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Notes *on the* Structure *of* Several Forms *of* Land Planarians, *with a* Description *of* Two New Genera *and several* New Species, *and a* List *of all* Species *at present known*.

By H. N. Moseley, M.A., F.R.S., Fellow of Exeter College, Oxford. (With Plate XX.)

Having made a special study of the structure of the Land Planarians of Ceylon, the results of which were published in the 'Phil. Trans. R. Soc.' of 1874,[1] I was naturally led to extend my observations of the group during the voyage of H.M.S. 'Challenger.' I collected specimens wherever the opportunity offered, and made such observations on them as my other work permitted. The present paper contains the results of these observations, which are very far from complete, since I have not yet been able to make an extended investigation of all the specimens which I preserved for that purpose.

Land Planarians of Brazil.

In September, 1873, during the stay of H.M.S. 'Challenger' at Bahia, I found abundance of a species of Geoplana, apparently hitherto undescribed, and a single specimen of a second species undetermined was found by Dr. von Willemöes-Suhm. The new species, *Geoplana flava*, was found in moist shady places in the neighbourhood of Bahia, and especially beneath the sheathing bases of the leaves of Bananas, which retreat is that selected also most usually by the Ceylon land planarians of the genera *R. Rhynchodemus* and *Bipalium*. A few specimens were also found crawling on palm stems in the daytime in very rainy weather, but in places where there was very little light.

I repeated the experiments made by Fritz Müller as to the ciliation of the surface of the animals, using, however, very small fragments of paper to place on the animal to indicate the direction of currents, instead of arrow-root meal, and with a somewhat different result.

Fritz Müller ("Beiträge zur Kenntniss der Landplanarien," Dr. Max Schultze, 'Abhn. der Naturforschenden Gess.,' in Halle 4 Bd.) found that the meal moved on the dorsal surface of the animal forwards and somewhat outwards, on the ventral surface backwards. When the animal was resting in a contracted and quiescent state, I found that no ciliary motion was shown on the

[1] "On the Anatomy and Histology of the Land Planarians of Ceylon; with some Account of their Habits, and a Description of Two New Species, and with Notes on the Anatomy of some European Aquatic Species." By H. N. Moseley, 'Phil. Trans. Roy. Soc.,' 1874, p. 105.

dorsal surface at all, but that immediately the animal began to crawl the indicating fragment of paper began to move.

In the species examined by me the ciliary action had a forward direction only in the anterior region of the dorsal surface, in the posterior region the indicator moved always backwards towards the tail. In all regions of the dorsal surface it moved outwards, as was observed by Fritz Müller at the same time as backwards or forwards, and was thus rapidly thrown off at the side of the body, the dorsal cilia apparently subserving especially, this function of the speedy removal of foreign substances from the surface of the body. The ciliary current on the under surface of the body flowed directly from before backwards, so that the indicator moved parallel to the middle line of the body. The current was much more rapid towards the hinder extremity.

The animal moved to a large extent by muscular action, the body alternately contracting and expanding during motion. When moving it lifted its anterior extremity often, just as does Bipalium, and moved it to and fro as if to feel or see its way.

When the anterior extremity of the body was cut off the remainder of the animal seemed still to move with definite purpose, avoiding obstacles and retreating from the light, whilst the cut end was raised and thrust in various directions as if to search for an object on which to climb.

Eye-spots were present in two elongate patches on either side of the head, and scattered along the whole length of the body on its lateral margins.

A transverse section of the fresh animal was examined in saliva. Cilia were present over the entire dorsal surface of the animal, but are there very short and difficult to see, whereas they are very long and strong on the ventral surface. The free surface of the gastric lining of the digestive canals was ciliated.

Large cells were seen in the parenchym of the body, which had a finely granular content, with a nucleus and nucleolus. These cells showed active amœboid movements when isolated by pressure, and at the same time a rapid movement of their granules somewhat like a cyclosis.

The pigment present was in the form of small rounded masses as in Bipalium.

