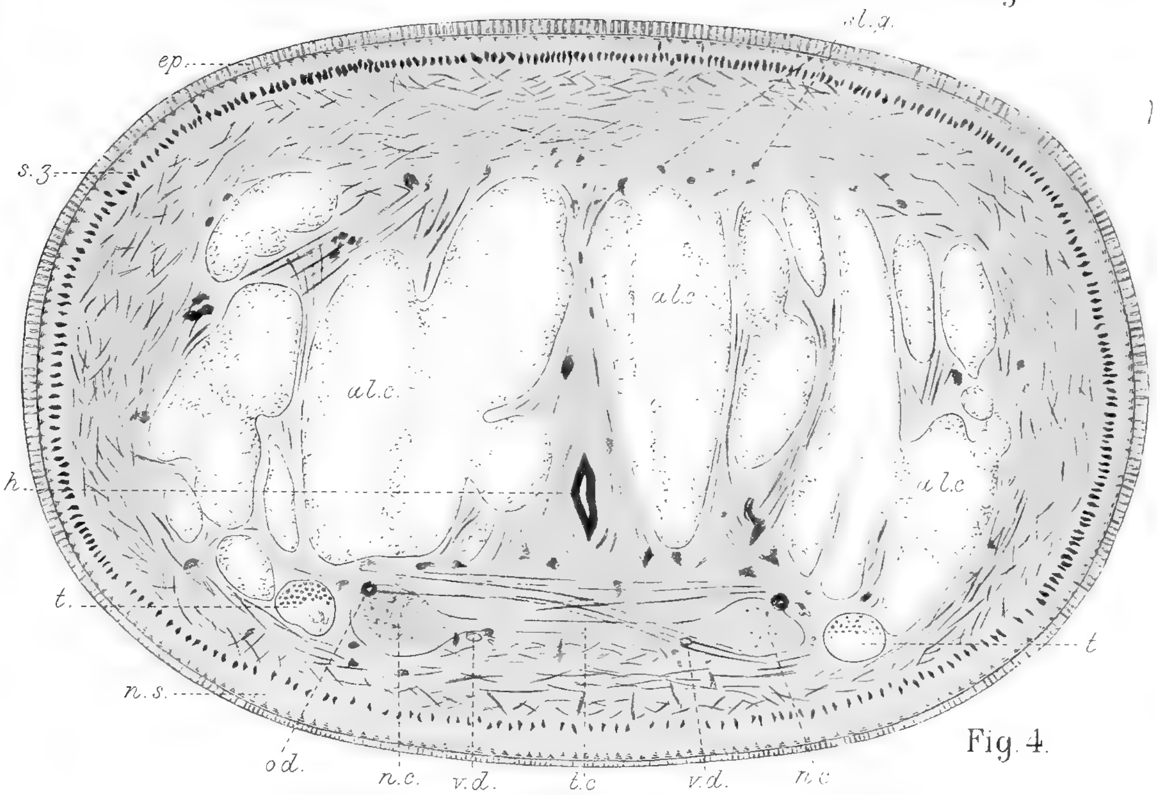

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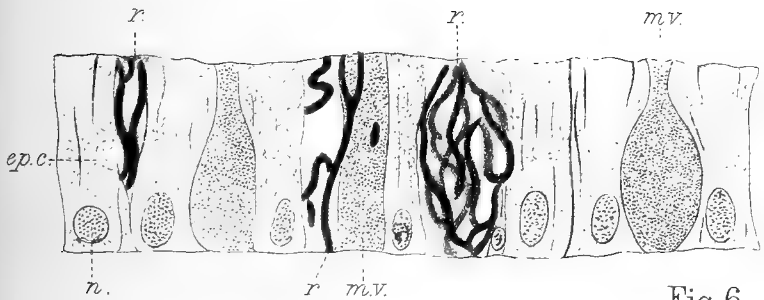

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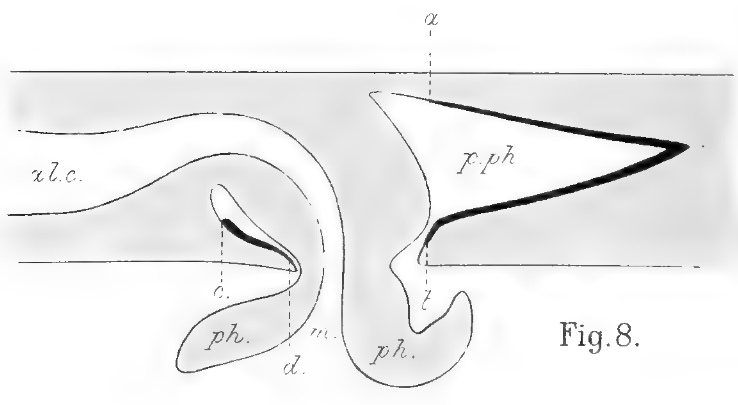

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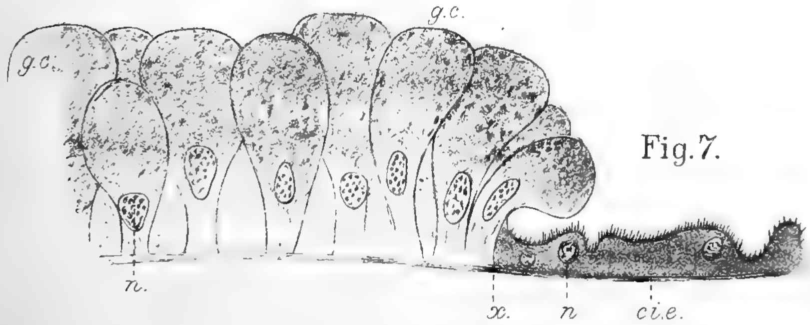

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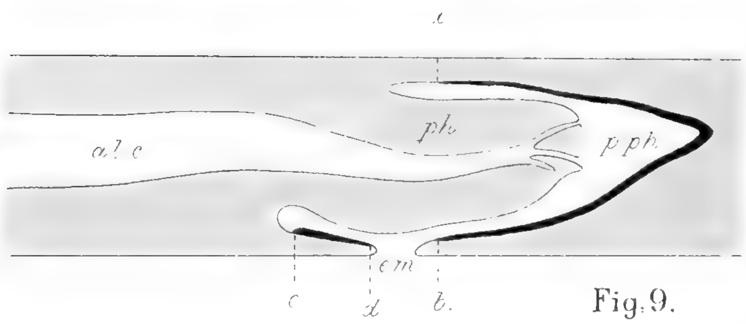

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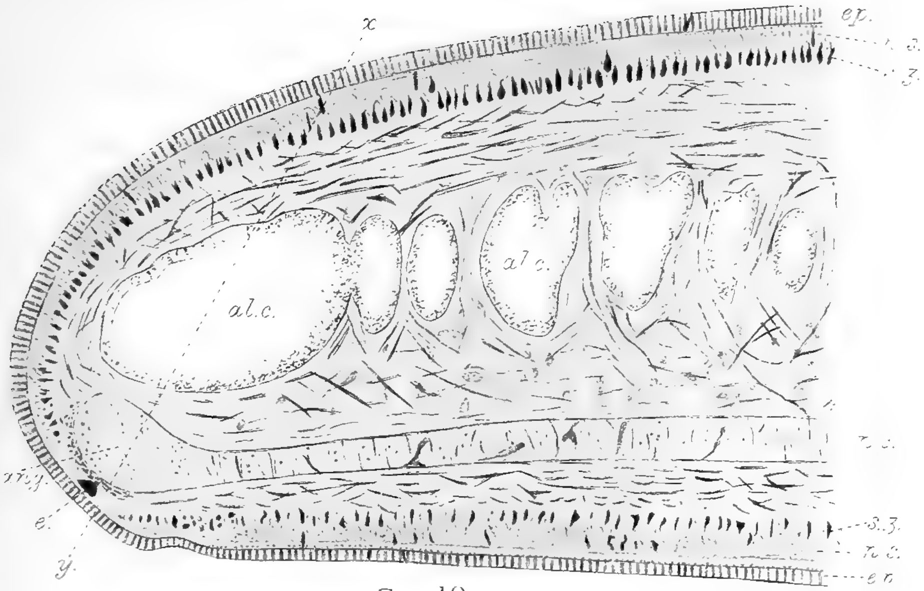

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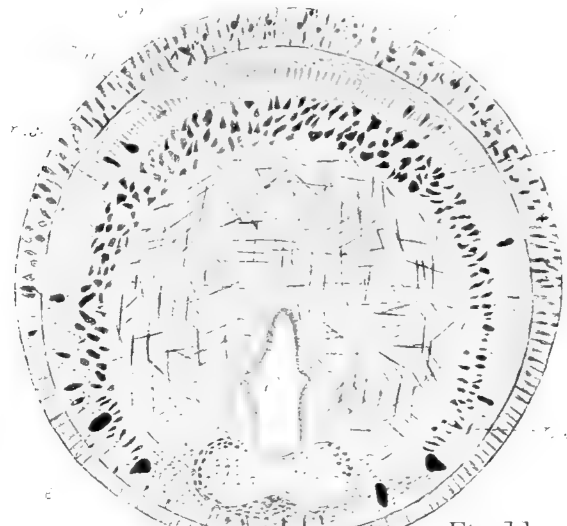
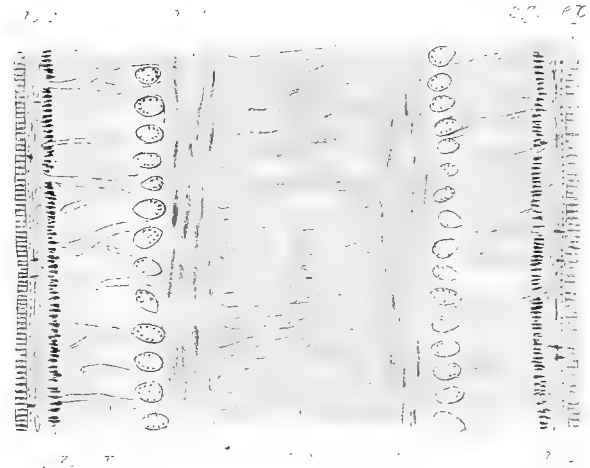


Fig. 11


Fig. 12.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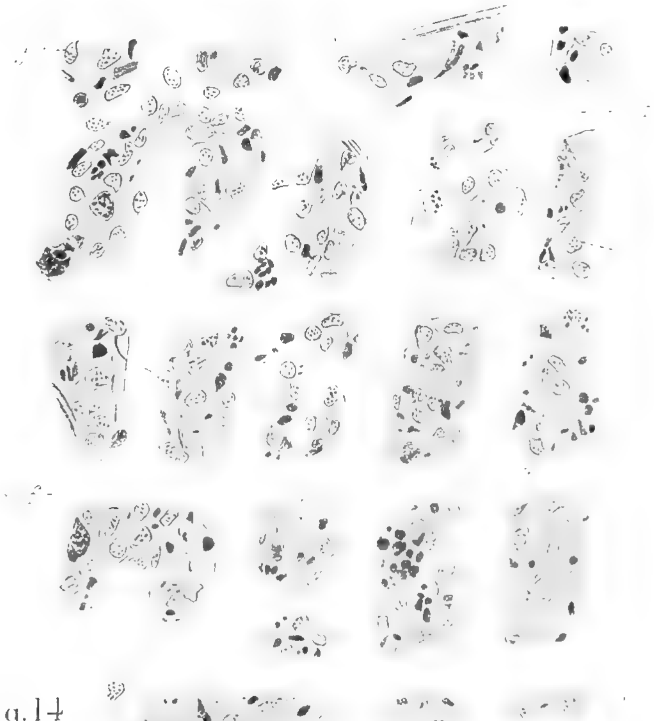
Fig. 14

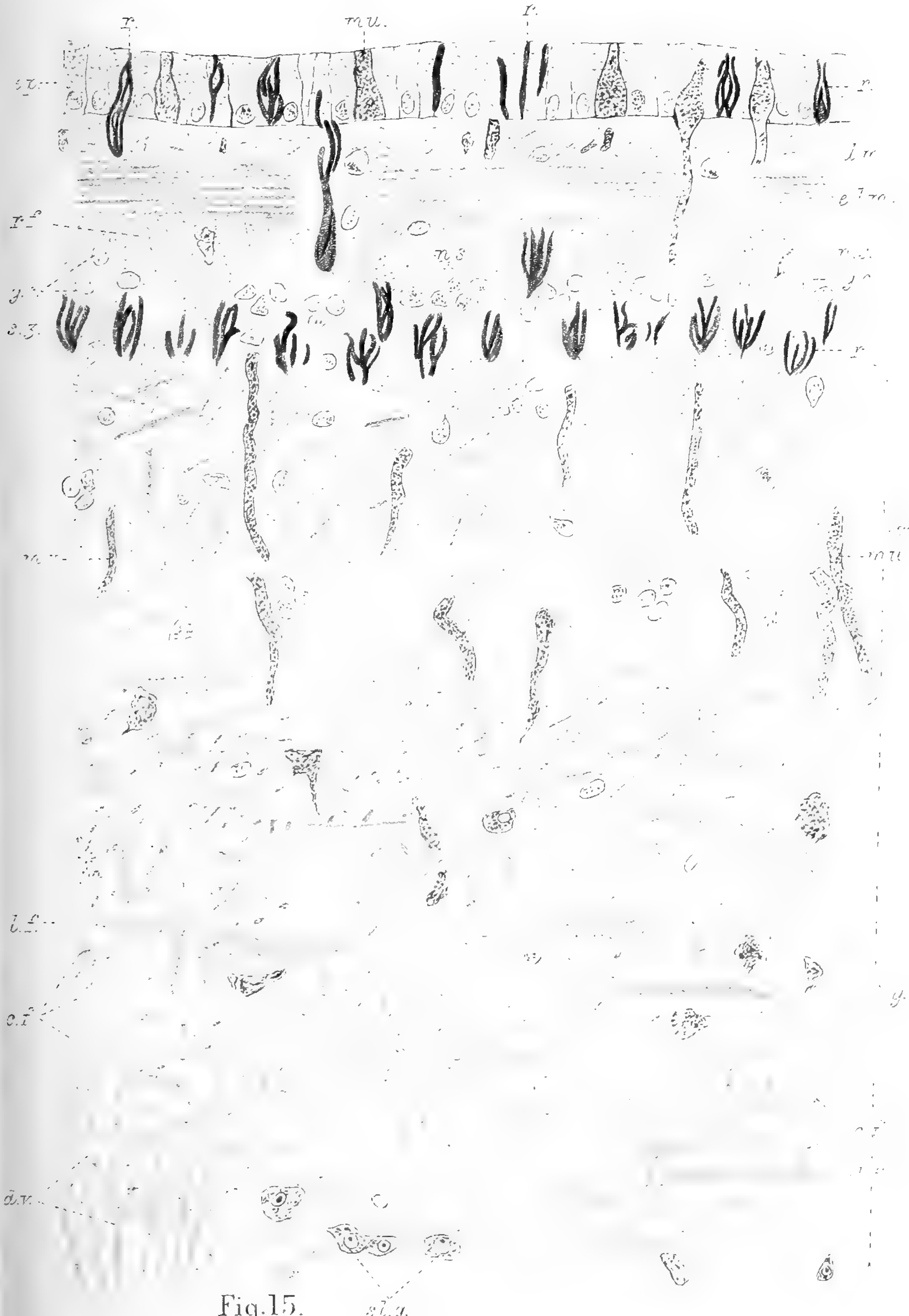

Fig. 15.

Fig. 16.

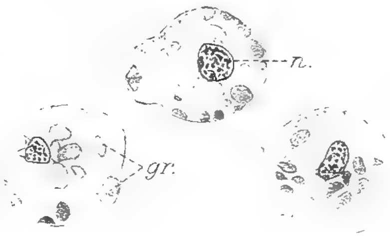

Fig. 17.

Fig. 18.

Fig. 19.

Fig. 20.

Fig. 21.

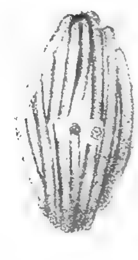

Fig. 22.

Fig. 23.

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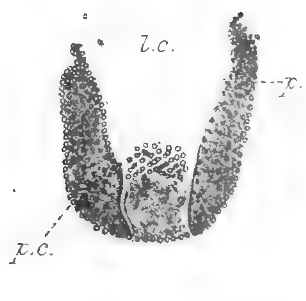

Fig. 25.

Fig. 26.

Fig. 27.

Fig. 28.

Fig. 29.

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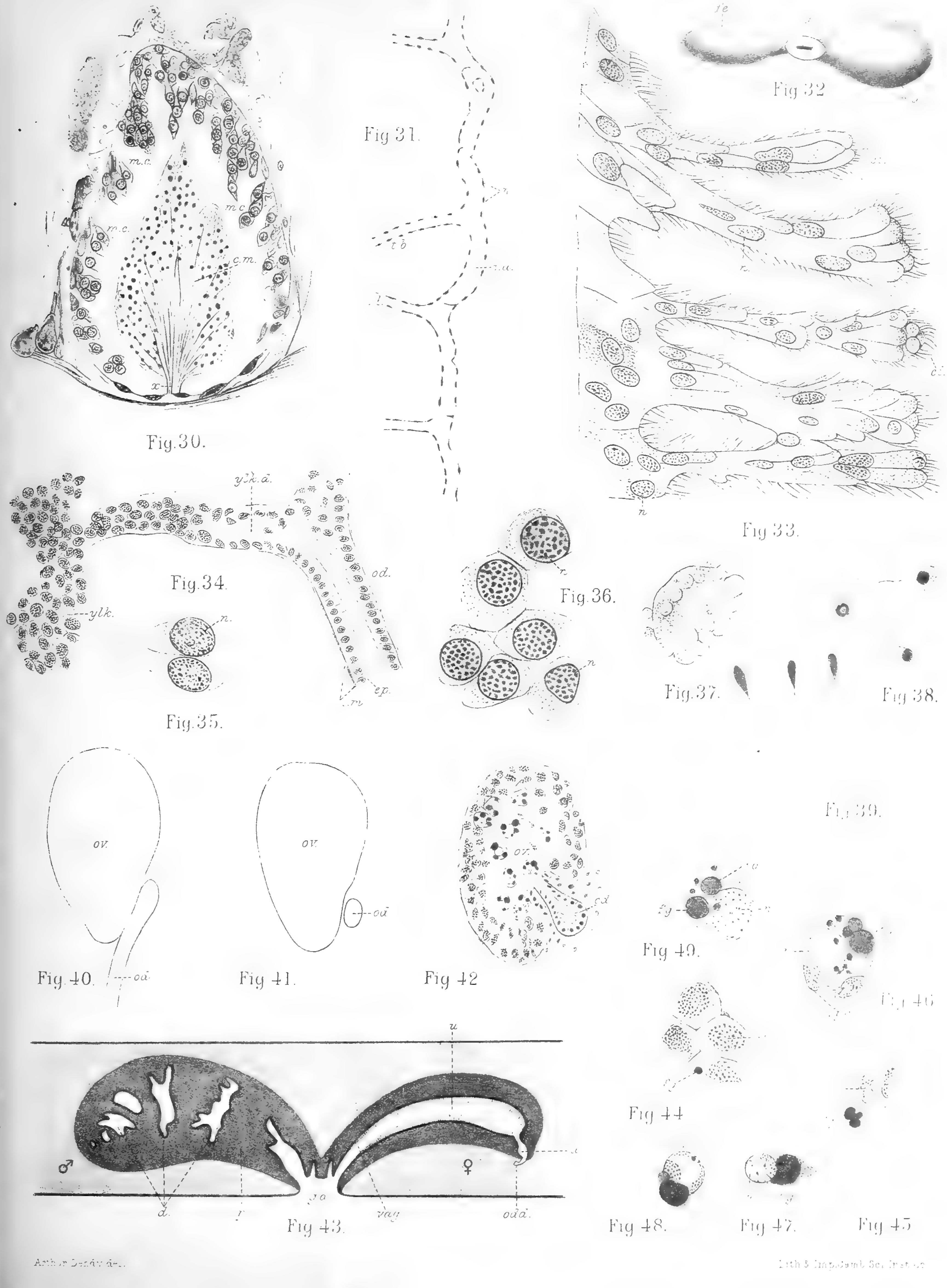


Fig. 30. Fig 31. Fig 32. Fig 33. Fig. 34. Fig. 35. Fig. 36. Fig. 37. Fig 38. Fig 39. Fig. 40. Fig 41. Fig 42. Fig 43. Fig 44. Fig 45. Fig 46. Fig 47. Fig 48. Fig 49.

Figs. 40-42.—Three longitudinal, horizontal sections of the ovary, to show the way in which the oviduct opens into it. (The sections are arranged in proper order, commencing at the most dorsal. Histological details are given in figure 42 only.) Zeiss D. oc. 2. *ov.* ovary; *od.* oviduct.

Fig. 43.—Longitudinal vertical section through the copulatory organs, slightly diagrammatic. (Compare Fig. 32.) The darker tint shows the extent of the muscular tissue. *g. a.* genital aperture; *p.* penis; *d.* sections of convoluted duct in penis; *u.* uterus; *vag.* vagina; *odd.* point of union of the two oviducts; *a.* small dilated chamber into which the united oviducts open, and which opens in its turn by a narrow duct into the posterior part of the uterus.

Fig. 44.—Portion of lining epithelium of ovary, from the cells of which the ova are developed. Zeiss F. oc. 2. *n.* nucleus; *f. g.* small food granule already deposited in one of the cells.

Fig. 45.—Young ovum in the amœboid stage, with one long, spindle-shaped (nutrient) cell adherent. Zeiss F. oc. 2. *n.* nucleus; *f. g.* food granules; *sp. c.* spindle-shaped cell.

Fig. 46.—Older ovum, showing four adherent spindle-shaped cells. Zeiss F. oc. 2. Lettering as before.

Fig. 47.—A developing ovum with reticulate nucleus (*n.*) and one very large food granule (*f. g*). Zeiss F. oc. 2.

Fig. 48.—Further stage in development. Zeiss F. oc. 2.

Fig. 49.—Mature ovum as found in the central part of the ovary. (Compare Fig. 42.) The nucleus (*n.*) has assumed its characteristic transparent, swollen appearance (already shown in Fig. 46), and several large food granules (*f. g.*) are present. Zeiss F. oc. 2.

ARTICLE IV.

On the Organisation of Australian Tribes, by A. W. Howitt. (With a Map.)

(Read Dec. 12, 1889.)

Introduction.

Anthropologists have always felt great interest in the social institutions, and in the customs and beliefs of the Australian aborigines, for the reason that these savages, having for so many ages been apart from other races of mankind, afford an unequalled example of the social institutions of a primitive people. The vast extent of the Australian continent, its secluded situation, and its homogeneous population, have given opportunity, moreover, for a social development, free from external influences. For the slight contact in the northern shores of this continent between Australian tribes and Papuans and Malays, although, no doubt, it has influenced custom locally, has had no effect upon the general population of the continent.

The disappearance of the indigenous Australians before the white race has been so rapid, and is so continuous, that it seems probable that another generation will see almost its extermination, unless in the fastnesses of the coast mountains of tropical Australia, or the most inhospitable portions of the interior of the continent.

Thus it becomes of especial importance that now, while there is still opportunity for so doing, every detail may be recorded which it is possible to learn as to the social organisation, the customs, and the beliefs of these aborigines. Much has been done in this direction, and especial interest attaches to those works, which are the result of direct enquiries by persons residing in favourably situated parts of Australia, who may be expected to write from actual knowledge, or from carefully tested information given by competent observers, rather than from unchecked statements. The last work on this subject, namely, that of the late Mr. E. M. Curr, "The Australian Race," was the outcome of the labour of years by an author who had personal acquaintance with the aborigines, and which comes to us bearing the authoritative stamp of publication by the Government of Victoria.

Mr. Curr has collected together a vast amount of most valuable data, and he has given his own opinions and views upon, among other matters, the structure of society as found among the Australian tribes.

There are, however, some statements which Mr. Curr has thus made and conclusions at which he has arrived, from which, as a worker in this part of the anthropological field, I have felt myself constrained to dissent. I feel it necessary to draw attention to them, as otherwise, if passed over in silence, it might seem that their accuracy is not to be doubted.

It was understood between Mr. E. M. Curr and myself that any discussion of the matters in which we differed in opinion should be deferred until the publication of the present memoir. The lamented decease of Mr. Curr has rendered this impossible, and it must therefore be left to the decision of competent anthropologists as to which views are in the future to be received as authoritative.

In order to bring into view all the points to which I desire to give pre-eminence it will be necessary to go over some of the ground already covered by certain papers of mine which have been published in the Transactions of the Anthropological Institute of Great Britain, and of the Anthropological Society of Washington.

The various subjects to be discussed will fall naturally under the subjoined sections.

This memoir, as its title indicates, deals with the "organisation of Australian tribes," but it does not treat of every matter which may have, to some extent, a bearing on the social status. Such subjects as blood feuds, wizards and doctors, initiation ceremonies, food rules, which all have an influence upon society, are not touched upon.

In order to avoid repetition, I now subjoin some short particulars as to the tribes quoted, and give the names of my authorities for the statements contained herein. I take this opportunity of thanking these gentlemen for their kind and willing aid to me in my inquiries, and for the patience with which they have borne the constant reiteration of my questions.

The information as to the Kurnai, Thed-dora, Murring, Wotjobaluk, and Woiworung I have carefully collected from the survivors of these tribes, as well as from personal observation of their customs.

Wakelbura tribe, Belyando River, Queensland—Mr. J. C. Muirhead, of Elgin Downs.

Turribul tribe, Maryborough, Queensland—Mr. Harry Aldridge and Mr. J. Petrie.

Kuinmurbura tribe, Pine Mount, Rockhampton—Mr. W. H. Flowers.

Kunandaburi tribe, Barcoo River, Queensland—Mr. W. J. O'Donnell, formerly of Mt. Howitt Station.

Kamilaroi tribes, Maitland, New South Wales—Mr. C. Naseby, per Dr. Fraser, of West Maitland.

Kaiabara tribe, Bunya Bunya Mountains, Queensland—Sub-Inspector J. Brooke.

Gringai tribe, New South Wales—Mr. A. Hooke, per Dr. Fraser.

Dieri tribe, Lake Eyre, South Australia—Mr. S. Gason and the Revs. H. Vogelsang, Meyer, and Flierl.

Structure of Aboriginal Society in Australia.

(*a*) *The Social Organisation.*—It may be laid down as a general proposition that all Australian tribes are divided into two moieties, which intermarry with each other, and each of which is forbidden to marry within itself. In certain rare cases these two moieties cannot be distinguished in the familiar form in which they usually present themselves to the investigator, but usually cases can be found which will fully justify the belief that they also at one time existed in these exceptional communities. As an example for the purposes of this paper, I take the case of a Queensland tribe in which the two inter-marrying moieties in dialectically varying names have a wide geographical range, and as to which the information furnished by a most competent authority is full and exact.* The tribe referred to is the Wakelbura,† on the Belyando River. It will serve as a type of many other tribes extending over a thousand miles north and south, and at least five hundred miles east and west. I subjoin once for all, for present as well as for future reference, the full class system of this tribe in a tabulated form:—

WAKELBURA CLASS SYSTEM.

Two Primary Classes.	Four Sub-classes.	Totem Names.‡
Malera.	Kürgila	Plain Turkey Small Bee
	Banbe	Opossum Kangaroo and others.
Wüthera	Wüngo	Emu Carpet Snake Large Bee
	Obü	Gidea Tree Black Duck and others.

* Mr. J. C. Muirhead.

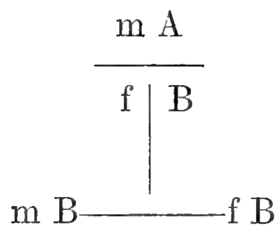
† From Wakel = Eels. "Bura" appears to be analogous to the Kamilaroi suffix "aroi," which may be translated "of" or "belonging to."

‡ The English equivalents of the totem names are here given.

I first proceed to consider the relations of Malera and Wuthera to each other. One moiety of the tribe is Malera, and the other moiety of the tribe is Wuthera.* On the same level in a generation, all such in the Kurgila sub-class as are of the same totem name are regarded as brothers and sisters. The father of Kurgila is Wungo, and the mother of Kurgila is Banbean. These sub-classes are the parents of the sub-class Kurgila, and so on with the other sub-classes and totems. It will be shown further on why it is that these different levels in the generations are thus regarded, but for the present it will suffice to point out that such is the case, and that it indicates a relationship of group to group. This inference the reader will do well to bear in mind in perusing these notes.

Malera and Wuthera intermarry. A Malera man marries a Wuthera woman, and a Wuthera man marries a Malera woman. No one may marry one of the same class, sub-class, or totem, and even casual amours between such are regarded as a grave offence. The child takes the name of its mother.

Replacing the names Malera and Wuthera by the letters A and B respectively, we can now construct a little diagram of the marriages and descents in the primary classes, which will also be of some use later on in this paper. The letters m=male, and f=female.



In very many tribes the primary classes are directly subdivided into lesser groups, each of which bears the name of an animal, or of some other natural object, and which, from their analogy to the well-known North American tribal divisions, have been called "totems."

In the Wakelbura example I have, for the sake of clearness, given the English equivalents of those names. In this tribe, as in almost all tribes throughout Eastern Australia, there are also other sub-divisions of the community which are interposed between the primary classes and the totems. The well-known and often described Kamilaroi classes—Ipai=Kumbo and Muri=Kubi, are familiar examples. I shall describe, shortly, their equivalents in the Wakelbura system.

Malera divides into two sub-classes, named Kurgila and Banbe; and Wuthera into two, named Wungo and Obu. Each sub-class, as I have already stated, forms a

* The female name is formed by adding the feminine termination "an." Thus the man Wuthera has Wutheran for his sister, the sister of Kurgil is Kurgilan, of Banbe is Banbean, and so on with the other names. This applies also to the totem names.

related group, in which all the men of the same contemporaneous level in a generation are regarded as brothers, and the women of it as sisters, and the two groups are brothers and sisters. Kurgila marries Obuan, and the children of this marriage take the name of the sister-class of Obuan, namely, Wungo and Wungoan. The same rule applies *mutato mutandis* to the other three classes. The above little diagram may be conveniently expanded as under, and the small letters, a, a', b, b' may be taken for the four sub-classes in the order above given :—

```
            m A a
           -------
            f B b'
              |
              |
   m B b------------f B b
```

It now becomes evident that, although the children of Obuan* are Wungo and Wungoan, that they count their descent through the mother's, and not through the father's line; for they are of their mother's primary class, and of that sub-class which, with hers, represent the primary of both.

There remain now the totem sub-divisions to be considered. The Wakelbura, as do a number of other tribes, indeed, probably many more than are thought of, divide the whole universe between their two great classes.

Every natural object, including the blackfellow, is either Malera or Wuthera. Moreover, they are again subdivided under the four sub-classes, so that man is, in one sense, no more than one item in the great assemblage of totems which range themselves under the classes Malera and Wuthera. Man is so intimately connected with his fellow totems, and they are regarded as having so great a control over him, that scarcely an action of his life is beyond their influence. The totem influences him waking and sleeping, when alive, and affects him even when dead. Certain animals are the especial game of each sub-class. Obu, for instance, claims as his game emu and wallaby, and, if he desires to invite his fellow totemites in a neighbouring tribe to hunt their common game, he does so by means of a message-stick made from a tree which, like themselves, is of the Obu class. When a man desires to perform some magic act he must use for it only objects which are of the same class as himself, and when he dies he is laid upon a stage made of the branches and is covered with the boughs of some tree which is of his class.† Among all these natural objects, which are of his class, there is some one which is nearer to him than any other. He

* It is well to bear in mind that "an" is the female termination.

† Among other instances of analogous beliefs, I may refer to the Wotjobaluk of Victoria, who also divided the whole universe between their two primary classes.

bears its name, and it is his individual totem. Thus, there is a group of totems attached to each of the primary classes, and among the Wakelbura some of these totems are common to both the sub-classes into which their primary divides*

A totem of one class can only marry with a certain totem in the other class, and the children are of the same totem as their mothers. Here we find again proof, which in this case is clear and direct, that descent is counted in the female line.

We may carry with us these preliminary conclusions, namely, that in tribes such as the Wakelbura, each class, sub-class, or totem is a group of individuals, all of whom are related to each other by bonds which run through the female line of descent.

I have now shown the manner in which the community divides into certain hereditary groups, and the fundamental laws which govern marriage and descent in them. For further details as to variations of type which occur, I may refer the reader to my previous memoirs on this subject.†

(b) The Local Organisation.—I have now shown how the Wakelbura community is divided socially into two great inter-marrying classes with sub-divisions.

But beside and independently of this social organisation there is what may be termed a local organisation of the tribe. The Wakelbura tribe as a whole occupies a certain defined tract of country, which forms its hunting and food grounds, and which it claims exclusively, not admitting the right of any other tribe or any other individuals to use it unless when they happened to be within its boundaries as the visitors of the Wakelbura. The boundaries of this tribal country coincide with the boundaries of the social organisation of the classes of the Wakelbura community, although the names of the classes, sub-classes, and totems extend beyond the tribal boundaries, and include in a wider social bond other adjoining tribes.

The tribal country is divided into lesser areas, each of which is claimed by a corresponding local division of the tribe, and these are again subdivided until we get down at last to the local unit, namely, that small tract which is occupied and claimed by the smallest tribal sub-division, which may be considered in the light of an undivided family, that is to say, of those who are very nearly related to each other, and who have a common descent from a known ancestor, together with their wives who have been brought from other localities.‡

* Mr. Muirhead informs me that at present he is unable to find out why it is that some totems are peculiar to one of the sub-classes, whilst others are common to both sub-classes.

† Notes on the Australian Class Systems, Journal Anthropological Institute, May, 1883. Further notes on the Australian Class Systems, Journal Anthropological Institute, 1888.

‡ I may refer the reader for a good instance of how a tribe is divided into local groups to the Kurnai tribe, as to which, see "Kamilaroi and Kurnai," Fison and Howitt, Robertson, Melbourne, 1883, p. 224, *et infra*.

Thus we find that the tribe is divided and again subdivided according to locality, just as the community is divided and subdivided into what has been termed for the sake of convenience, perhaps not quite happily, "class divisions." This twofold division of the tribe, although it coincides in its external boundary, is not coincident in its internal divisions. The members of the different totems, for instance, are scattered over the whole tribal country, and are found in all the local divisions. The class and totem names change from place to place in succeeding generations, under the influence of the laws which regulate descent through the female line. But the local groups are permanent. The hunting grounds which a man roams over are left by him to his sons, although these do not bear his name.*

It is most important for a true understanding of the manner in which the society of the Australian savages is organised to not only see the distinction which I have drawn between the two organisations, but also, what is perhaps quite as important, to become acquainted with the ratio which the two organisations bear to each other in the tribes respectively as a whole.

Starting with the most complete organisation, namely, that of which the Wakelbura tribe is a type, wherein the social organisation into classes is full and vigorous, and runs through the female line, a series of tribes can be shown to exist with an increasing variance, until the ultimate result is reached of a tribe in which the social organisation into classes has become extinct, leaving only faint traces of its former existence behind,† in which the local organisation is the only one in which the community is arranged; and, finally, in which descent has completely changed to the male line. The study of such a series of communities is one of deep interest. It is pregnant with suggestions, and it goes far to prove that which is also indicated by other independent lines of evidence, to which I shall by and bye refer, that the society of aborigines of Australia has undergone a process of development from a status in which descent was necessarily counted through the mother to one in which the conception of descent from an individual father became possible.

The tribes which I shall use for the purpose of illustration in this paper afford a brief example of such a series. The Wakelbura tribe stands at the one end with a full vigorous class organisation with female descent.

The Turribul tribe has a class organisation precisely analogous to that of the Wakelbura in its primary and sub-classes, but descent is counted through the male line under a cross law of the sub-classes, analogous to that of the Wakelbura, and it has no totem groups.

* I have in this section taken the Wakelbura tribe with maternal descent as my text. But there are tribes in which, with the same type of organisation, the descent is in the male line. In these the son bears the primary class name of his father.

† E.G. Kurnai and Chepara tribes.

The Woiworung tribe had the two primary classes and one sole surviving totem, but descent was through the father, and the classes were aggregated together, each one into separate localities.

The Kurnai tribe had no classes or totems, but in some cases animal names remained transmitted from father to son, and the restrictions upon marriage were purely local.

Tribal Government.

Headmen and the Tribal Council.—When an Australian tribe is looked at from the standpoint of an ordinary observer, the conclusion seems to be justified that there is in it no recognised form of government. That is to say, there is not manifested any person or group of persons who have the right to command, under penalties for disobedience, and whose commands are obeyed by the community. There does not seem to be any person to whom the whole community yields submission, who has peculiar privileges which are patent to observation, or who is surrounded by more or less of savage pomp and ceremony. On a general view of an Australian tribe all that is seen by the superficial observer is that there is a number of family groups, which roam over certain tracts of country in search of food, and that while they appear to show considerable respect to the old men, all the males enjoy so much liberty of action that each one may be considered to do that which seems best in his own eyes. A more intimate acquaintance with such a tribe shows clearly, however, that there must be some authority and restraint behind this seeming freedom. For it is seen that there are well-understood customs or social laws, which are perfectly binding upon the individual, and which regulate his actions towards others.

It is quite true that many such customs or laws are obeyed without the dread of punishment being inflicted for their infraction by any tribal authority, individual or collective. Such laws are, for instance, those relating to the use of certain animals for food, or the doing of certain acts.

But these laws are obeyed because the aborigine has been taught from his earliest childhood that their infraction will be followed by some supernatural punishment, personal to himself. For instance, taking again the case of laws relating to food, the Wakelbura youth is not permitted for a time to eat certain creatures after he has been initiated at the Bora ceremonies,* such as emu, spiney ant-eater, or black

* Though Bora is a term only used by certain tribes for the initiation ceremonies, it is well known to anthropologists, and may be adopted as a convenient term for those rites.

snake. He has been taught to believe that should he do so he would become sick, and gradually pine away and die, uttering the sounds peculiar to the bird, reptile, or animal eaten; and similar beliefs are so strong in probably all Australian tribes that well established cases can be given of men who have died through the dread produced by consciousness of having broken such a law.

But there are other rules of conduct which are observed under other than supernatural sanctions. A man who is believed to have caused the death of another by arts magical is, among some tribes, *e.g.*, the Dieri, killed by a Pinya,* or armed party, which is commissioned by the Council of the Tribe, or more commonly in other tribes, *e.g.*, the Kurnai, is compelled to appear before the assembled tribe and submit to an ordeal of spear-throwing, or the recourse to some other weapon. Lesser offences, such as the abduction of women within the tribe, are also, in certain cases, dealt with by the offender submitting to a similar ordeal.

These offences are clearly to be considered in the light of acts of violence towards an individual of a kindred, or injurious to them. But there are others which may be called offences against the moral code—such, for instance, as the cohabitation together of persons too nearly related. In most tribes such offenders would be killed.

It is evident that there must be some executive power by which such offences as the above are dealt with and punished.

It is sometimes said that this executive power is no more than public opinion, but public opinion as such is merely a moral influence, and requires some executive to give effect to its wishes or its commands. Mr. E. M. Curr, in his late work on "The Australian Race," says: "The power which enforces custom in our tribes is for the most part an impersonal one."† This "impersonal authority" must have been either public opinion or a supernatural sanction. According to Mr. Curr it is "education," that is to say, a blackfellow is educated from infancy in the belief that departure from the customs of his tribe is invariably followed by one at least of many possible evils, such as becoming prematurely grey, being afflicted by opthalmia, skin eruptions, or sickness, but, above all, that it exposes the offender to the danger of death from sorcery.‡ This is undoubtedly true as to food, or as to some rules regulating the sexes—for instance, that a novice must not receive food from the hand of a woman (Kurnai tribe), but it does not account for the actual punishment inflicted for such breaches of custom, or for offences against the tribe. Mr. Curr denies, in

* The Pinya custom has been described by Mr. S. Gason, whose statements as to the customs of the Dieri tribe are of the first authority, and I became acquainted with the existence of a similar custom in tribes allied to the Dieri during my explorations in Central Australia. We may see in the Pinya clearly a custom in which the offender is pursued by the avengers of blood, the Bluträcher, under the sanction of the elders of the tribe.

† Op. cit., p. 52.

‡ P. 54.

fact, that there is any "government in Australian tribes," and he defines "government" as being the "habitual exercise of authority by one or a few individuals over a community or a body of persons."

I have already said that there must be some executive to carry out punishments inflicted for offences. I propose now to show what this executive power is, and how it acts in an Australian tribe. To do this it will be best to give some instances taken from tribes far apart, and which will thus show the generality of the principles deducible from them. But I must again remind the reader that custom varies much, and that it is never safe to argue from a practice in any one tribe to the practices in all tribes.

I have very fully described the customs of the Kurnai tribe in several places,* and may refer the reader to them for general information as to the organisation of that tribe. I shall now only add some particulars which will illustrate the present position I take up. Nearly thirty years ago two old men were recognised by the tribe's people as their Gweraeil-Kurnai or "Great Men." One lived in the northern and the other in the southern part of the district. These men were the recognised leaders in peace and war of the northern and southern divisions into which the tribe had naturally fallen through locality and language. There were also other old men who were "Gweraeil-Kurnai" respectively in the divisions of the tribe to which they belonged, and it is significant that some of these men gave their names to those local divisions.† The two principal "Gweraeil-Kurnai" determined when the initiation ceremonies should take place, and were the respective leaders of their moieties of the tribe in war.‡ When some man was called to come forth and submit to the ordeal of spears it was the Gweraeil-Kurnai who directed the proceedings, and it was he who sent out messengers on errands of peace or of war.

In a case which I have referred to in a former work,§ when a man named Bunbra was compelled to stand out in an ordeal of spears and other weapons, it was the Gweraeil-Kurnai of the northern division of the tribe who conducted the proceedings. This Headman, Bruthen Munji, is long dead, and all the other Headmen of the tribe of that time have gradually died off, and I have watched with much interest the manner in which the governing power of the tribe has been perpetuated. As the oldest of the Headmen died, the next oldest survivor became invested with authority, until at length, within the last few years, the abovementioned Bunbra came to be the oldest man among the survivors of the tribe, and

* Kamilaroi and Kurnai, Geo. Robertson, Melbourne, 1883.
The Jeraeil or Initiation Ceremonies of the Kurnai tribe. Journal of Anthrop. Inst., May, 1885.
On Australian Medicine Men. Journal of Anthrop. Inst., August, 1886.