Unfortunately no specimens of the geoplana were obtained which had their generative organs fully developed, all the specimens being young.

The muscular arrangement appears to resemble that occurring in the New Zealand Geoplana. There is no ambulacral line, the external longitudinal muscles are evenly developed all over the sole or under surface, and but little over the dorsal region. The lateral organs or primitive vascular system are diffuse and closely

similar to those in Geoplana N. Zealandiæ. Rod-cells closely similar to those of the South African land planarians were observed in this species. They contain each several long spirally-wound rods (Pl. XX, fig. 15). Others occur (Pl. XX, fig. 14) in which the rods are short and straight. Cells were observed with the rods in all stages of development (Pl. XX, fig. 16). The rods when short show a tendency to spiral winding.

Description of the Structure of a New Zealand Land Planarian, Geoplana Traversii.

Captain Hutton, in his essay on the New Zealand fauna, mentions the occurrence in New Zealand of two or three species of Land Planarians, one or two of which he states belong to the genus Bipalium.[1] This short reference is as far as I know the only notice of these Planarians which has hitherto been published.

When H.M.S. 'Challenger' was at Wellington, Mr. W. T. L. Travers, F.L.S., gave me two specimens of a species of Land Planarian occurring in the neighbourhood of Wellington. Both of these were sexually mature and in sufficiently good preservation to enable me to make out the anatomy of this form with considerable completeness.

The Planarians are of elongate form, broadest in their middle and gradually attenuated from thence towards either extremity. They are flattened below and slightly rounded above, and thus resemble the other members of the genus Geoplana in general form. The body is marked with longitudinal stripes, as in most Land Planarians. The length of the largest specimen obtained was 3 cm., and its extreme breadth 8 mm.

The mouth, or opening of the sheath of the pharynx, is placed in the centre of the body and the generative aperture at a little less than half the distance between the mouth and the posterior extremity. There is no ambulacral line, the whole under surface acting as one uniform muscular sole.

Numerous eye-spots are present; these are placed in a single row composed of twelve or more along the front margin of the head and in an elongate patch on either side of the head made up of two or three rows placed one above another, and containing about forty eye-spots (Pl. XX, fig. 1). Eye-spots are further scattered more sparsely on the lateral margins of the body, along its entire length posteriorly to this patch.

The patch itself is thickly beset with pigment which has an irregularly ramified disposition, but amongst which clear trans-

[1] The Geographical Relations of the New Zealand Fauna," by Captain F. W. Hutton, C.M.Z.S., 'Trans. New Zealand Inst.,' vol. v, 1872, p. 23.

parent oval spaces entirely free from pigment occur, and in these the eye-spots lie (Pl. XX, fig. 2).

In the structure of the eye-spots and histology generally the New Zealand Planarian closely resembles *Bipalium* and *R. rhynchodemus*.

Observations on the living animal and fresh structures were made on two small living specimens of another species obtained at Wellington.

Strong cilia are present on the ventral surface of the body, as was seen by examining sections of the fresh animal in saliva and by applying the test of a small foreign body as in Geoplana; but cilia if present on the dorsal surface are very small and could not be detected either by direct observation or experiment.

Numerous rod-bodies were observed to be shot out of a fresh section just as in Geoplana, but the rod-cells were not isolated successfully. The rod-bodies, which are long and thread-like when shot, are well preserved in reagents and are to be seen in sections set up in Canada balsam, the epidermis being in some places covered with a felt of them.

Abundance of pigment of the same nature as that of Bipalium is present. Much of it often occurs deep in the tissues beneath the external systems of muscles (Pl. XX, fig. 8, p.)