† Op. cit., p. 228.

‡ Op. cit., p. 212.

§ Op. cit., p. 216.

thus their acknowledged "Gweraeil-Kurnai," or Headman. During the same time, also, the tribal son* of Bruthen Munji also grew into age, and consideration attached to him in his twofold character as one of the elders, and as being the son of the former renowned Headman. During the lapse of more than a quarter of a century the pressure of our civilisation has broken up the tribal organisation. The greater number of the surviving aborigines have been gathered into the mission stations, and the few others wandered about the settlements, having apparently abandoned most of their tribal customs. When, however, it was decided to hold their initiation ceremonies, as I have described them elsewhere,† I found with much interest that the old tribal organisation arose again, so to say, out of the dust, and became active. Bunbra, who at the time when Bruthen Munji presided at the ordeal of spears to which he was subjected, was a comparatively young man, and, without any consideration in the tribe, had now become its Headman, and to him all matters were referred. To him messengers went. He gave orders, and the others obeyed them, as to the time of assembling. Indeed, without him they would not have moved.

At the ceremonies themselves he was the leader, and it was mainly his voice which decided questions which were discussed at several councils of initiated men which were held. When, during the ceremonies, two of the novices were brought before the old men in council, and were charged with having broken some of the ceremonial rules, it was he who spoke last, and his directions as to them were obeyed.

In the olden times the Gweraeil-Kurnai, or, as I have almost literally translated the title, Headman, took an active part together with the other old men in dealing with breaches of their moral code, such, for instance, unlawful, *i.e.*, incestuous marriages, which were punished by death.

Among the Murring tribes of the New South Wales coast, adjoining Victoria, I have made similar observations. Each division of the tribe had its Headman, who was called Gommera. To become a Gommera a man must have been aged, must have been able to speak several languages (dialects), must have been skilful as a warrior, and, above all, must have been able to perform those magical feats which the wizards exhibit at the initiations.

There was a Gommera (Headman) in each division of the tribe. In his particular locality he was master and directed his people. Umbara, the tribal bard of the coast Murring, put it in the following manner to me:—"A man is the Biamban (master) of his wife and children. An old man is the Biamban of the young men. The

* As to "tribal son," see *infra.*, p. 131.

† See the Jeraeil or Initiation Ceremonies of the Kurnai Tribe, Journal of the Anthrop. Inst., May, 1885.

Gommera is the Biamban of all the men, and Daramulun is the Biamban of all."* The Headman sent messengers to call people together for ceremonial purposes, and to call upon offenders to come forward and submit to punishment. At such meetings the Headmen were present, and directed the proceedings. When men were believed to habitually practise the injuring of others by casting magical spells upon them the Gommera would, after consulting with the other old men, give orders for the offender to be killed, and an armed party of younger men carried out the sentence. The Gommeras were the repositories of the old customs and laws. When a number of the divisions of the tribe were collected together their Gommeras met, as occasion required, at some place apart from the camp and consulted upon such matters as required to be dealt with. I have been present at such meetings. I have observed that they were carefully guarded against the intrusion of women, or of the uninitiated. The younger men sat round at a little distance and listened attentively, but did not venture to speak. The old men spoke in turn, and the Headman spoke usually last, and his views were generally adopted. I was much struck by the profound and respectful attention with which a younger man has listened with bent head, and eyes cast down, to the directions given him at such a meeting. At such meetings offenders against custom are dealt with by the old men.

The power of the old men in such tribes is riveted upon the young men by the impressive instructions as to implicit obedience due to their orders given at the initiation ceremonies, and by the apparently supernatural powers which they thereat exhibit to the novices.

The accounts which Mr. Gason has given me as to the status and powers of the Headman of the Dieri tribe, before it came into contact with our civilisation, are most interesting and important,† and my own acquaintance with this tribe and the neighbouring Yantruwunta, while they were still purely in their primitive condition, enables me to corroborate, to some extent, Mr. Gason's statements. These tribes inhabited country in the Barcoo delta, west of Lake Eyre, and they represent a great number of tribes which extend over a very wide area in Central Australia, all of which have the same social organisation.

The Dieri are divided into two great classes, named Kararu and Materi, each having a number of totems (Murdu). The tribe is also divided into a number of local divisions, which I have termed hordes. Of these there are five principal ones. In each totem the oldest man was its Head or Pinaru.‡ In each horde there was also a Pinaru, who might also happen to be the head of a totem. But it did not necessarily follow that the head of a totem or the head of a division had much influence beyond

* See "Australian Ceremonies of Initiation," p. 12, Journal Anthrop. Inst., May, 1884.

† I have communicated a memoir on the Dieri and kindred tribe to the Anthrop. Inst.

‡ From Pina=great. Thus being the analogue of the Kurnai word Gweraeil=great. Pinaru is, therefore, to be translated as "great one," or Headman.

his own totem or his native locality. I remember such a case at Lake Hope, where the Headman was the oldest man of the Kurawura Murdu (eagle totem). He was this by reason of his age, and he wore a circlet of red feathers as token thereof, but he had little influence.

These Piraurus, collectively, were the Headmen of the tribe. Of them some one was superior to all others. At the time when I knew the tribe, and when Mr. Gason speaks of it, the Headman was one Jalina Piramurana.* He was the Head of the Kunaura Murdu or Portulaca† totem, and he was recognised as the Headman of the whole Dieri tribe. Mr. Gason describes him, from a personal acquaintance of six years, as a man of polished manners, of persuasive eloquence, a skilful and brave warrior, and a powerful wizard. As the supreme Headman of the Dieri he presided at the Council of Headmen, sent out embassies to the neighbouring tribes, and even had the power in his own tribe of giving young women, not related to him, in marriage, of separating men from their wives when they could not agree, and of making for them fresh matrimonial arrangements.

He periodically visited the various hordes of the Dieri, from which he also periodically received presents. Distant tribes, even as far as three hundred miles off, sent him presents, which were passed on from tribe to tribe.‡

The Heads of totems and of hordes, the great orators, warriors, and wizards, and speaking generally, the old men, met at times in secret, when the tribe was more or less assembled to concert upon matters of importance. To reveal to outsiders what took place at such meetings was punishable by death.

Mr. Gason, after a long time, and only when he had learned to speak the Dieri language, was permitted to be present at these councils. The council was directed by the principal Headman. It dealt with offences against the tribe and against tribal morality. When an offender had been adjudged guilty of having caused the death of another by magic he was, as I have already stated, killed by an armed party (pinya) sent out by the Headman. It also dealt with offenders against the strict rules which govern the intermarriages of the classes, and which prohibit cohabitation between those who, by the Dieri system of relationship, are held to be too closely related to each other. It also made the arrangements for the holding of the several ceremonies of initiation, and allotted to each other the several pairs of Pirauru, to whom are permitted new marital privileges at the ceremony of circumcision.§

* From Pira = moon, and Murana = new.

† Portulaca oleracea.

‡ In the memoirs of Buckley, the so-called "wild white man," it is recorded that a message came from far off, passed on by tribe to tribe, demanding that presents should be sent to the man who had charge of certain props supporting the world.

§ See *infra.* p. 124.

I may add to this that when a blackfellow acting as a guide to a white man ran off and took refuge with another horde, and was followed, the Headman, after hearing all the particulars and being satisfied that no harm was intended to the fugitive, could order him to go and was obeyed.

I have observed the reverence shown by the young men to the old men, and by these to the oldest, that is to say, to their Pinaru, to be very great. On one occasion, when travelling in the southern edge of the so-called "Sturt's" Desert, a deputation of old men interviewed me, and requested that I would visit their "Pina-pinaru," whom I found to be a man almost imbecile from extreme age, and who was carried about by the other men.

A large group of kindred tribes inhabited an extent of country to the north, south, and west of Melbourne, to which, collectively, the name of the "Kulin nation" may be applied, from the word which in some form of dialectic variation was used by them as meaning one of their own men. My information is derived from Berak, the sole survivor of the tribe, an intelligent and trustworthy old man, who was a boy when Batman first founded Melbourne.*

These tribes were divided into two great exogamous inter-marrying classes, named respectively Bunjil and Waa (eaglehawk and crow), with descent counted in the male line, that is to say, the children of a Bunjil man were Bunjil, and of a Waa man were Waa. There was, however, this peculiarity, that each of the component tribes was either all Bunjil or all Waa. Thus of the sixteen tribes which have been enumerated to me, six were Waa, eight were Bunjil, and the two remaining ones had escaped the memory of my informant. One of these tribes was the Urunjeri baluk,† which occupied the country lying along the Yarra, Plenty, and Saltwater Rivers. The Urunjeri people were also commonly spoken of as the Woe-worung, that being the name of their language. The Urunjeri tribe being Waa‡ was divided into three great local clans§ at the time when Melbourne was first settled. There was a Headman to each clan, whose designation was Ngurungaeta. A Headman must be of mature age, must be respected for eminent qualities. He sent out messengers to bring people together for corroborees or for fighting. It was he who sent out parties to revenge the death of anyone who was thought to have been killed by the magic of neighbouring tribes. At the set fights, in expiation of some wrong done, it was the Ngurungaeta who had the power of putting an end to it if he thought that enough had been done.|| Berak specially said that he did not remember any occasion when the Kulin had refused to obey the orders of the Ngurungaeta. There was a Headman

* As to Berak, see "Songs and Song Makers of Australian Tribes," Journal of the Anthrop. Inst., February, 1887.

† Urunjeri = White gum (E. viminalis)—Baluk, a number of people—a horde or clan.

‡ That is to say, all Waa men with Bunjil wives and Waa children.

§ I again point out for safety that I use horde for local divisions of tribes having maternal descent, and clan for local divisions of tribes having paternal descent.

|| See Morgan's memoirs of Buckley, p. 41.

at each local group, and some one of them was recognised as their Head. Some were orators, some warriors, others great wizards. When a number of people met together the old men used to meet at some place at a distance from the camp, and consulted over matters of importance. For instance, although a man could promise his infant daughter in marriage, it was the old men in consultation who decided when any marriageable girl might be taken by her promised husband. The Headman always had some particular friend who assisted him, and at times served as his mouthpiece. The following illustration has been given me :—A man from the tribe at Geelong went to the quarry near Mount Macedon, whence the blacks obtained the stone for their tomahawks, and took some without the leave of the man who lived there, and who, with his kindred, claimed the quarry as his own. This man, who was the Headman of the clan which inhabited the country from Melbourne up the Saltwater River, and including the neighbourhood of Mount Macedon where the quarry was, sent a message to the offender's section of the tribe at Geelong, which, in consequence, proceeded to Mount Macedon under the direction of its Ngurungaeta. Berak, who was present at the meeting, described it to me. The meeting was near the Werribee River, and the men met at a place apart from the camp. The old men sat near each other, and the younger men near to them. The Geelong men sat together, and the Mount Macedon men and their Headman sat together. Their weapons were all left at their camps. Bilibileri, who had the charge of the quarry, and who was the Headman at that place, had beside him his friend, the man to whom he gave his words, and who spoke for him, and who, standing up, said, "Did some of you send this young man to take the tomahawk stone?" The old men of the Geelong tribe said, "No; we sent no one." Then Bilibileri said to his spokesman, "Tell them to say to the young man not to do so any more, and that when people speak about being in want of stone for tomahawks they must send messengers to us." The Geelong men said, "Very good; we will do so." They then spoke strongly to the young man, and cautioned him not to do so any more. After this meeting the tribes were again friendly.

According to Berak, a Headman could order the young men of his camp to do things for him, and his wife could likewise order the young women to do things for her, and they would obey.

If a Headman had a son who was respected by the tribe's people, he would become a Headman also in time. If he were, however, a bad man, or if people did not like him, they would have someone else, and most likely some relative of the former Ngurungaeta, such as his brother, or his brother's son.

Living at the Wimmera River, and along its course to the mallee scrub beyond Lake Albacutya, was the Wotjobaluk tribe.* It was divided socially into the two

* See "Further Notes on the Australian Class Systems," p. 60, Journal Anthrop. Inst., August, 1888.

classes Krokitch and Gamutch, each having totems with descent in the female line. It was also divided into a number of local hordes. The oldest man of the totem and the oldest man of the horde were respectively their Headmen. When a quarrel arose between the totems, as, for instance, when a man of one totem had been killed by violence by a man of another totem, the respective totems met for a set combat, and were under their respective Headmen, who could end the fight between the *offender* and the *aggrieved* when either Headman considered that enough had been done.

If the Headman was not obeyed, that is to say, if the kindred persisted in their attack, the totemites of the defendant would forcibly interfere to compel obedience to their Headman. Thus in exceptional cases a general fight between the totems was occasioned.

When several of the totems met their old men consulted together, and having decided what was to be done, announced their orders to the people generally, and were obeyed. At such meetings the oldest of the Headmen present was also its Head. These councils were held at a place apart from the general camp, and such a place of meeting was called "Jun." To this place the younger men were permitted to come, and to sit near, but not to join in the discussions. It was the Headman who sent out messengers to summon people to attend corroborees, or for other occasions, and it was he who made the message-stick, which, after approval by the other old men, was delivered to the messenger to carry with his verbal message.* It was the Headman of the invited people who gave them their orders for departure.

A few more instances, taken from the communications of competent correspondents, will suffice to show the practice of more distant tribes.

Mr. Augustus Hooke in a communication, for which I have to thank Dr. John Fraser, formerly of Maitland, says of the Gringai tribe in New South Wales :—"The tribe is governed by a Chief called 'Noorjain,' who must be an aged man before he is thought much of. This office is held by descent, and the members of the 'Royal Family' are either Ipai or Kumbo.† There is a tribal council of the oldest, and, as a rule, the most intelligent men of the tribe. I once came upon a group of these old fellows sitting in a circle in deep deliberation, and was told by one of them in a whisper not to tell the blacks what I had seen."

* "Notes on Australian Message Sticks and Messengers," Journal Anthrop. Inst., May, 1889.

† I have more than once received statements from correspondents as to one or other class name having a pre-eminence over others. My own acquaintance with tribes of the Kamilaroi group has been limited, but a remark made to me by one of the old men of the tribe which formerly hunted on the Tumut River, in New South Wales, seems significant. This man was Yibai-Malian, that is to say, his class name was the equivalent of the Kamilaroi "Ipai," and his totem was Malian=Eaglehawk. He said that Daramulun, the great supernatural Being of these tribes, is Yibai; and that "Malian" is also one of his names. This seems to point to a pre-eminence in this class, such as Mr. Hooke indicates by "Royal Family."

Mr. C. Naseby, of Maitland, who has had fifty years' experience of the Kamilaroi tribes, writes as follows :—" There may be two or three Headmen in each division of a tribe. Their position is one of influence and authority, and depends upon the valour of the individual. A man who distinguished himself as a warrior or orator would become a leader. His son would be highly regarded, and if valiant, would also become in time a Headman. The oldest Headman would be the chief or president of a council of the elders, and he could carry any measure by his own voice. All disputes were settled by the Headmen. In the olden time a white man could not be marked off for death but by their voice. Such a Headman had authority in a local division of his tribe, but not as Head of his totem. A Headman might be a Koraji,* but a Koraji was not necessarily a Headman."

Mr. Jocelyn Brooke, sub-inspector of Queensland Native Mounted Police, writing of the Kaiabara tribe, of the Bunya Bunya Mountains, says :—" The tribe is ruled by two Headmen, one being of the Kubatine class, and the other of the Dilebi class,† and they rule their classes respectively. When one of them dies, his son, or one of the next of kin, inherits the rank of the dead man. The Headman wears a band round the left arm made of Bunya Bunya fibre. The old men hold councils on all matters of importance, sitting in a circle with their clubs stuck in the ground. The young men are permitted to stand round and listen, but may not laugh or speak. One man at a time makes a speech while the others listen."

Mr. Thomas Petrie, of the North Pine River, in Queensland, says of the Turribul tribe :—" There was no regular council, but the old men met and consulted as to such matters as hunting and fishing, or going on a journey, and regarding the death of any person. They sent messengers out when the time for " making kippers "‡ came round, or when the mullet came in, or the Bunya fruit was ripe."

That which Mr. Petrie describes is the council. It falls in with previous instances.

I have given instances which extend over a large part of the continent. I have shown from my own observation, and from the statements of competent correspondents, that in those tribes which I have taken as illustrations there are men who are recognised as having a control over the people with whom they live, whose orders are obeyed, and who receive from their tribe's people titles which, in some cases, may be translated " elder " or " great one." The illustrations which I have given justify the conclusion that similar Headmen existed in other tribes in the same localities, and, in fact, their existence in general. No doubt in some tribes their

* Wizard.

† " Further Notes on the Australian Class Systems," p. 49, Journal Anthrop. Inst., August, 1888.

‡ The time of the initiation ceremonies—the Bora.

power and influence was wider and better established than in others. In some tribes there was certainly a tendency for the power of the Headman to be transmitted from father to son, if the latter were worthy.

I have chosen the term Headman as being less likely to be misunderstood than that of Chief, for with this title there is in the mind of the reader an insensible connection with the idea of a Highland Chieftain or an Indian Sachem. Vich Ian Vohr, or Chingahgook, are not to be found in Australian tribes. But if the word "chief" implies the idea of a person having power to direct the people of his clan or tribe, and that his directions or orders are obeyed by them, then I say that the Gweraeil Kurnai, the Gommera, the Ngurungaeta, the Pinnaru are Chiefs. For although, when compared with the power of the Chiefs of other well-known tribes, their power is but limited, yet it has and is an actual power of command, coupled with a certain measure of ability to compel obedience thereto.

The authority which was possessed by the Headman and the council of old men in an Australian tribe is "the power which enforces custom," which, according to the belief of the late Mr. E. M. Curr, is "mostly impersonal."

Marriage.

The status of marriage in Australian tribes has been for some time an object of study, and it is only now that true views as to its nature are beginning to be established. Early observers, who saw the outside features of Australian marriage, saw what appeared to some of them merely the almost lawless cohabitation of a male savage with a woman of some tribe other than his own, who had been seized upon and reduced to subjection by violence.

Later observers came to see that marriage in these tribes is subject to strict rules, and then came the time when these rules were discovered and recorded, and the class names connected with them.* It was then seen that the laws of intermarriage were very complicated, and by their restrictions permitted only of marriage between certain persons. These rules were so complicated that probably until lately no white man understood them, and even now there is, probably, not a single case in which all the laws which rule the classes, the sub-classes, and the totems, and which regulate their intermarriage, and the course of descent in them, have been fully and completely recorded and explained. The latest advance which has been made in the subject of Australian marriage was the conception of marriage in the group, and of group to group, and of the filial relation of one group to another. This view was advanced first in the joint work of the Rev. Lorimer Fison and myself, and

* The class names were first noted by Mr. T. E. Lance, who informed the Rev. W. Ridley of them. Mr. Fison called Mr. Ridley's attention to the effect of the totemic divisions on marriage rules.

is, I venture to say, very generally accepted by anthropologists. But Mr. E. M. Curr in his late work dissents from this proposition. It, therefore, becomes more than advisable to record at some length the evidence upon which the existence, at the present time, of group marriage and descent is established. The study of the Australian marriage customs is calculated not only to show in what manner these savages have regulated the relations of the sexes, but it also affords a side light, which casts a strong illumination into obscure places in the existing customs of other races, as well as into the crumbling records of the past, thus enabling the student to decipher, at least in part, their otherwise unintelligible records.

Although there is a general similarity of custom on broad lines throughout Australia, yet, when one comes to compare the customs of a number of tribes, one sees readily that just as there are so many dialects, being variations of one stock language, so there are almost as many variations in general custom. Thus when the inquirer brings his results into orderly sequence for comparison, he finds, taking for instance the status of marriage as the basis of comparison, that the tribes may be arranged in a connected series, in which the lowest discovered form of group marriage, associated with individual marriage, is at one end, and the highest form of individual marriage (as found in Australian tribes), with either the rarest occurrence of group marriage, or with mere traces of its existence, at the other. The intermediate examples approximate more or less to one type or the other.

It is thus found that there are no two tribes which are precisely upon the same level as to status of marriage. Two results seen from such a comparison of the data are—first, that there appears to have been a process of development of institutions in the tribes, though of unequal intensity; and second, that it is most unsafe to generalise from one, or even a few examples to the whole series.

The organic structure of the Australian tribes is so complicated, and the various parts of the organisation are naturally so dependent upon each other, that in following out an inquiry as to the laws of marriage in any tribe, one is brought into contact with other questions which are so intimately connected with that which is being followed out that one is compelled, in order to trace its course, to also follow out and explore those new tracts. In fact, the whole of the customs which form the foundation and the superstructure of aboriginal society ramify so much that in order to understand any part it becomes necessary to study the whole.

This is, indeed, only saying in other words that the social organisation in its growth has developed as a whole by the gradual growth of the component parts.

In following out an inquiry into the marriage customs, one is forced to inquire into the principles which underlie the complicated set of class divisions on which they rest, the complicated and peculiar system of terms which describe and give names to the relationships which connect, in various degree and manner, the members of the community, and the very structure of the tribe in its local and social aspect, for these even are found to have a powerful influence upon marriage.

I may commence by saying that the form of marriage which we are most accustomed to see among the Australian aborigines is that where a blackfellow has apparently one wife, or more rarely two or more wives. This may be termed individual marriage, in contradistinction to the less patent form under which a group of men have one or more women, or a number of women equal in number to themselves in common. This may be spoken of as group marriage. Individual marriage in Australian tribes has been evident to everyone, but group marriage was first pointed out as existing by Mr. Fison and myself, and has even now been denied by the late Mr. E. M. Curr.

I shall first note the different modes in which individual marriage is brought about, and then shall detail the evidence upon which the existence of group marriage is now proved to obtain in quite a large number of tribes simultaneously with individual marriage.

Individual marriage in Australian tribes may be defined as that status under which a man claims a woman as his wife exclusively for himself, while he recognises no reciprocal obligation to restrict himself to monogamy. Yet it must be clearly understood that this individual right to his wife does not obtain in all tribes with the same exclusiveness.

In the Kurnai tribe it was absolute, with the one exception to be hereafter noted. In the Dieri tribe, which may be chosen as the example standing at the opposite end of the series, the exclusive right of the husband did not affect his own brothers, or those tribal brothers who, as will be explained hereafter, became the Piraurus of his wife.*

With this proviso, I now proceed to briefly discuss the different manner in which individual marriage arose, that is to say, the different ways in which an Australian blackfellow obtained his wife.

It may be safely laid down as a broad and general proposition that among these savages a wife was obtained by the exchange of a female relative, with the alternative possibility of obtaining one by inheritance (Levirate), by elopement, or by capture. I have already shown that, in accordance with the laws of the classes, there is underlying the whole system the principle of exchange of women by the great inter-marrying exogamous divisions of the tribe, and, to this law of exogamy, all the various means of obtaining a wife are subject.

* As to Pirauru, see p. 124.

It seems to me that the most common practice is the exchange of girls by their respective parents as wives for each other's sons, or in some tribes the exchange of sisters, or of some female relatives by the young men themselves. It must be always borne in mind that in such cases it is not merely the *own* sisters, but also the tribal sister, who is thus available. For in all cases the relationship term, whatever it may be, covers a group rather than the mere individual, who only becomes perceptible to the inquirer upon special quest. The reader may be referred to the explanation given hereupon in the section treating of relationships.

Thus, it seems in a case where I found the right of betrothal of an infant daughter to be in the mother's brother, that in default of the own brother to the girl's mother, the son of the girl's mother's sister had the right to dispose of her. This practice is quite logical when examined by the light of the explanation given at p. 131, for the children of sisters are in the fraternal relation to each other, and as, in the tribe in question, descent was in the female line, they were in the same class. Before quoting some instances in illustration of this practice, I may remind the reader that no man was permitted to take to himself a wife until he had been duly admitted to the status of manhood by passing through the Bora ceremonies of his tribe, and the permission to take a wife depended upon the consent of those old men who controlled the ceremonies.

The practice of exchange as a means of procuring a wife is so common that it is not necessary to do more than to note its general prevalence, and also some variations in the custom which have come under my notice, or which have been recorded by competent correspondents.

In the Woeworung tribe, according to Berak, marriage was arranged by the fathers respectively, often when the girl was quite small. But before the matter was arranged between them the girl's father had to consult with his wife. The girl being promised, the fathers of the girl and her promised husband announced the arrangement to the other people, and at a future time, when the girl became marriageable, a council of the old men having decided that the marriage should take place, all the people then went to the bridegroom, taking the girl with them. One of her kindred—for instance her father, her brother, or in default of them her mother's brother—led the girl forward, and some one of the old men addressing the bridegroom, said to this effect: "This is your wife, the people give her to you, do not beat or ill-treat her;" and to her: "Do not run away from him or you will be killed."

In the Wotjobaluk tribe a wife was obtained by exchanging a sister, own or tribal, and such exchanges were often arranged when the girl was not more than a year or two old. The father had no right to arrange this exchange, *suo proprio motu*, but he did it sometimes when he had a great desire to give his daughter to the son of some particular friend. He could do this with the consent of the girl's brothers, own or tribal, but if so, he would have to arrange for some other girl to be given in exchange for her to the oldest of her own or tribal brothers. It was, therefore, a certain group of young men in this tribe who exchanged the girls of another group which was sister to them for wives to themselves. The most usual manner of arranging these exchanges was at the time when all the people were assembled at one of the great tribal gatherings, at the termination of which, and before the people left for their homes, a kind of fair was held for the bartering of things which they had brought with them.* Before such a meeting the young men who were matrimonially disposed, and who were in a position to take wives, made themselves acquainted about the girls who were disposable. Two such young men would seat themselves near each other at this assembly, and when the Headman announced: "Now you can exchange the things you have brought and make friends," the two young men hand to each other the articles they wish to exchange. During the day they keep together and make much of each other. Towards evening, when they have become good friends, one will say, "I will give you my sister for a wife."† If the other has a girl to exchange he promises her and the matter is arranged.

In the Murring tribes of the south coast of New South Wales, marriages were arranged solely by the fathers, and very often in the following manner ‡:—At the termination of the Bora ceremonies, at which the whole inter-marrying community was necessarily assembled, a meeting was held for barter. At this marriages were arranged. For instance, a man whose son had been admitted to the rank of manhood, and who in the ordinary course of events would by and bye be permitted by the Headman and the elders to marry, would announce that he wanted a wife for his son. Every one there knew the relationships of everyone else, and as these matters matrimonial had been discussed in the camps, the probability was that some other man would say that he would give his daughter. This implied that the father of the boy would on his part give a sister of his son, own or tribal, to a brother of the girl. This matter being settled, the girl was considered as the boy's future wife, and when he had finished his term of probation, when his father and the Headman of the locality gave their consent, the youth's father would tell him to take his sister with him and go and get his wife. The exchange would thus, in fact, be finally made by the two young men.

An exception to the general rule is afforded by the Wakelbura tribe, as to which Mr. Muirhead says:—"Girls were betrothed as infants by their mothers, and connected with this practice there is in this tribe no restriction upon the man and the mother of his wife seeing or speaking to each other."

* Such meetings for barter seem to have been very common in other tribes of South-eastern Australia.

† Djadjt=elder sister—go tuk=younger sister also include mother's sister's daughter.

‡ In these tribes there was paternal descent. In the Wotjobaluk tribe, just mentioned, descent was in the female line. The line of descent seems to have had a strong influence on the right of betrothal in many of these tribes.

In the Kuinmurbura tribe, according to Mr. W. H. Flowers, girls were betrothed when mere infants by their parents, and the act of betrothal was signified by a ceremonial act. The parents having painted the girl and dressed her hair with feathers, her male cousin* takes her to where her future husband is sitting cross-legged in silence, and seats her at his back, and close to him. He who has brought the girl after a time removes the feathers from her hair and places them in the hair of her future husband, and then leads the girl back to her parents.

After this time, and until the marriage takes place, the man sends constant presents of game, fish, &c., to the girl, but he never goes near the camp or speaks to the girl's mother.

Next in order in the modes of obtaining a wife comes the practice of the Levirate. Under this, the widow becomes the wife of the oldest surviving brother of her deceased husband. Some few instances will suffice.

Among the Kurnai, the widow went to her deceased husband's eldest surviving brother, but not necessarily to his full brother, for he might be his half brother, either by the same father or of the same mother. In default of an own brother, she went to a tribal brother. The reader may here be referred to my remarks on the Kurnai relationships. It is evident in this instance also that the right to the widow was in a certain group of men, and not in any one individual. In the Wotjobaluk tribe, a widow did not become the wife of her deceased husband's brother, but he had the disposal of her. I am told that the Wotjo thus departed from the usual rule of the Levirate because they thought that if married to the brother of the deceased husband, she would be always a reminder to him of his dead brother. The widow did not re-marry for some months, perhaps six or seven, when the brother of her deceased husband would dispose of her.

In the Wakelbura tribe, the widow went to the brother of her deceased husband, if there were one, if not, then she went to the best friend of the deceased being of the same totem.

In the Turribul tribe it was considered monstrous for a widow to become the wife of her deceased husband's brother, but he had the disposal of her.

The next form of individual marriage is that by elopement. It may be said with safety that this mode obtains in all tribes in which infant betrothal occurs, and where the young men, or some of them, find more or less difficulty through this practice, or by there being no female relative available for exchange, or indeed wherever a couple fall in love with each other and cannot obtain consent to their marriage.

* Mr. Flowers has not informed me as to the nature of the relation which he terms "cousin." Since, however, this tribe counts descent in the female line, I feel quite certain that on further inquiry "cousin," as used by him, would mean "mother's brother's son."

Marriage by elopement occurs so frequently, that although it is always regarded as a breach of the law and custom, yet, as it is under certain circumstances a valid union, it may be considered a recognised form of marriage.

A few instances will suffice, and, for convenience, I will here also notice the manner in which this offence is punished, not only in cases in which, had consent been obtained, the parties might have been married, but also in those cases in which there could not have been any lawful union, by reason of the woman having been betrothed to some other man, having been already married, or being of too near kin.

As I have stated elsewhere more than once, this practice reached its greatest extent in the Kurnai tribe. An old man of the Wolgal tribe in New South Wales, who had long known the Kurnai, spoke with contempt of this practice, not of elopement *per se* as an occasional event, but of the Kurnai elopement as a form of marriage.

I have little to add to that which I have said elsewhere as to the prevalence of this form of marriage and its punishment in this tribe,* which was aided by a special kind of wizard in this tribe, the Bunjil Yenjin, whose office it was to cause elopement by his magical songs.

It seems that the Kurnai have drifted necessarily into this form of marriage as the only one open to them, excepting in the small minority of cases. Their system of relationship is of the most archaic form, recognising, for instance, among kindred persons of the same level in a generation, only brothers and sisters, and none of those analogous relationships which we call cousins. The children of brothers, own and tribal, are in the fraternal relation to all eternity. So also are the children of sisters. Marriage being strictly prohibited between all those in the fraternal relation, and the choice of a wife being restricted by the local rules to a few local divisions of a tribe, to which, moreover, men's fathers before them had gone for their wives, it came about that this net of relationships and restrictions had such small meshes that almost every individual in the tribe was fast hand and foot, and could escape only by violent means. If men cannot take wives with the consent of those in authority, they will take them without it, and the natural results of elopement follow. The Kurnai man ran off with some girl whom he could not lawfully marry, either with or without the aid of the Bunjil Yenjin.

With the Murring it happened not infrequently that some girl who had been promised in marriage, and who did not like her promised husband, ran off with some other man. This being discovered, her kindred pursued the couple, and, if possible, brought them back. If the intended husband was with the pursuers a fight probably

* Kamilaroi and Kurnai, p. 200. On Australian Medicine Men, Journal of the Anthrop. Inst., p. 34, August, 1886.

took place there and then between him and the offender. Otherwise a set fight was arranged, at which the offender had to do battle with the girl's promised husband and his kindred, one after the other. If he was so fortunate as to knock down all of them, and had any woman available to exchange for his inamorato, he might be permitted to keep her for his wife. If he was knocked down several times by his adversaries (some informants said four times), the girl would be at once compelled to go to her husband.

Among the Woeworung it also happened that a girl sometimes preferred another man than him to whom she had been promised, and she then eloped. The married men followed her, and, if they caught her, brought her back. She met with severe treatment by her mother and sisters, and possibly her brother would spear her through the leg to prevent her running off again. The man with whom she had eloped had to stand out in an expiatory fight. He was armed with a club and shield, and the girl's male relatives first threw their boomerangs at him, and he then fought them one by one. Berak said that frequently after this ordeal he was permitted to keep her for his wife.*

With the Wotjobaluk there were also elopements arising out of betrothal. According to my informants, however, the punishment for this offence was much less than in most other tribes with which I am acquainted. When the elopement was discovered, the girl's friends were sure to pick a quarrel with those of the man, and a fight was certain to take place, yet, when the couple returned after a time, nothing was done beyond his having to stand out in an expiatory fight, after which the girl was regarded as his wife.

An excellent account of the course and consequences of elopement in the Wakelbura tribe has been given me by Mr. Muirhead. He says: "Wives are only obtained by betrothal, excepting in cases of elopement and capture. In elopement, the man to whom the girl was promised claims her from the offender, and there is a set fight between them. The victor keeps her, but there are usually two or three contests before the matter is settled. But if the girl had given her consent to her betrothal, and then eloped, the case would be quite different, even supposing that the man she eloped with were otherwise eligible by being of the proper class and totem, and that she had been compelled to elope by force. She would then be almost cut to pieces before being restored to her proper husband.

"In cases where a man from a distant tribe, say from the Barcoo or Mackenzie Rivers, ran off with a Wakelbura woman, and got away safely to his distant home before her people would catch him, and that meanwhile the woman's promised husband died, the other must forsake his own people and join hers, or her relatives

* See Life and Adventures of William Buckley, &c., by John Morgan, Tasmania, 1882, p. 62.

would call him to combat. In every case of this kind which has come under my notice, the man forsook his tribe and joined hers. He would be free from any interference from them, and his own people would not feel any anger against him. From this time forward he would be called by the name of the tribe he had joined, and would take part in their ceremonies, and fight on their side even against his former tribe."

These instances will, I think, suffice to show the universality of this custom.

In connection with this subject may now be considered those cases of elopement in which the woman was married, or where the parties were within the prohibited degrees of kindred or of class.

The elopement of a betrothed woman is not only an offence against her promised husband, and necessarily, in some tribes, against those who join with him in marital rights over her, but it is a direct loss to that group which is fraternal to her, and which is thereby deprived of a valuable equivalent for a wife for one of themselves. One cannot, therefore, feel any surprise that such cases are usually dealt with by the groups affected in a severe manner. But it is an offence of a far graver nature when elopement takes place between persons who are of the same class or totem name, or in some tribes, *e.g.*, the Kurnai, of the same locality, or who stand towards each other in certain degrees of kinship.* In these cases, and in almost all tribes, the offence is punished with death. Among the Kurnai, if the parties were too nearly related to each other they were pursued and killed by the conjoined kindred of each, unless they could make their escape out of the country. There seems to be reason to believe that the Bidwelli tribe, east of the Snowy River, was recruited by "broken men" of this kind. The Woeworung also killed those who, being too nearly related, eloped.

It was the same with the Dieri. The offenders were tried in a secret session of the old men in council under their Headman, and, if found guilty, were killed. Mr. Gason tells me that he has been present at such times. This punishment of such offences against the moral code of these aborigines is so universal in Australia that I need not give further instances beyond an example taken from the Wakelbura tribe, which Mr. Muirhead states as follows:—

"In cases of unlawful connection or elopements between persons of forbidden class or totem, or who are too nearly related to each other, such, for instance, as children of a brother and of a sister respectively, the law is very strict. For instance, if a Kurgila-Tunara (opossum) ran off with an Obuan-Wallaruan (hill kangaroo), who would in due course have become the wife of a Kurgila-Burkum (plain turkey), his

* Australian Group Relations. Smithsonian Report for 1883, p. 22.

own brothers would be against him, as also the woman's brothers, and the brothers of her promised husband, in all cases, both own and tribal, for such a woman would be prohibited to him by the totem laws of marriage. In short, he would have to combat with all of them. They would fight in the camp, or wherever they happened to meet. Generally in such cases of elopement the brothers of the woman get the promised husband to go with them in pursuit, but sometimes, if he is a strong fighting man, he will follow the eloper into his own camp. The woman, if caught, would probably be cut, and even killed, by her mother. The man's own brothers would attack him, first challenging him to fight by smashing boomerangs or other weapons about him. If he did not accept the challenge they would then turn upon the woman, who, if she did not escape into the bush, would be crippled, or even killed, by their weapons. The man would, in any case, be compelled to fight with the woman's promised husband, who almost certainly in such a case gets the better of him, for even if he were more than a match for his adversary the brothers of the latter, or his own brothers, would then cut him severely, and his brothers would be his worst antagonists, for they would not care if they killed him. When, under such circumstances, a man was killed, nothing was done to his brothers who killed him.

"In such a fight, when all weapons at hand were exhausted, the combatants would draw their knives, a dense ring of blackfellows being formed round to see fair play, and, if necessary, to separate the men. Even here the promised husband has an advantage, for if he is seen to be in serious danger the onlookers will interfere to prevent it. But it happens sometimes that when one man can place his knife against a vital part of his antagonist, and then call upon him to give in and he refuses, the other plunges his knife into him and kills him. In these fights the woman receives a terrible cutting with knives, and may even be killed."

Finally, I may mention marriage by capture. When a woman was captured she became eligible as a wife for the captor only, if she were of that class or totem with which his class and totem could legally intermarry. Among the Kurnai, who had no classes or totems existing, this rule applied to the local divisions.*

An extremely interesting and suggestive statement has been made to me in a communication from Mr. C. Naseby, of Maitland, than whom no one probably has had better opportunity during 50 years' acquaintance with the Kamilaroi of learning their customs. He says: "Wives were not there obtained by betrothal, gift, barter, or exchange, of female relatives. If a white man took to wife a native woman, he gave as barter blankets, hatchet, shirt, trousers, &c., but a black man gave nothing. The Muri has a right to choose a wife from the class permitted him by the native laws.

* "Kamilaroi and Kurnai," p. 227, *et infra*. Australian Group Relations, Smithsonian Report, 1883, p. 23.

He comes to an unmarried woman whom he fancies, and he says, 'Ngaia Kulade Kura-mula yarala,' that is to say 'Myself wife will take (steal) by and by.' This he says in the presence of the woman's parents, and they cannot refuse his demands. They wait until he comes and takes her. If, however, her relations find that his hands are stained with the blood of her kindred, they object to the marriage. Then in such a case the Muri comes by stealth, and usually alone, and carries her off. Her relations ascertaining where he is camped, send a message to him, and demand that he shall meet their champion in single combat. This he must do if he wishes to retain his wife."

Practices simulating capture also obtain in the Kunandaburi and Kuinmurbura tribes. In the former, the promised husband, having obtained the consent of the girl's father to take her, waits until she is some distance away from the camp and then seizes her. He is accompanied by some man who is "abija" to the girl, that is to say, one who might lawfully have become her husband. The girl resists violently, but no one interferes. The other women only laugh. Being joined by other men who are "abija," the girl is kept away for several days, under the exercise of the *jus primæ noctis*. On the return to the camp festivities are kept up for several days. Women boast of the resistance they offer before being taken. The word used for taking the bride away is "mamera," which means "to steal."

In the Kuinmurbura tribe, when a girl who has been promised is considered to be old enough for marriage by her father, he sends the girl as usual with the other women to gather yams or other food, and he tells the man to whom he has promised her, who, then painting himself, takes his weapons and follows her, inviting all the unmarried men in the camp to assist him. When they come up with the women he goes forward alone, and telling the girl he has come for her he takes her by the wrist or hand. The women at once surround her and try to keep her from him. She tries to escape, and if she does not like him she bites his wrist, this being an understood sign that she refuses him.

As simulating capture of women for wives, the following account, given by Mr. Aldridge, of the customs of the Maryborough tribes is valuable:—"A fight always terminates the Bora (Dora) ceremonies. After this the two parties who attended the Bora invite each other to a corroboree on a piece of neutral ground situated between their respective camps. At the termination of this corroboree all the people depart in divergent lines, and the young men who lie in wait in the dark rush the girls off. That is to say, the young men of one tribe carry off the girls of the other. They must, however, be quick about it or their friends will rescue them. If the young men are followed, and the pursuers are stronger than the abductors and their friends, these run off and leave the girls, who otherwise become their wives."

Having now dealt with individual marriage, I turn to the consideration of group marriage.

I have omitted speaking of marriage in the Dieri tribe for the reason that it seemed to be advisable to discuss the individual and group marriage of that tribe together.

Betrothal was the most common means by which a girl became a wife, and the relation of individual marriage was called in this tribe Noa. A woman was thus the Noa of some particular man, who was also her Noa, but while she was restricted to one individual husband, he was not so restricted, but might have several Noas.

In the Dieri tribe there is, in addition to the Noa or individual marriage, also that which I have called Pirauru or group marriage, from the word in the Dieri language which defined the practice which I am now about to describe. This practice, which has been long known to the white settlers under the name of "paramour," is not confined to the Dieri tribe, but also obtains in those surrounding it, and the instances which I shall give extend for at least a distance of one thousand miles, east and west—how much further I know not.

The Pirauru relation is created, not by the gift or exchange of the women or by the consent of the parties to it, but by the action of the council of old men immediately before the day fixed for the rite of circumcision. After consultation certain men and certain women are allotted to each other as Pirauru, and their names are announced to the assembled tribe by the Headman (Pinnaru). A couple can only be Pirauru to each other who are of such class name as would permit of marriage. Persons who have thus become Pirauru are henceforward in that state towards each other, so that a man or woman may, after successive ceremonies have been held, become the Pirauru of a number of women or of men. The relation may exist between members of an adjoining tribe. Thus, as Mr. Gason says, the principal Headman of the Dieri, Jalina, whom I have elsewhere mentioned,* was the Pirauru, not only of a number of Dieri women, but also of women of adjoining tribes, and his own wives (Noa) were similarly the Piraurus of Headmen in them. The following *precis* of facts, as drawn up from Mr. Gason's statements to me, and since revised by him, will show clearly the relation of the Pirauru and Noa marriages to each other.

Each Dieri man or woman is the Pirauru of one or more women or men. The relation of Pirauru may exist between men and women of different local divisions of the same tribe (*e.g.*, Dieri), or of different tribes (*e.g.*, Dieri and Yantruwunta).† But it may not exist between persons who stand to each other in the relation of father, father's brother, father's sister, mother, mother's brother, mother's sister, brother's

* See p. 108.

† This tribe lived at Cooper's Creek, about the Queensland boundary.

child (male or female speaking), sister's child (male or female speaking), father's brother's child, father's sister's child, mother's brother's child, mother's sister's child, brother, or sister. It will be seen on reference to the section on relationships why it is that, for instance, father and father's brother stand in the same relation to any one individual. The Pirauru relation may not exist between persons of the same "Murdu" (totem), for the reason that all persons of the same "Murdu" are regarded as brother and sister, or mother and child, &c., as the case may be.

A Dieri man, having passed through the Mindarie ceremony, may have a suitable Pirauru allotted to him. The Piraurus are allotted to each other by the council of old men on the evening before the ceremony of circumcision. As the relation of Pirauru always continues, some old men and women have as many as five or six or more Piraurus. Seniority in the man regulates the temporary right to any one Pirauru. Thus, supposing that an older and a younger man were both at the same camp, and that the latter had with him a Pirauru, the former being alone, the older man could lawfully claim the Pirauru common to both from the younger man, who would, in accordance with custom, resign her to him. The principal men—for instance, the Headmen and the Heads of Murdus (totems), had more Piraurus than the other men, partly because of their eminence, and partly because through their position in the tribe, and their influence in neighbouring tribes, they were in a position to give many presents.

A man and a woman became "Noa" to each other, either by the woman being promised to the man during her infancy by her father, or by being allotted specially to him as "Noa" by the Headman and the council of old men of the tribe for some special services to it. A man cannot acquire a Noa, that is, he is not permitted to take the girl promised to him until he has passed the ceremony of Wilyaru.* The relation of Noa is always superior to that of Pirauru, when the two co-exist or come into conflict. Thus, when sleeping in a camp, the two Noa lie next to each other, and the female Pirauru next to them. A distinction is drawn between the children of a Noa and the children of a Pirauru. For instance, a woman having a Noa and also a Pirauru, her children would call both of them "father," but would distinguish by calling the Noa of its mother "apiri murla" (real father), and her Pirauru "apiri waka" (little father). But, in fact, the women frequently are unable to distinguish the true father, and, as Mr. Gason puts it, "will not admit of only one father." In the example just given the children of the Noa and of the Pirauru, whether of the same mother or some other woman, would regard each other as brothers and sisters, just as the children of a female Noa and of a female Pirauru would look upon each other as brothers and sisters. When the Noa of a man died his Pirauru would take the children of the deceased and treat them as her own.

* The ceremony of blood-letting which follows that of circumcision. The Mindarie or peace ceremony follows the Wilyaru.

Each man in time obtains a Noa, but it may be, perhaps, only the old wife of one of the older men. Each woman becomes the Noa of some man at an early age. A woman can be the Noa of one man only at the same time, but she may be the Pirauru of several men at the same time. But a man may have several Noas and several Piraurus at the same time. A man's Noa is his only, unless under certain circumstances, when she becomes the Pirauru of other men, but his Pirauru is at the command of any of her Piraurus who are older than he. It was the custom of the Dieri to send what may be called "embassies" to neighbouring tribes on important matters. On such occasions women were sent to negotiate the affair, and it was their Piraurus who accompanied them, and not their Noas. The reason given by the Dieri for this was that a man would, on such occasions, not object to the lavish distribution of favours, which was the custom on such missions, by his Piraurus, while he might do so by his Noas. On such occasions the Noas of the men remaining at home were in the position of Piraurus.*

Group marriage, as shown in the Pirauru practice of the Dieri, extends through the neighbouring, and even more distant tribes in precisely the same form. Mr. Gason describes it in the South Australian mountains south of the Dieri country. Mr. Hogarth says that it runs in the tribes to the west of Lake Eyre, and I have seen it as far north as Sturt's Desert, and as far east as the boundary of Queensland.

I have no doubt that it extends much further, for I found it strongly marked in the Kunandaburi tribe, near Mount Howitt in Queensland. Mr. W. J. O'Donnell has described it thus in letters to me:—"In this tribe the relation is termed 'Dilpamali,' while the individual wife is termed 'Nubaia.'" Mr. O'Donnell stated that the two classes in this tribe are Matara and Yungo, and that the "Dilpamali," or, as it is called there by the settlers, the "paramour" relation, is such that a number of Matara men and Yungo women cohabit together, and *vice versa*. That is to say, they do so when a greater or less number of people collects, but when the tribe is dispersed over its hunting grounds the Nubaias are mostly together. That is to say, when the tribe is gathered together for any special occasion group marriage arises; while on ordinary occasions there is individual marriage.

Mr. A. N. Hughes, writing to me from the Wilson River, still further to the eastward in Queensland, says of the Kungerduchi tribe:—"Married women are permitted to have paramours, subject to their husband's consent, the rule being that a man of the same name as herself could not cohabit with her, but she might cohabit with paramours whom she might otherwise have married." This, looked at by the light of the Dieri and Kunandaburi practice, is evidently group marriage.

* I may refer the reader to a full account of the Dieri and kindred tribes communicated to the Anthrop. Inst.

In the Wakelbura tribe the practice also exists, as described by Mr. Muirhead with his usual fulness of detail. He says:—" Say that there are seven men, all 'Matera-Kurgila (small bee),' and who are some of them own and some of them tribal brothers, that is to say, some of them actual brothers, and the others of the same class, sub-class, and totem as themselves. One of these men is married, his wife being 'Wutheran-Obukan (carpet snake),' that is say, of that class, sub-class, and totem which marries with that mentioned. All these men call the woman 'wife,' and she them 'husband,' and the seven men have and exercise marital rights over her. Her children call the men father, and these are bound to protect the former."

This is precisely the Dieri Pirauru practice under slightly different conditions. It resembles also the customs of the Dieri and Kunandaburi, amongst whom, but *sub rosa*, a man's brothers are the husbands of his wife. It is also an example of that practice of the Nairs and Thibetans, on the strength of which the late Mr. M'Lennan founded his theory of polyandry. We can see how among primitive savage peoples the foundations of the customs of the Nairs and Thibetans may have been laid.

The practice of group marriage, which I have now shown to be in actual existence over an enormous area in this continent, can be seen to have had a latent existence in other tribes which are now extinct, or almost so. For instance, in the Thed-dora tribe of the Omeo district, and the Kurnai tribe of Gippsland, on the occasion when the Aurora-Australis was visible, the old men ordered an exchange of wives to take place temporarily. It may point to some reversion to ancient custom, for the Kurnai believed the Aurora-Australis to be "Mungan's fire," which their tradition told them had once before destroyed their ancestors for disregarding his laws. However this may have been, the occasional reversion to group marriage in these tribes points to its former more general existence in them.

What we find here is then the existence of marital rights between a number of men of one moiety of the tribe and a number of women of the other moiety, and *vice versa*. When the tribes people meet in more or less number the rights of the Piraurus, or group husbands, are exercised; when the tribe is scattered the right of the Noa husband predominates. This is group marriage in actual existence, and is a complete answer to a statement contained in the late Mr. E. M. Curr's work* to the effect that "women in our tribes have never been found living with one man one day and with another the next, but that the reverse is a matter of fact of notoriety." In a further passage, when he mentions a practice which is evidently the same as that I have now described, he says that no one ever doubts the occasional prostitution of

* "The Australian Race," vol. I, p. 126.

wives within and without the tribe, but he denies "the existence of any custom which requires or compels husbands to give up their wives to prostitution."* The Pirauru practice is not "prostitution," but a well recognised and lawful "group marriage," and to its laws, as Mr. Gason has shown, all the people of the tribe give obedience.†

The group marriage, which exists in the tribes of Central Australia as a living fact, was inferred by Mr. Fison and myself, on theoretical grounds, to have existed in Australia. This was pointed out by us in our joint work, "Kamilaroi and Kurnai," and our inference was drawn from a consideration of the relationship terms used by the tribes.

In the section of this memoir dealing with relationships, I have shown how the terms used to describe these fall in with the actual relations existing in the Pirauru groups, and are, indeed, their necessary consequence.

It will now not be any longer possible to deny the existence of group marriage, which must be admitted as a fact, just as group relationship has come to be admitted after a severe opposition.

Relationship Terms.

The white man who has been born and brought up in civilisation, apart from contact with savagery, seems to consider the terms of relationship which he has been taught to use for the purpose of describing the nearness or remoteness to him of his kindred and relations, as something which must be of universal application amongst all mankind.

When such a man is first brought into contact with races of men who use some other system of terms to denote relationships, he feels in most cases surprise, tinged perhaps with pity and even contempt, for those poor savages who are so benighted in intellect as to think it possible that a man can have several men in the relation to him of father, several women as mother, and an extraordinary number brothers, "sisters, cousins, and aunts." It seems to him that no human being possessing the ordinary amount of sense could think such to be possible.

Even the white man in the character of a scientific investigator has not, it would seem, been free from such feelings, for he has declared that savages using such classificatory terms of relationship must have invented them for the purpose of politely addressing each other, and thus avoiding the use of personal names. It has seemed almost impossible for many persons, including writers on savage custom,

* "The Australian Race," vol. I, p. 127.

† Mr. Curr seems to have quite overlooked Eyre's remarkable Latin note, quoted by us in "Kamilaroi and Kurnai," p. 52, although he quotes Eyre as his authority for statements made at p. 121, vol. 1, of "The Australian Race," as to the position of husband and wife.

to conceive that a savage may have inherited the relationship terms which he uses, in consequence of his ancestors having been in a state of society different from that of the existing savage tribes, much as the society of these differs from the more developed society of civilised peoples.

Our own relationship terms have been developed, without doubt, in accordance with the development of our civilised society. If the often-quoted and often-doubted statement made by Julius Cæsar as to the Britons (his contemporaries) is a true statement of their society, then there cannot be any reasonable doubt that he described a form of group marriage among our British ancestors—a custom which was almost on all fours with the practice of Australian tribes as described by Mr. Muirhead, in Queensland, and shown in this paper to exist in a very marked form in tribes having a range of a thousand miles in Central Australia.

The white man must, therefore, not only free himself from such preconceptions as to the universality of the relationships which he himself recognises, but he must, in order to understand those recognised by the Australian blackfellow, put himself into the place of the latter and endeavour, with such success as he may attain to, to regard them from his standpoint. Unless he does this the classificatory system of relationships will never be more to him than a delusion and a snare.

In endeavouring to disentangle the puzzling system of relationships of the Australian savage, and to offer a reasonable explanation of their origin and purpose, I start from the two existing fundamental inter-marrying groups. I do no more at this place than to note that the existence of these two groups appears to me to pre-suppose the previous existence of the undivided commune, whose segmentation would give them existence, and of whose structure each of the two groups may be thought to bear evidence in its own. If such an original undivided commune can be postulated, then it gives an explanation of some peculiar terms of relationship which occur in the Australian system, and which, it seems to me, it will be difficult to explain otherwise. It has been shown in a preceding section that the fundamental principle of aboriginal society in Australia is the division of the community into two exogamous inter-marrying moieties. Out of this division into two groups, and out of the relations thus created between the contemporary members of them and their descendants, the terms of relationship must have grown. As the two primary divisions (classes) have become again subdivided in the process of social development, and as the groups of numerous totems have been added, so has it become necessary to use new terms to define and distinguish the new relations thus created. On reflection, it seems to me quite evident that the new names must have come into existence after the new relations, which caused their want to be felt. Hence we cannot feel surprise that in all cases the existing system of relationship terms, to a greater or less extent, lags behind the existing relations.

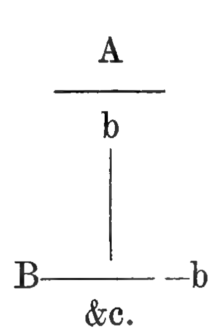
The process of social development has evidently not been quite the same, nor has it progressed at the same rate of change in each tribe of the vast number of tribes in Australia. As I have already said, the social conditions of the tribes enable the investigator to place them in a series, commencing with that tribe whose organisation is most archaic. The various systems, or rather, to speak more correctly, the variations of system of relationship terms, may also be placed in a progressive series. The first will represent a community having terms fitting accurately with the theory of group marriage, and agreeing very closely with the existing practice of group marriage as I have explained it in this memoir. The most extreme variation will retain the principles of the group system, but it will be found on examination that the earlier types of groups have been more or less broken up, and that some of the group terms have been differentiated into individualised terms. It will be, moreover, observed that the most differentiated systems of relationship do not fully agree with the actual practice of the several tribes using them, yet that they do agree with the practice of other tribes standing further back in the series.

The conservatism of savages as to that which has been handed down to them from their ancestors fully accounts for this, and one may herein also see the tenacity with which ancient customs hold in their death grip those who have been reared in them.

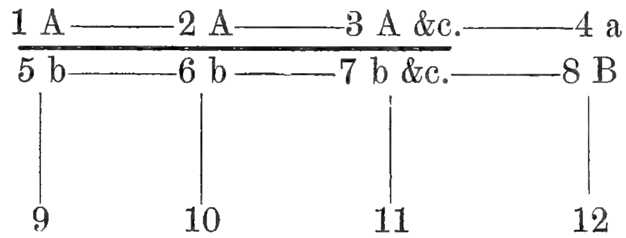
In illustrating the typical group relationship terms, and in explaining their relation to the class systems, I shall, for the sake of clearness, disregard the group of sub-classes and totems, and shall use the two primary classes. The illustration would not be made any clearer by introducing the lesser social divisions which rest upon and are underlaid by the fundamental older law.

For the sake of brevity and clearness the two moieties of the community may be indicated as the A moiety and the B moiety. The fundamental law, therefore, is that A male marries B female, and *vice versa*. In the majority of tribes children take the class names of their mothers. Cases in which descent is in the paternal line may be for the present disregarded.

Such marriages and descents may be formulated by a simple diagram in which capital letters are used for males, and small letters for females, thus :—



In this diagram A or b is not merely an individual, but also may represent a group as large as the whole moiety, for the cases which I have quoted in this memoir show that the theory of group marriage in those tribes wherein it now exists is that the males of the one moiety of tribes are the potential husbands of those women of the other moiety who might lawfully become their individual wives.* In other words, group A is the husband of group b. But where, as in this section, I am dealing with the relation of various individuals to each other, I shall expand the above diagram, as shown below:—



In this diagram the numbers are added merely for convenience of reference. 1, 2, 3 represent men of one moiety of a tribe; 4 is the sister, own or tribal, of these men; 5, 6, 7 represent women of the other moiety of the tribe, the individual or group wives of 1, 2, and 3; 8 represents the brother, own or tribal, of these women; 9, 10, 11 represent the children of the respective couples; 12 may stand for the children of 4 of 8, or of both, if it be assumed that 4 and 8 stand in the marital relation to each other.

The above diagram may be taken to represent a group of people of the Dieri, Kunandaburi, Kungerduchi, or Wakelbura tribes, and in the present instance I take Mr. Muirhead's example of group marriage in the latter tribe.

It is well to again point out that my researches have now proved, as a matter of fact, that group marriage exists in these tribes, and no doubt in the intervening tribes over a thousand miles of country. Further, that this group marriage is that of a number of men, who are own or tribal brothers, with a number of women, who are own or tribal sisters to each other. I take this indisputable fact as a starting point in the explanation which I shall now give of the peculiar system of relationships which is known to obtain in these tribes.

This diagram shows at once by inspection that since 1, 2, 3 are in the marital relation to 5, 6, 7, the children of these women must of necessity regard each of 1, 2, 3, as their father, and be regarded by them as their children. Moreover, since 9, 10, 11 are all children of the same group-father, they themselves must stand as a group,

* That is to say, lawfully as regards their nearness of kin.

and individually in the fraternal relation to each other. So far as 5, 6, 7 are concerned, it is quite true, as might be objected, that there cannot be any doubt as to which of the women is the mother of any particular child. Yet each woman, other than the actual mother, stands in the marital relation to the group-father of the child, and thus stands in the relation of group-mother to it. It may be likened, in some degree, to a case with us where a man has two wives successively. The child of the first wife will have no doubt as to its own mother, but the second wife stands in the maternal relation to it. When strictly defined, the relation in which she is is that of "step-mother;" with these tribes, *e.g.*, the Dieri, she would be defined as "andri waka," or "little mother."

When, however, we come to consider the relations of the groups 1, 2, 3 and 5, 6, 7 to 4 or to 8, it will be found that an entirely different relation exists; 4 is the sister, own or tribal, of the group 1, 2, 3, and cannot be possibly in the marital relation to it. Hence it cannot be in the maternal relations to 9, 10, 11. This relation, therefore, necessarily receives some other term equivalent to "father's sister."* This relation is clearly quite different to "mother's sister," for the diagram shows that 5, 6, 7 being sisters, own or tribal, to each other, are indeed mothers to 9, 10, 11. These two relations, which we confuse together in our collective term "aunt," are clearly distinguished by the aborigines. The same line of argument will show that 8 being the brother of 5, 6, 7, is not possibly in the paternal relation to 9, 10, 11, but is the "mother's brother," and as such received a special designation. In our collective term "uncle" we join "mother's brother" to "father's brother," who, under group marriage, is necessarily "father" to his brother's children.

No. 4 being the sister of the group husbands 1, 2, 3, and 8 being the brother of the group wives 5, 6, 7, are both units in similar marital groups, and are (regarded from the tribal point of view) potential, if not actual, husband and wife. The child 12 has for its parents the groups 4 and 8. It cannot be in the filial relation to 1, 2, 3 or 5, 6, 7, and hence cannot be fraternal to 9, 10, 11.

Here we come to a further consideration of those relations which we confuse in our collective term "cousin," which itself includes paternal cousins and maternal cousins. With us 9 would be "cousin" to 10, 11, 12. But under group marriage as it exists here, based upon the segmentation of the community into A and B, 9 is the brother or sister of 10 and 11; 12 would be the brother or sister of 13 and 14 were they added to this diagram, but cannot be the brother or sister of 9, 10, 11. This other different relation also finds a distinctive term in group relationship.

* It is well to entirely abandon the use of such terms as our "uncle," "aunt," &c., which are terribly misleading in these investigations.

It must be now evident that, keeping clearly in sight the distinctive features of the group relationships, our words uncle, aunt, nephew, niece, cousin, son-in-law, daughter-in-law, &c., cannot have any "substantive collective" equivalents in the languages of the Australian tribes, as has been alleged by the late Mr. E. M. Curr in his voluminous work on "The Australian Race."

His argument in proof of this allegation is worthless when examined. He says that there are such terms "because he finds them given in vocabularies, and he finds them in the lists filled in by his correspondents." This assumes the correctness of the vocabularies and of the lists, which is, indeed, part of the question at issue. An examination of the tables given in the work quoted at p. 141, Vol. I, will show at first view that the compilers were either ignorant of the true principles of the group relationships or of the terms themselves, or desired to come as near to the English collective terms given by Mr. Curr in his circulars as they could manage. One compiler of the table (Mr. Taplin) takes the trouble to distinguish between the paternal and maternal uncles. Mr. Gason, who is also quoted, and with whom I have communicated on the subject, gives me a list of the relationship terms in question, which is conclusive. This list I annex to this section for reference.

It is, therefore, evident that in the matter of the "substantive collective" equivalents of our terms uncle, aunt, &c., the late Mr. Curr did not study the subject with that analytical care which was necessary in order to place himself in a position to speak with certainty.

I bear willing testimony to the value of the information which he has recorded in his contribution to the science of anthropology, and I am very sensible of the vast amount of labour which is implied by his work, but I am compelled to point out that he has, in parts of his work to which I have alluded in this memoir, fallen into errors; and in regard to the terms "uncle, aunt, &c.," that he has done an injustice to Mr. Fison. It was my intention to have entered at length into the question, and I communicated my intention long ago to the late Mr. Curr during correspondence after the publication of his work. Now, however, that his lamented decease prevents any reply on his part, I shall content myself with merely correcting his error, and of adding that his charge against Mr. Fison, of what amounted to literary dishonesty, in "keeping to himself" terms which would be adverse to his argument, is now seen to have been founded upon a mistake as to the true meaning of those terms which Mr. Curr himself fell into.

DIERI TERMS.	ENGLISH TERMS.	ACTUAL RELATIONSHIPS.
1. Apiri	Father	Father
2. Apiri Waka	Uncle	Father's brother
3. Kaka		Mother's brother
4. Andri	Mother	Mother
5. Andri Waka	Aunt	Mother's sister
6. Papa		Father's sister
7. Atamura	Son	Son M. (*)
8. Atani		Son F. (†)
9. Atamura	Nephew	Brother's son (M.)
10. Atani		Sister's son (F.)
11. Atamura		Brother's son (F.) (‡)
12. Thidnara		Sister's son (M.)
13. Negi (§)	Brother	Brother
14. Negi	Cousin	Father's brother's son
15. Negi		Mother's sister's son
16. Kami		Mother's brother's son
17. Kami		Father's sister's son
18. Noa	Husband	Husband
19. Noa Waka	Brother-in-law	Husband's brother
20. Noa Waka		Sister's husband (F.)
21. Kareti		Wife's brother
22. Kareti		Sister's husband (M)
23. Noa	Wife	Wife
24. Noa Waka	Sister-in-law	Wife's sister
25. Noa Waka		Brother's wife (M.)
26. Kamari		Husband's sister
27. Kamari		Brother's wife (F.)

Conclusion.

From the statements which have been made in the preceding sections of this paper, the reader will, I doubt not, be now prepared to deduce certain general conclusions as to the structure of Australian tribes. It will be well to summarise these shortly, for it is always of advantage to take stock of results, and to observe those prominent facts which may serve as further stations for observation in the course of the inquiry.

It has been shown that the fundamental idea in the conception of an Australian community is its division into two groups. The relationships which obtain between the members of them are also those of group to group; the liability for wrong is one by the group for its individual member, and the group is also liable, collectively and individually, for wrong done by any one of its members, and it is liable to the entire group of the injured person.

(*) Male speaking.

(†) Female speaking.

(‡) At first sight this term appears to be erroneous, as according to the ordinary rule it would have been *atani*, but three independent correspondents have confirmed the exception.

(§) I have taken "elder brother" as the example. If "elder sister" had been used "Kaku" would have replaced "Negi," and if "younger brother" or "younger sister," "ngatata" would have replaced "Negi" in 13, 14, 15; but in all cases Kami would remain in 16 and 17.

The unit of aboriginal society is, therefore, not the individual, but the group. It is the group which marries the group and which begets the group. The idea of the relation of individual to individual, and of the parentage of the individual, without reference to the group, is of the later origin, and is the result of a number of social forces acting in the same general direction, and producing change.

It is of no little interest to observe by the aid of such analytical investigations as those which I have discussed in this memoir, that custom among the Australian savages is not so fixed and unchanging as the laws of the Medes and Persians were said to be. Savages are, no doubt, among the most conservative of peoples. They look upon custom as being sacred, and their reply, "Our fathers did so," is to them an unanswerable argument as to the authority and wisdom of any practice. But it is now quite evident that their customs have not been in the past unchanging. We certainly cannot notice a process of change in any given custom, partly because our period of observation has been far too limited, partly because probably the changes have been brought about by small and almost imperceptible degrees. Yet there are not wanting pieces of evidence which show that change in custom may have been brought about, not only by what may be called the orderly process of change, but by violent innovation by some strong and masterful Headman, such as the Jalina herein mentioned. The instance quoted in "Kamilaroi and Kurnai" of half-sister marriage in a Kamilaroi tribe looks much like such a case, and the evidence that in some of these tribes superior authority is acknowledged in the Ipai class supports the view.

The impulses which produced change in custom may, as it seems to me, have acted from within the community, and the causes which set those impulses in motion must have been diverse in kind and degree; they must have arisen at different times during the long age in which the aborigines have roamed over Australia. Changes have, therefore, been produced in the different tribes, of different degrees of intensity, and at different times, or it may be also that analogous changes were not in progress in the tribes affected by them at precisely the same time. However this may have been, it is worthy of note that the changes in custom affecting the social organisation, the class divisions, marriage, and descent, have all been in one great direction, following parallel courses in a line of advance on the same road along which the civilised races of the world have already long since passed.

The changes which have taken place have been from the general to the special, from group marriage to individual marriage, from a group relationship to a specialisation of the different group relations. These are precisely such changes as might have been forecast from a consideration of the laws which have governed the evolution of language and of society.

The principal points which thus stand out as prominent landmarks in this field of investigation are as follows :—

1. The group is the sole unit. The individual is subordinate in the more primitive form of society, but becomes more and more predominant in the advancing social stages. Thus group marriage becomes at length completely subordinate to individual marriage, or even practically extinct and forgotten where descent has been changed from the female to the male line.

2. An Australian tribe is not a number of individuals associated together by reason of relationship and propinquity merely. It is an organised society governed by strict customary laws, which are administered by the elder men, who in very many, if not in all, tribes exercise their inherited authority after secret consultation.

3. There are probably in all tribes men who are recognised as the Headmen of class divisions, totems, or of local divisions, and to whom more or less of obedience is freely given. There are more than traces of the inheritance by sons (own or tribal) of the authority of these Headmen, and there is thus more than a mere foreshadowing of a chieftainship of the tribe in an hereditary form.

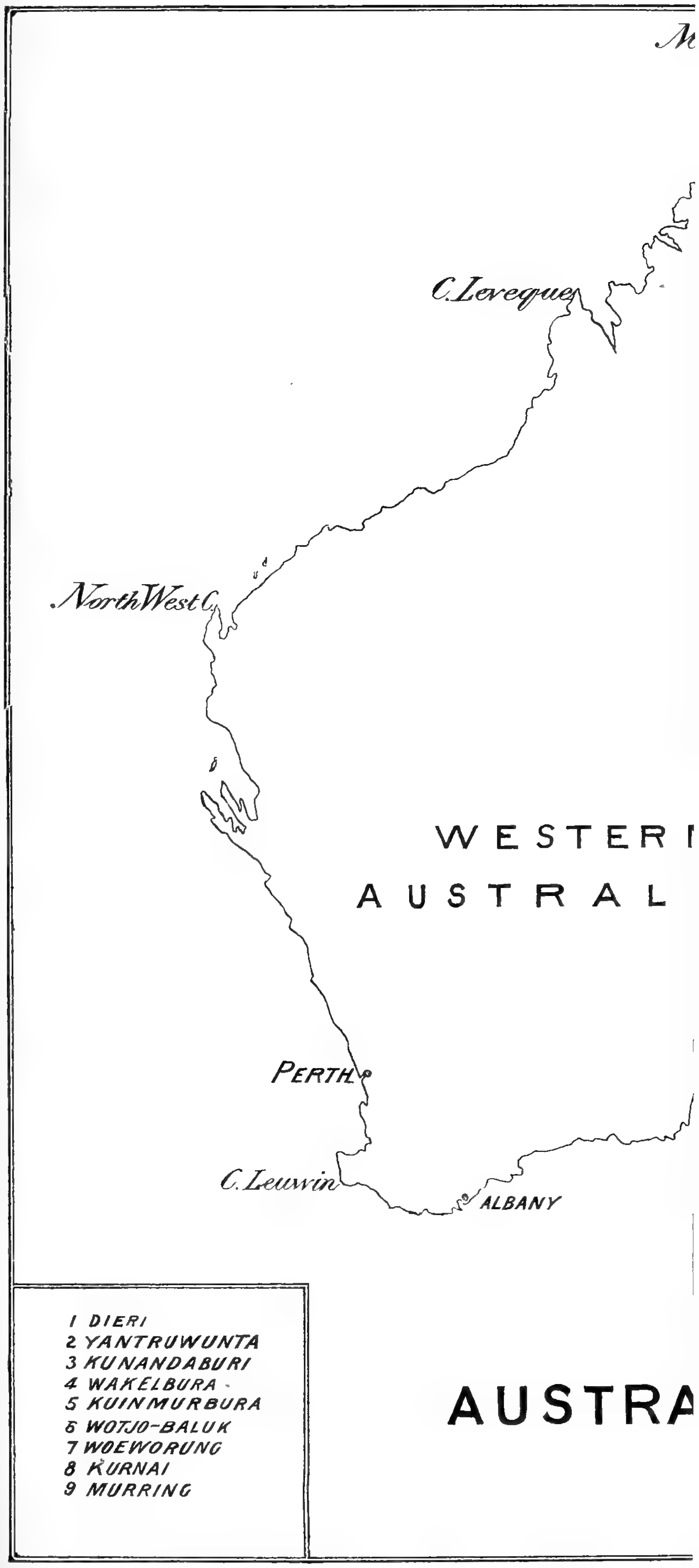
4. Relationship is of group to group, and the individual takes the relationship of his group, and shares with it the collective and individual rights and liabilities.

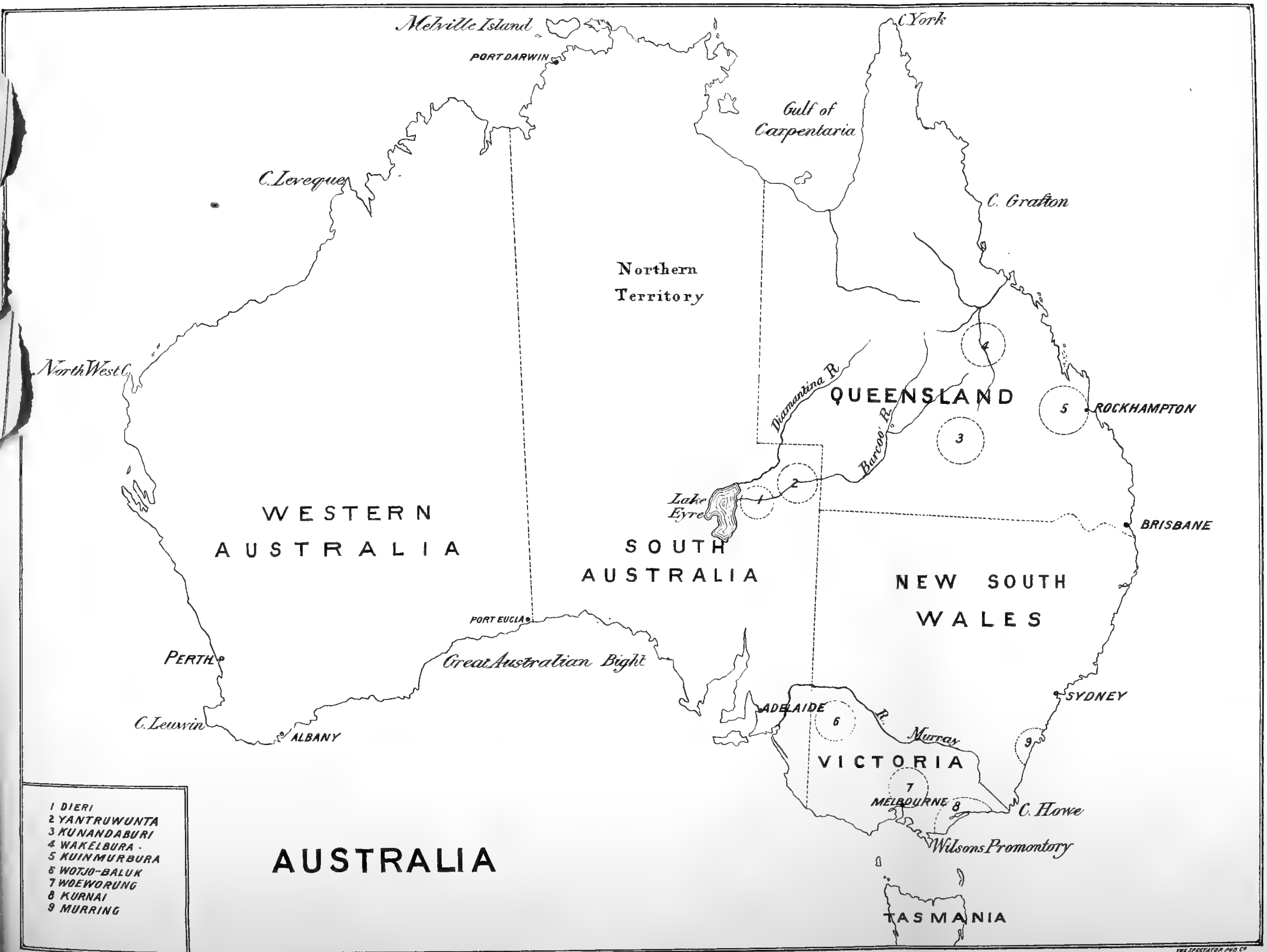
The general result arrived at will be that the Australian savages have a social organisation which has been developed from a state when two groups of people were living together with almost all things in common, and when within the group there was a regulated sexual promiscuity.

The existence of the two exogamous inter-marrying groups seems to me to almost require the previous existence of an undivided commune, from the segmentation of which they arose. The evidence which I have collected, and which I have elsewhere noted as to the occasional recurrence of license, even in the class divisions themselves, is most important as indicating a reversion to ancient practice. The aborigines themselves recognise the former existence of the undivided commune in their legends, but I do not rely upon this as having the force of evidence.*

It seems to me that the once existence of such an undivided commune may well be provisionally accepted as being in the highest degree probable. The evolutionist is led to its contemplation logically. The special creationist may accept it as showing, if it pleases him to place the matter in that light, to what a pitch of moral degradation man had fallen from his once high estate.

* The Dieri and the Woeworung both say that their class divisions were formed in consequence of a command conveyed from their great Supreme Being.


C. Leveque
North West C.
WESTER
AUSTRAL
PERTH
C. Leuwin
ALBANY
1 DIERI
2 YANTRUWUNTA
3 KUNANDABURI
4 WAKELBURA
5 KUINMURBURA
6 WOTJO-BALUK
7 WOEWORUNG
8 KURNAI
9 MURRING
AUSTRA



Transactions R. S. Victoria, 1889.

That any direct evidence as to the existence of the undivided commune will be forthcoming seems to me very doubtful. The only part of the earth's surface on which it could have survived might have been Australia, and the area in this continent which still remains for critical examination of custom is now so narrowed down that little probability remains for it being found therein.

ARTICLE V.

THE ANATOMY OF AMPHIPTYCHES URNA (GRUBE AND WAGENER), BY W. BALDWIN SPENCER, M.A., PROFESSOR OF BIOLOGY IN THE UNIVERSITY OF MELBOURNE. (With plates 11, 12, and 13.)

(Read Thursday, July 11th, 1889.)

This interesting parasite was first described and figured by Dr. Wagener.* It was obtained by him from the alimentary canal of *Chimæra monstrosa*. Out of seventeen specimens which he examined, no fewer than fifteen contained the parasite, which on one occasion was found in the gill cavity, though then the fish in which it was parasitic had been some twelve hours out of the water.

The *Chimæra* of the Northern Hemisphere is represented by the very closely allied *Callorhynchus antarcticus* in the seas of the Southern Hemisphere. The specimens obtained by myself—three in number—were taken from the mouth of a fine example of the latter fish sent to me by Mr. J. Bracebridge Wilson, and their presence in such a position was doubtless associated with the fact that the fish had been dead some twenty-four hours, though the parasites were still living, and evidently trying to find their way out of the dead body. The fish contained no more than these three specimens.

(1.) *External Anatomy*.—The living worm which, unfortunately, I was unable to study in this condition, was of a creamy white colour, with the sides of the body and one end beautifully crenate. This end is called by Wagener the posterior; in my opinion, what evidence there is available upon this point tends to show that this is the anterior rather than the posterior end, and accordingly it will be so described in the following pages. At the end called the anterior by Wagener the crenations are absent, and the margin is smooth, and tapers off to a blunt point (Pl. 11, Figs. 1 and 4). The end is formed by a muscular sucker, the opening into which shows as a slight round aperture in the living or dead worm, resembling thus the somewhat similar sucker at the anterior extremity of the Trematode worm. It must, however, be borne in mind that in Amphiptyches this sucker has no relationship to a digestive tract, nor even, so far as can be seen, to any rudiment of one. Wagener regards the two suckers as homologous. I cannot see that there is any sufficient evidence of this homology; the sucker has, as stated above, no relationship to an alimentary system, nor has it the relationship to the nervous

*Uber einen neuen in der *Chimœra monstrosa* gefundenen eingeweide-wurm, *Amphiptyches urna*. Arch. f. Anat. u. Phys. 1852; also Arch. f. Nat. 24. 1, 1858.

system, such as exists in Trematoda. A nerve ring is present in Amphiptyches, but this is at the opposite end, and it is the presence of this which leads me to regard this end as the anterior. Certainly the reproductive organs open near the sucker end, but their structure and relationships are considerably different to that obtaining in the Trematoda, and can furnish no decisive evidence. They are apparently much more closely allied to those of *Caryophyllæus* than to those of the Trematoda or ordinary Cestodes.

The opposite extremity of the body (posterior of Wagener) is very different in appearance, being characterised, as already described by Wagener, by a rosette of folds. It is pierced in the centre by a small tubular space leading into the body, which space, after traversing a very short distance (not more than one eighth of an inch), turns dorsalwards and opens to the exterior through a slight proboscis-like structure on the dorsal surface. This proboscis is capable of extrusion and retraction. In the three specimens secured by myself it was retracted, but in one, for which I am indebted to the kindness of my friend, Dr. Haswell, of Sydney, it is extruded, and forms (Pl. 1, figs. 2 and 3) a prominent feature close beneath the rosette of folds which marks the anterior end of the body. In this specimen also the sides of the body are much less crenate, which may perhaps be due to the fact that the food yelk glands are much less developed than in the three other specimens. When retracted the dorsal opening simply has the form of a short slit. This slit and the protruded proboscis have been figured already by Wagener (Pls. 14 and 15). It is difficult to assign any function to this curious structure, or to homologise it with anything present in other Cestodes, or in fact in other Vermes, but as will be shown later, the nerve cord has a definite relationship to the canal which pierces the anterior extremity and opens on the proboscis. Over the whole surface of the body spines are scattered, much as in certain Trematodes; the sharp pointed ends of these (Pl. 13, Fig. 6) protrude from the apex of a slight papilla, and in connection with each are special muscles which, on contraction, cause the spine to be protruded. These spines are irregularly distributed and are most numerous on the margins of the body and over the surface at the posterior and anterior extremities, as described by Wagener.

The posterior end, as before said, is marked by the presence of a small opening leading into a sucker. Slightly more than half an inch beyond this, and on the left side ventrally, is present, in the dead worm, a well-marked somewhat conical and muscular papilla (Pl. 11, Figs. 1 and 4). The three worms obtained by myself were placed before killing between plates of glass, so as to prevent the contraction and curling up of the body when hardened, and in these three the papilla was but feebly marked, and the genital opening, which is placed at the apex (when the papilla is present), was almost upon the margin of the body. On the ventral side of the body also, and just at the base of the papilla towards the middle line, is another opening concerned with the reproductive organs. On the dorsal side, slightly anterior to the level of the first-mentioned opening, and about half-way between the margin of the body and the middle line, is a third opening. These three openings were recognised by Wagener, but he was apparently unable to determine the meaning of two of them, the first mentioned and the third; the second he rightly recognised as connected with the female organs. Of these openings the first is the male opening, the second that of the duct of the receptaculum seminis, and the third that of the uterus.

By means of making the body transparent the greater part of the structures can be determined, so far as their macroscopic anatomy is concerned. Series of consecutive sections enable us to more minutely and exactly investigate the structure and connection of the different organs than was possible when the worm was first described, and the study of three such series leads me to a somewhat different interpretation of certain structures to that placed upon them by Dr. Wagener, and to a more complete account of the various structures present, and the relationship, especially, of the ducts to the various organs of the reproductive system.

(1). *Structure of Body Wall and Musculature.*—What is, perhaps, the most prominent feature of the body wall, the presence of very distinct and numerous spines, has been described by Wagener. They are distributed generally over the body surface, but are most numerous along the side folds, and more especially at the anterior end, both on the dorsal and ventral surface, and again at the posterior end, beyond the region of the side folds. They are sparsely distributed over the central part of the body, both dorsally and ventrally. Only the somewhat rounded point of each protrudes externally, and is placed at the apex of a minute papilla. The spines (Pl. 13, Figs. 5, 6, and 13) are somewhat elongate in form, with a slightly swollen internal end, to which special muscle fibres are attached, which are so arranged that on contraction they serve to extrude the spine. Each spine, as the figures show, is composed of concentric layers of a transparent material, and when cut in transverse section is circular in outline.

The whole of the body is covered with a cuticular layer; beneath this lies the epidermis, consisting of long, thin, columnar cells, which pass internally into a layer of apparently homogeneous material. The character of the epidermic cells is the same everywhere, except on the inner surface of the folds of the rosette at the anterior and on the walls of the space holding the proboscis, where the cells become (Pl. 12, Fig. 9) glandular and goblet-shaped. The function of these gland cells is difficult to imagine unless it be that of secreting a sticky material, enabling the parasite to adhere to the walls of the alimemtary canal of its host.

Next to the epidermis lies a layer of smooth muscle fibres running circularly round the body. Within this (Pl. 13, Fig. 3) is a layer of longitudinally arranged muscle fibres, which is followed by a second layer of circular fibres, enclosing the central part of the body. This central part is occupied by the various organs—the reproductive, nervous, and excretory; it is crossed by dorso-ventral muscle fibres. In front of the reproductive organs, which traverse some three-quarters of the length of the body, the central part (Pl. 13, Fig. 3) is occupied by a very compact and homogeneous mass of connective-tissue, in which nuclei are scattered irregularly, and in which the excretory vessels ramify. Except the cavities of the excretory and reproductive organs no trace of any spaces are to be seen. In the region of the uterus the latter occupies by far the larger portion of the body.

(2.) *Nervous System.*—This consists of a pair of longitudinal cords, strongly developed, and passing one along each side of the body, from the anterior to the posterior end. (Pl. 11, Fig. 1.) From these cords branches arise on either side, supplying the different parts of the body. As described by Wagener, there is also a stout band of fibres passing across the inner end of the sucker, and uniting the nerve cord of either side ventrally; beyond this commissure, two branches pass on which hug the sides of the sucker, and pass to the very posterior end of the body (anterior of Wagener), but in this position no nerve ring is formed, so far as I can discover by means of sections. In the figure the cords are represented for the sake of clearness, as running one on either side of the uterus. Really they run somewhat nearer to the median line than is represented in the figure, and lie dorsal of the uterus. At the very anterior end the cords form a ring, which runs round the "proboscis." The commissure on the ventral side is more strongly developed than that on the dorsal side, which can only be traced by means of series of consecutive sections.

No nerve cells can be detected with certainty. In certain parts nuclei can be seen on the outer surface of the cords, but these probably belong to the connective tissue surrounding the cords.

(3.) *Excretory Organs.*—These consist, as described in the main by Wagener, of a network of tubes, some of which contain cilia. This network is best developed at the sides and two ends of the body. The tubes all lie within the inner layer of circular muscle fibres. Branch vessels pass across the uterus, connecting the networks of the two sides, and along each side a main lateral vessel, running very irregularly and connected with numerous branches, can be more or less clearly distinguished. (Pl. 13, Fig. 1, *ne.*) The vessels vary greatly in size, and cilia are confined to the larger ones. In these, as described by Wagener, they do not line the whole surface. Transverse sections (Pl. 12, Fig. 8) show clearly the structure of the vessels. Each is lined by a clearly outlined membrane-like layer, which, in appearance, more resembles a fine cuticular structure than anything else. From one side a tuft of cilia projects into the lumen, having just the appearance represented in the drawing.

These cilia are seen in longitudinal section to form a continuous line along one side of the vessels, and are apparently connected at their bases with cells, the nuclei of which can be detected. Each vessel is immediately surrounded with a specially dense ring of connective tissue, in which also distinct nuclei can be seen. The cuticular-like lining is wanting where the cilia pass through. There are no structures to be found resembling the "flame cells" of other Cestodes or of Trematodes, and another point of distinction lies in the fact that the vessels are for the most part placed *in* the central core of connective tissue, and not superficial to this. Where a network of canals is present in other Cestodes, as in *Tetrahynchus*, *Bothriocephalus*, and *Caryophyllæus*, it lies superficially.* A ring of vessels is formed just posterior to the proboscis (Pl. 13, Fig. 1, *ne.*), and from this ring a number of smaller vessels pass forward into the folds of the anterior "rosette," and break up into an innumerable quantity of very fine vessels, without cilia, which ramify in the connective tissue within the folds. These vessels have extremely fine linear outlines (Pl. 12, Fig. 9), and form a dense network in this part of the body. Another well-developed network is found enclosing the sucker at the posterior end, but the tubes, so far as I can determine, have no connection with this sucker.

Wagener was unable to find any external opening of the excretory system, but, after long searching, I have been able to find two unmistakable openings on the ventral surface, one on either side of the body (Pl. 13, Fig. 1, *ne. o.*), slightly in front of the opening of the uterus to the external surface.

Amphiptyches is not alone amongst Cestodes in having these paired openings to the exterior, and it is possible that more than this single pair may be present.

It is difficult to say in what part the act of excretion of waste fluid material is actually carried on. Probably the minuter vessels are associated with this function, but no definite evidence of this is forthcoming, save the negative evidence that the larger vessels are lined by what appears to be a layer of cuticular material, only broken through where the cilia pass into the tube. As before said, no trace of structures comparable to "flame cells" can be detected; what might appear in single transverse sections to be such structures (*cf.* Pl. 12, Fig. 8) are seen, when continuous series are examined, to be simply sections of tubes lined by a continuous longitudinal band of long, well-marked cilia, so arranged as to have a curious flame-like appearance, though very different to that ordinarily figured for "flame-cells."

(4.) *Reproductive Organs.*—The animal is hermaphrodite, and, as in the Trematodes and simpler Cestodes, only one set of organs is present. It may, however, be well doubted whether *Amphiptyches* is self-fertilising or not. It, together with

* Jackson—"Forms of Animal Life." Second Edition, page 658.

Caryophyllæus, alone amongst Cestodes, so far as I am aware, possesses a definite receptaculum seminis, a structure characteristic of forms which are not self-fertilising amongst hermaphrodite animals. In the former the structure is more definitely developed than in the latter, and has an external opening distinct from that of the other organs.

It is quite possible that this spermatheca serves to store up the spermatozoa of some other form, and not those produced in its own testes.

(*a*) *Male Organs*.—Wagener has described as testis a structure lying at the anterior (according to him posterior) end of the reproductive organs, and which certainly contains ripe spermatozoa. This structure, however, is to be regarded as a receptaculum seminis, and as such will be described in connection with the female organs.

The real *Testes* are a series of somewhat globular, sack-like structures, scattered about irregularly in the posterior part of the body (Pl. 11, Fig. 1, *te*.). They are placed to the sides of the hinder part of the uterus, and extend backwards as far as the posterior sucker. In these testes, which in their scattered nature agree generally with those of other Cestodes and of Trematodes, the spermatozoa are to be found in different stages of development. Each testicular mass is enclosed in a capsule of connective tissue, the walls of which are lined by mother cells. The outline of these cells cannot be clearly determined, and the structure has rather the nature of a protoplasmic syncytium containing numerous nuclei. Cells apparently separate off from the wall, and dropping into the cavity of the capsule, undergo division, and develope in much the same way as in many other worms (*e.g.*, Chœtopoda and Turbellaria). Sperm-blastophores could not be clearly distinguished, but the spermatozoa remain grouped together as they do when one is present, and in all probability such a structure is developed from a portion of the spermatosphere.

Fine ducts, very difficult to distinguish and probably only fully developed when the spermatozoa are actually in the act of transit to the exterior, pass from the testes into a common duct on each side, which again opens into a coiled tubular organ, which in part overlies the posterior end of the uterus. These are the structures of the exact nature of which Wagener was in doubt, and which, judging from his description, I believe he described as "Keimstock," stating that their nature was doubtful.

The coiled tube, which is filled with a curious coagulated material in hardened specimens of the worm, is to be regarded as a *vesicula seminalis*. From it one of the curiously coiled tubes noticed by Wagener, but the exact connection of which he was unable to determine, passes off towards the left side of the body; this tube is surrounded by a very well developed layer of circularly disposed muscle fibres, and opens close to the margin of the body on the conical papilla previously mentioned, which is hence to be regarded as the male genital opening (Pl. 11, Figs. 1 and 4, *m.o.*) The vesicula seminalis opens into the tube leading to the exterior on a small well-marked papilla with muscular walls. Probably the tube itself is eversible.

(*b*) *Female Organs.*—The most prominent structure in the body is the coiled tubular *uterus*, occupying the central part of the body, and described by Wagener as the " eierstock."

Ovary.—This consists (Pl. 11, Fig. 1, *ov.*) of two parts, (1) a series of small somewhat grape-like ovaries, occupying much the same relative position in the body at the anterior end which the testes do at the posterior. From the scattered ovaries ducts unite on either side into a common one, passing into a centrally placed, somewhat saccular organ, filled with ova. It would appear that this holds the same relationship to the ovaries which the vesicula seminalis does to the testes; that is, the ova are developed in the scattered ovaries and then pass into this central part, in which they are stored, and subsequently, perhaps, undergo maturation, and possibly even fertilisation in this position. In the worms examined, the ovaries of the three obtained by myself were in a different state of development from that of those in the specimen for which I am indebted to Dr. Haswell. In the first mentioned the ova were evidently passing down into the uterus, in which they were but very slightly developed. The ovaries, consequently, were full of fully formed ova, having the nature of distinct cells with clearly defined nuclei. In the second the uterus was full of much more highly developed embryos, and no ova, apparently, were passing into it. In this case the ovaries were evidently in the act of developing a fresh supply of ova. Each consisted of a mass of protoplasm, containing nuclei, evidently dividing up rapidly, whilst the outline of the cells could only here and there be distinguished with anything approaching to clearness (Pl. 13, Fig. 11). Each little ovary has thus, when the ova are not fully formed, the structure of a polynuclear mass of protoplasm, which only subsequently becomes divided up into a number of distinct cells (Pl. 13, Fig. 8).

Yelk Glands.—These consist of innumerable dark-brown coloured little spherical masses (Pl. 11, Fig. 1., (*Ylk.*), which are smaller than either the testes or ovaries. They are distributed plentifully along the sides of the body, passing into and distending the folds, and at the anterior and posterior end pass across from one side to the other, both dorsally and ventrally. They lie always just within the circular muscle layer, and hence much more superficially than either the ovaries or testes. This position is constant. Especially towards the anterior end they are united by fine tubes, rendered evident by their brown contents, and on each side the ducts unite, just as in Trematodes, to form a common duct passing towards the median line where the two join, a single duct coming from the median space filled with ova. A difference of structure has been noted above in the case of the ovaries of the two examples examined, containing embryos at different stages of development in the uterus, and a curious difference obtains also in the yelk glands of the two forms. In the one containing highly developed embryos the yelk glands, like the ovaries, are evidently providing a fresh supply of material in prospect of the next period of reproductive activity. Each consists of a mass of cells, the outlines of which are somewhat more clearly marked than in the case of the ovaries, with large nuclei evidently undergoing division (Pl. 13, Fig. 10). The cells are remarkably similar to ova, but the relative size of the yelk masses and their definite superficial position renders them distinct from the ovaries. In the case of the form containing ova passing down into the uterus, the yelk glands are in a much more advanced stage. Each is filled (Pl. 13, Fig. 9) with a mass composed partly of distinct yellow globular bodies, and partly of nucleated cells. These pass on until they reach the duct coming from the median space containing ova, and then with the latter pass on into the uterus, in connection with which their probable fate will be further dealt with.

Uterus.—This commences at about one-third of the length of the body from the anterior end. At its point of origin it is connected with the duct from the ovaries and the yelk ducts, and as it passes towards the posterior end it very much enlarges and coils about from side to side, until finally it opens to the exterior at the base and to the inner side of the papilla (Pl. 11, Figs. 1 and 4, *f.o.*), on which the male opening is situated. Wagener observed the eggs passing out of the opening of the coiled tube whilst the animal was alive in water.

The uterus is completely filled with embryos, the maturer ones lying nearer to the opening to the exterior. Two very different stages of development were observed. In three, as before mentioned, the ova had evidently not very long ago passed into the uterus, in fact, they were still in the act of passing in. The shells surrounding the ova were not completely formed in the upper part of the uterus, but when fully formed as they were, except in this special part, were so resistant that no stain had been able to penetrate to the embryo within. The latter had undergone but very little development.

So far as can be seen there are no definite "shell-glands" present; all the other structures connected with the reproductive organs could be distinctly made out by means of sections, and presumably shell-glands would have been able to be recognised if they were present as distinct and separate structures. In plate 13, figure 2, is represented a portion of the first part of the uterus, in which, evidently, the shells are being formed around the ova. In addition to nucleated cells, the uterus contains very numerous little drop-like yellow structures, which resemble exactly those which have previously been described as present in the yelk glands. It appears as if these, as it were, "ran together," and formed a case enclosing certain of the nucleated cells, some of which are ova, and some probably cells from the yelk glands (*cf.* Fig. 9), which will serve as food yelk for the developing ova. This appears to be the only construction which can be placed upon the appearances.

As before said, at an early date in the formation of ova and food yelk, whilst they are within the structures which respectively give rise to new supplies of each, there is a very close resemblance between the two.

In the other worm, previously referred to, the embryos are in a much more highly developed state. The shell is less evident, and evidently less resistant as the stain has penetrated. An embryo is represented in plate 13, figure 13. It is oval in form; the body seems to be composed of a syncytium, with very numerous nuclei on the outer surface. Within the external layer strands of protoplasm containing fewer nuclei pass across the centre of the body. The anterior end is marked by the possession of a circlet of ten spines, which, when fully formed, have each the shape of a crescent attached to a long straight piece. In development (Fig. 7, *a*, *b*, *c*, *d*) the crescent piece is the first formed, and the longer straight portion appears later on as a small outgrowth, which gradually increases in length.

Receptaculum seminis.—This is the structure previously referred to as having been described by Wagener as testis. It forms a small saccular body lying in close contact with the central structure containing ova. (Pl. 11, Fig. 1, *r. s.*; and Pl. 12, Fig. 7, *r. s.*) From its dorsal side there passes posteriorly a long single median duct, the walls of which consist of long ridges of cells enclosed within a connective tissue coat. The duct runs along the median line dorsal to the uterus, and, passing backwards, stretches beyond the uterus and vesicula seminalis, turns to the left, and opens dorsally slightly in front of the level of the male opening (Pl. 11, Fig. 1, *r. s. o.*). The duct is a very distinctly marked structure, and receives no branches of any kind.

The receptaculum is full of ripe spermatozoa, and amongst these are found some very deeply staining nucleated cells; these were present in all three specimens of which sections were cut (Pl. 12, Fig. 7, *x.*), and they have in general appearance and the way in which they take stain, a marked resemblance to the ova. Possibly they may be simply the sperm blastophores from which the ripe spermatozoa have been separated, but such structures were not clearly made out, and there is no proof of this. I am strongly inclined to think that there is a connection between the receptaculum and the central space containing ova, though my sections do not allow me to determine this with certainty. On plate 12, figures 1, 2, 3, 4, 5, and 6, a series of drawings are given representing the structures as seen in a series of consecutive sections through the spot where the oviduct (*od.*) leading from the ovary passes very close to the walls of the receptaculum. Figure 1 represents it just arising from the central space containing ova, figure 2 shows it distinct,* figures 3 and 4 are cut through a part where it is just bending slightly upwards; in figure 5 the lower part appears to be connected with the wall of the receptaculum, though there is no distinct lumen present, whilst figure 6 represents in the next section a slight indent of the wall of the receptaculum where it has come in contact with the downgrowth (*od.*[1]) of the oviduct (*od.*).

It seems probable to me that these appearances indicate the existence of a direct connection between the store of ripe spermatozoa and the upper end of the oviduct, and point to the fact that the ova are fertilised as they pass into the uterus. We may fairly suppose that the ova of one worm are fertilised by the ripe sperm in the receptaculum, and as the latter opens upon the dorsal and the uterus upon the ventral surface, it is difficult to see how the contents of the one pass into the other, unless it be by some such passage as the one indicated. The uterus also is so crammed full with embryos that, unless these are completely ejected before a fresh supply is sent in from the ovaries, it would be very difficult for the spermatozoa to pass up the whole length of the uterus, and so reach the ova before they become invested in their shell membranes, for there is no structure corresponding to the vagina of an ordinary Cestode whereby the spermatozoa enter, independently, the uterus.

I have to thank Dr. Haswell, M.A., D.Sc., of Sydney, for his kindness in supplying me with a specimen of Amphiptyches, and especially for the trouble which he has taken in providing me with a copy of Wagener's paper and illustrations, which were inaccessible to me in Melbourne. I have also to thank Mr. Fletcher, M.A., B.Sc., for his kindness in obtaining for me a copy of Wagener's paper in the Arch. f. Naturgesichte.

* There is an interval of two sections between those represented in figures 1 and 2.

DESCRIPTION OF PLATES.

Plate 11.

Fig. 1.—Diagrammatic representation of an adult specimen of *Amphiptyches*, drawn from the dorsal surface, to show the principal structures. At the anterior end the rosette of folds is seen, and at the posterior the sucker. *eo.* opening to exterior of excretory organ; *mo.* opening of male organs; *n.* lateral nerve cord (this is represented as lying farther away from the median line than it does naturally); *n.* posterior commissure uniting the nerve cords in the region of the sucker; *nr.* nerve ring around the proboscis; *o.* the scattered grape-like ovaries at the anterior end; o^1 central cavity into which the ova pass before reaching the uterus. From this a fine (unlettered) duct is represented as passing to the receptaculum (*rs.*), this may possibly serve as a channel by means of which spermatozoa reach the ova; *p.* proboscis. At the posterior end the letters *p.* and *o.* respectively indicate the papilla on which the vas deferens opens, and the tube leading from this to the male opening. *r.* receptaculum seminis; *r. s. o.* opening of duct running along the dorsal median line to the receptaculum; *s.* sucker at the posterior end; *t.* the scattered testes at the posterior end; *ut.* uterus containing ova enclosed in shells; *vs.* vesicula seminalis into which the ducts form the testes open; *yk.* yelk glands; *x.* 3.

Fig. 2.—The anterior extremity from the ventral surface to show the funnel-shaped opening of the proboscis extruded. *x.* 3.

Fig. 3.—Side view of the anterior end of the body. *p.* proboscis. *x.* 3.

Fig. 4.—Ventral surface of the posterior end, showing, *sc.* the terminal opening of the sucker, *mo.* the opening of the male organs on a papilla, *fo.* the opening of the female organs at the base of the papilla anteriorly. *x.* 3.

Plate 12.

Figs. 1—6.—A series of transverse sections (of which figure 1 is the most anterior) through the region where there is apparently a duct leading from the central cavity, containing ova, to the receptaculum; o^1. central space containing ova; *od.* oviduct leading to uterus; $od.^1$ the supposed duct which in figure 5 has apparently come in contact with the walls of the receptaculum, though no lumen can be clearly distinguished. There is an interval of two sections between those represented in figures 4 and 5; *rs.* receptaculum full of ripe ova; *yk.* the duct of the yelk gland cut in section; in figure 5 it is seen to join the oviduct. Drawn under Zeiss C. oc. 2.

Fig. 7.—Portion of a transverse section in the region of the receptaculum at its anterior end. On the upper side is the central space containing densely packed and clearly nucleated cells—the ova—which here take the stain (borax carmine) more deeply and uniformly than in the scattered ovaries; *ct.* connective tissue forming the "ground substance" of the body; *ov.*[1] ova; *rs.* receptaculum; *x.* problematic nucleated cells amongst the spermatozoa, and which are perhaps to be regarded as sperm-blastophores. Drawn under Zeiss F. oc. 2.

Fig. 8.—Transverse section across an excretory canal. *cut*[1]. the definite cuticular-like lining absent at one point where cilia *(c)* project into the lumen. A longitudinal row of these cilia project into the canal. The cilia are apparently connected with cells, as nuclei can be distinguished at the base of the row, but not the definite outlines of cells. The cilia are massed so as to form the curious flame-shaped structure represented in the diagram; *c.* cilia; *e.* lumen of canal; *nu.* nuclei in the connective tissue surrounding the canal. Drawn under Zeiss F. oc. 2.

Fig. 9.—Section across one of the folds of the rosette at the anterior end of the body. The outer surface lies to the left hand. Both outer and inner surfaces are covered with a definite cuticle; but whilst the epidermic cells on the outer surface are of the ordinary columnar form, those of the inner surface have become largely transformed into distinct glandular cells, considerably shorter than the ordinary columnar ones, and taking stain deeply. Between the two layers lie the muscle layers and the central mass of connective tissue, which is permeated with a network of very fine tubules, non-ciliated, and connected with the excretory system. *ct.* connective tissue; *cut.* cuticle; *e.* excretory vessels; *ep.* epidermic cells of the outer surface; *gc.* gland cells on the inner surface; *mu.* muscle fibres. Drawn under Zeiss F. oc. 2.

Plate 13.

Fig. 1.—Diagrammatic representation of the network of excretory vessels. The reproductive organs are indicated in outline, and in the central part of the body occupied by the uterus the network is much more open than in the lateral regions. *f. o.* opening of female organs; *m. o.* opening of male organs; *n.* lateral nerve cord; *ne.* ring of excretory vessels just below the proboscis; *ne. o.* external opening of the excretory organs; *p.* proboscis; *sp.* duct of spermatheca; *sp. o.* opening of spermatheca; *ut.* uterus.

Fig. 2.—Section through a small portion of the uterus of a specimen containing ova in an early stage of development, and in which ova are still passing into the uterus. In the lumen of the tube are seen many nucleated cells, some of which will form, probably, ova, and others food yelk, and amongst these a yellowish material,

which in places appears to be "running together" to form the shells enclosing the ova. *x*. Portions of the yellow-coloured material of varying size and shape; *sh*. the same material, which has formed a definite "shell"; *sh*.[1] the same material prior to the definite formation of a "shell."

Fig. 3.—Transverse section across the body some little distance behind the proboscis, but anteriorly to any of the reproductive organs. *c*. Dense, somewhat homogeneous mass of consecutive tissue occupying the centre of the body; *circ*.[1] outer layer of circularly disposed muscle fibres; *circ*.[2] inner layer of circularly disposed muscle fibres; *cut*. cuticle; *dv*. dorso-ventral muscle fibres; *ep*. epidermic cells; *n*. lateral nerve cord; *ne*. excretory vessels lying in the central "core" of connective tissue; *yk*. yelk masses.

Fig. 4.—Transverse section through the region of the sucker. *ct. cut*. cuticle; *ep*. epidermis; *hk*. spines protruding from the surface. *n*. lateral nerve cords passing backwards from the transverse commissure at the anterior end of the sucker; *t*. testes; *yk*. yelk masses.

Fig. 5.—Transverse section through a spine, showing the concentric layers of which it is formed, and the special muscles attached to it.

Fig. 6.—Longitudinal section through a spine, showing the point protruding through the cuticle, the concentric layers of which it is composed, and the special muscles concerned in its protrusion and retraction.

Fig. 7.—Figures showing the development of the spines on the embryo. *a*. the youngest form; *d*. the oldest.

Fig. 8.—Part of one of the scattered ovaries in a specimen in which ova are passing into the uterus. The outlines of the cells can be distinguished in nearly all cases.

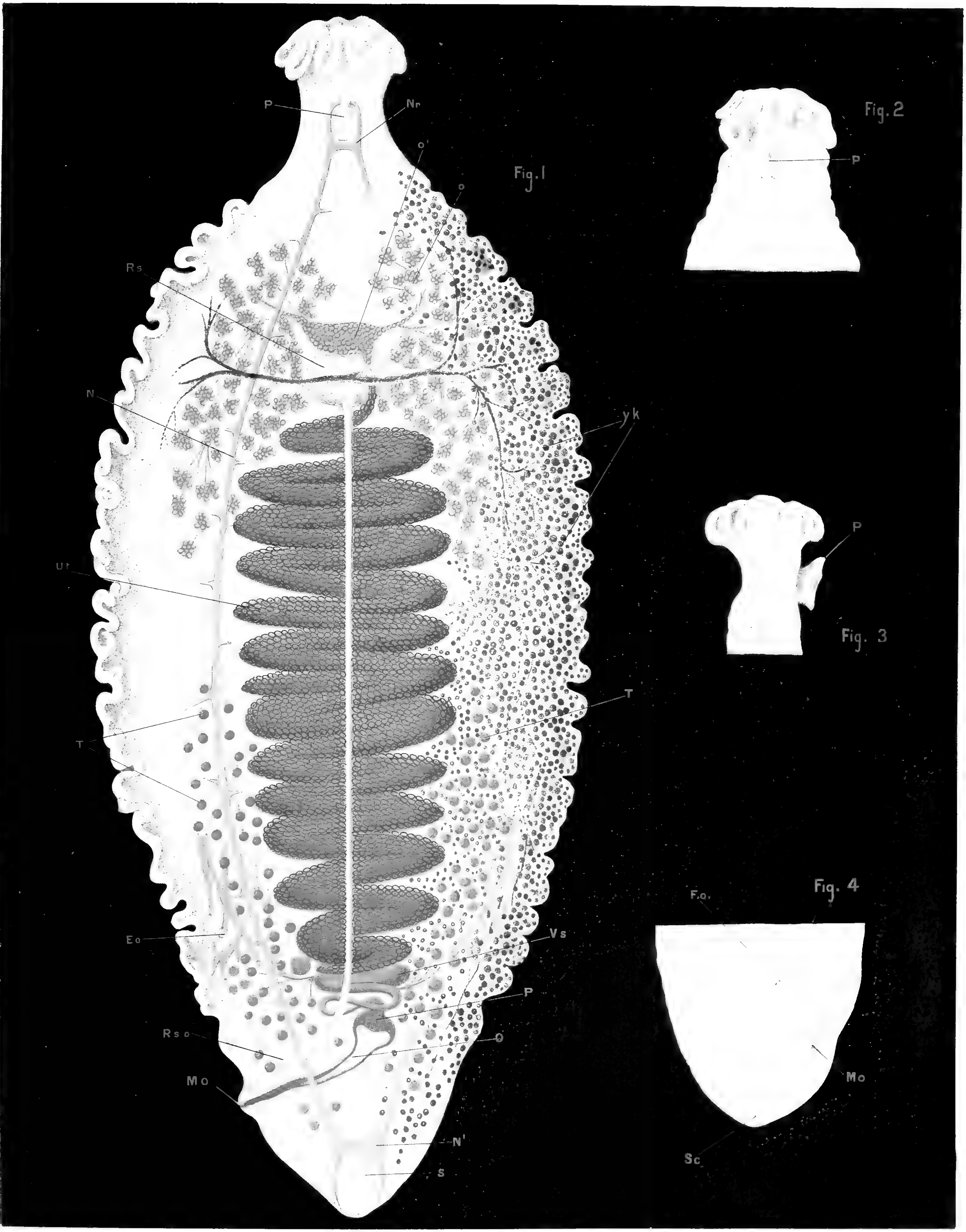
Fig. 9.—Two yelk masses from the same specimen as Fig. 8. Each contains nucleated cells and yellowish globular bodies, corresponding exactly to those found in the commencement of the uterus (*cf*. Fig. 2). *a*. nucleated cells, which will form food yelk; *x*. yellow-coloured material, which will probably give rise to the cell.

Fig. 10.—Three yelk masses, from a specimen in which the uterus is filled with embroyos which have undergone a considerable amount of development. Each forms a mass in which large nuclei are present, but only a comparatively indistinct separation into distinct cells, and no trace of the yellowish shell material.

Fig. 11.—A portion of one of the ovaries of the same specimen as figure 10. The nuclei are large and distinct, with well-marked chromatin masses, but the outline of cells is scarcely to be distinguished, the mass forming a syncytium. The nuclei have the appearance of undergoing division. *o.* nuclei ; *sy.* mass of protoplasm.

Fig. 12.—One of the testicular masses, showing the spermatozoa in various stages of development in the same mass. The wall is lined by an irregular mass of cells (1), from which apparently cells drop off into the cavity and become, by division of the nucleus, polynuclear masses (2), from which the spermatozoa are gradually developed (3, 4, 5, and 6).

Fig. 13.—An embryo from the uterus, encased in the shell and provided with a circlet of 10 hooks. *sh.* shell ; *h.* hooks ; very numerous nuclei lie close to the outer wall, and the inner part is apparently crossed by irregular strands of protoplasm, though this may perhaps be the effect of reagents.



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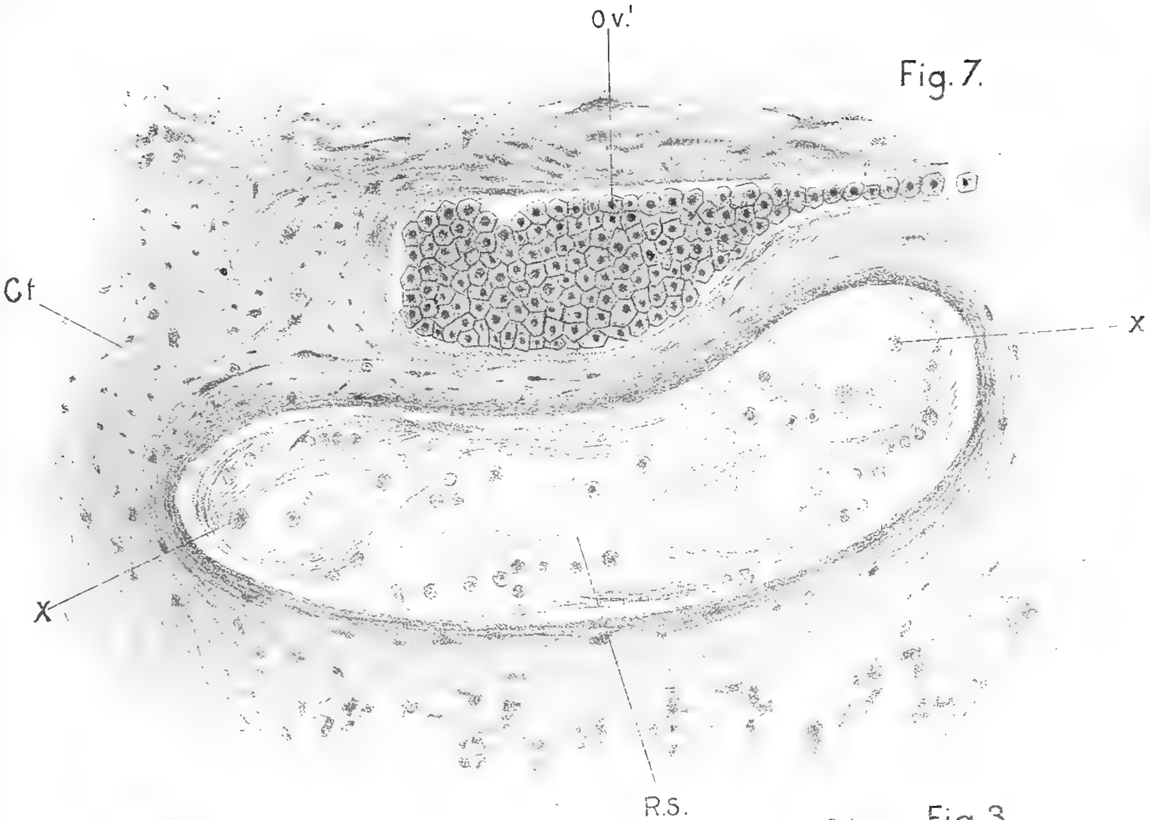
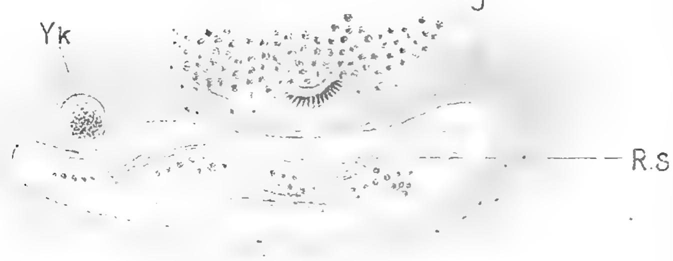


Fig. 7.



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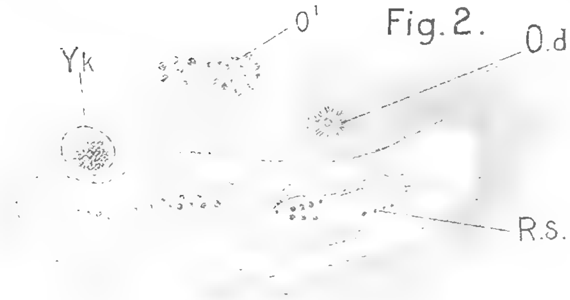


Fig. 2.

Fig. 3.

Fig. 8.

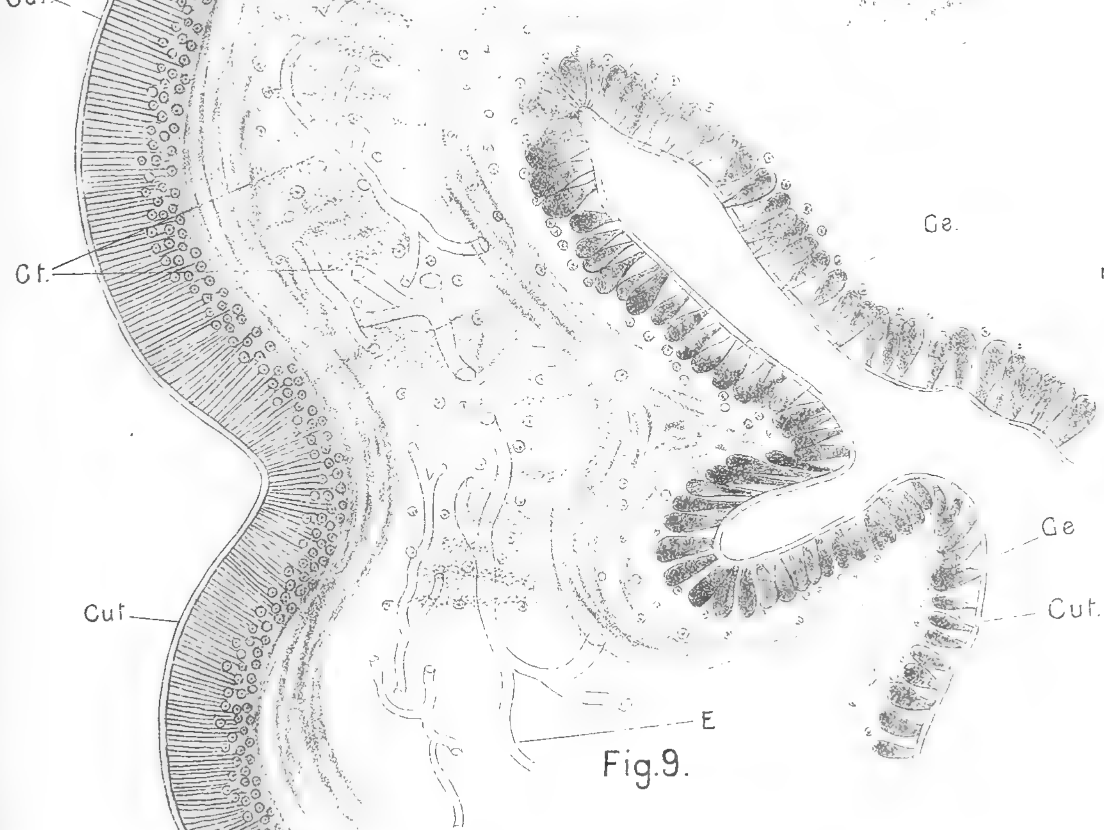


Fig. 9.

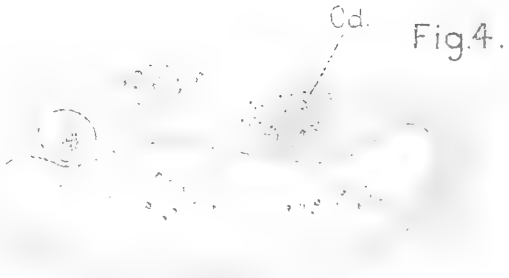


Fig. 4.

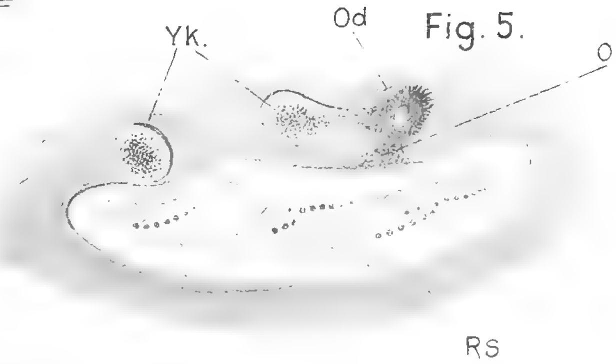


Fig. 5.

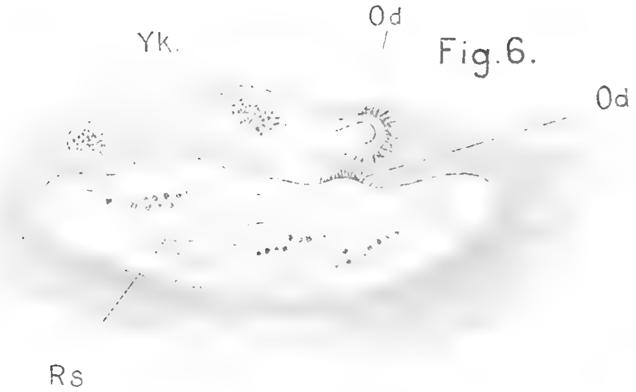
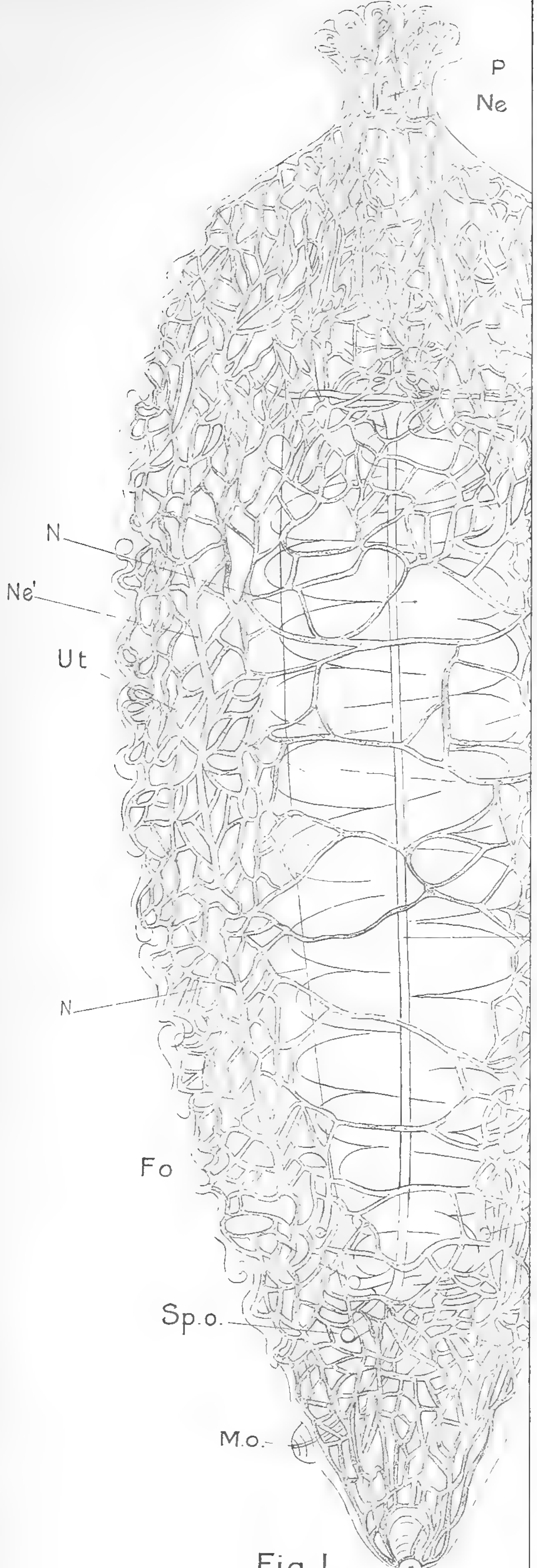


Fig. 6.



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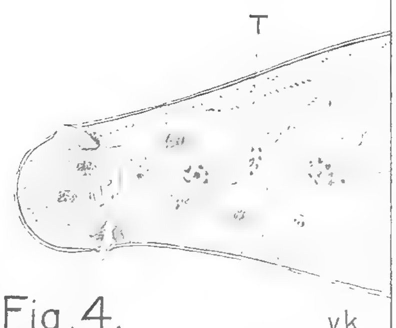

Fig. 4.

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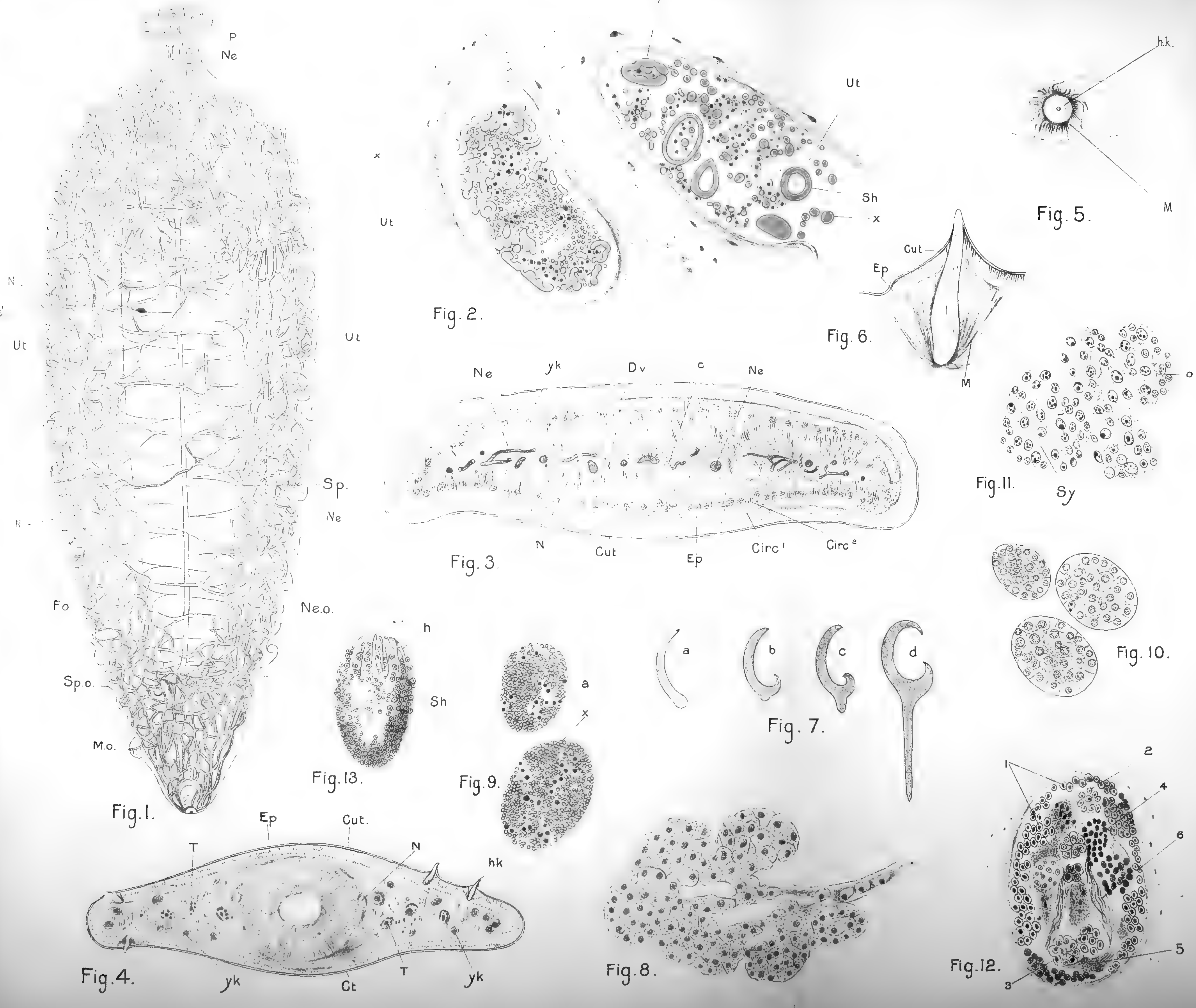

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