The arrangement of the superficial muscles is peculiar, and differs from that in other Land Planarians, probably even from that existing in the American Geoplanas. A thin layer of circularly directed muscular fibres, the external circular muscular coat, is present as in Rhynchodemus and Bipalium, situate immediately beneath the epidermis, and beneath this lies a layer of longitudinal muscles disposed in a series of bundles of fibres homologous with the external longitudinal coat of Bipalium. This set of longitudinal muscles is very little developed on the dorsal region of the body, but excessively so over the whole ventral region or sole, as will be seen from Pl. XX, fig. 8. This set of muscles is developed nearly uniformly over the sole, and there is no indication of any specialisation of an ambulacral line.

The external longitudinal muscles are evidently in this Planarian the main muscles of locomotion, and take upon themselves a great part of the function which in Bipalium is performed by more deeply situate longitudinal fibres.

An enlarged view of the arrangement of the muscular fibres is given in Pl. XX, fig. 9, from which it will be seen that the bundles of external longitudinal fibres are separated by radiating fibres which pass outwards to join the external circular layer. A layer of internal transverse or circular fibres succeeds an interval occupied by radiating fibres only, and scattered over this are

to be seen in section numerous longitudinal fibres of the internal longitudinal set.

The arrangement corresponds very nearly with that occurring in Rhynchodemus ('Phil. Trans.,' l. c., Pl. XI, fig. 2), except in the extraordinary development of the external longitudinal muscular layer.

Embedded in the inner muscular structures is an abundance of a matter which appears to correspond to the glandular tissue of Bipalium, and like it stains very deeply with carmine. In the lower regions of the body it forms large ramifications.

In the region of the body lying around the sheath of the pharynx and that of the generative organs a glandular tissue is present in great quantity, filling the interstices between the deeper muscles (fig. 8, *g*).

The structure marked x in fig. 8 is evidently homologous with the spaces present in Bipalium sections, which were considered to represent the primitive vascular system with the nervous system probably lying in them ('Phil. Trans.,' l.c., Pl. X, fig. 5, *w*). As in Bipalium these structures in the present species stain very slightly with carmine. Instead of being confined to two circumscribed areas in a vertical section, however, as in Bipalium, or to two such areas connected by a transverse link, the structures here assume the form of an irregular band stretching across the entire width of the vertical sections.

I have been unable to examine these organs in longitudinal sections for want of sufficient material. I cannot come to any certain conclusion as to what they represent, but think it probable that they may represent a diffuse and ill-differentiated nervous system, since well-developed nervous structures such as occur in Marine Planarians, such as Eurylepta, are certainly wanting in all the genera of Land Planarians examined by me. The portions of the structures in question, situate in the region near the position of the oviducts (Pl. XX, fig. 8, *od*), agrees in histological construction closely with the homologous areas in Bipalium, showing a fine reticulation of fibres whilst their continuations on either hand show a fibrillation in the direction of the plane of the section, so that it would appear as if in the region of the oviduct bodies of fibres and canals having a longitudinal direction in the animal's body were cut across, and that these longitudinally directed cords or canals gave off transverse branches, which appear in the sections as the horizonal extension of these lightly stained areas. As already described, a similarly diffused nervous system or nervous system and primitive vascular system appears to exist in the S. American Geoplanas. In the present form it occupies a much wider space in the head of the animal, just as in Bipalium ('Phil. Trans.,' l.c., Pl. XIV, fig. 7),

but does not there give evidence of any more elaborate structure. I am uncertain as to the exact nature of this structure in the Land Planarians, and at a loss to explain how it is that these forms should not possess a nervous system at least as highly differentiated as that of Eurylepta.

The digestive system is essentially similar in structure to that in other Land Planarians. There is a single mesially placed main digestive tube in the front of the body which divides into two at the point of entrance into it of the pharynx and remains double to the hinder extremity of the body, the two tubes embracing between them the cavity of the pharynx and the sheath containing the mass of the generative organs (Pl. XX, fig. 3). The two tubes remain without communication with each other to the extremity of the body. The lateral diverticula are given off as in *Rhynchodemus*. Very short rudiments of diverticula are, however, present on the inner sides of the two posterior main digestive tubes which are not present in *Bipalium* or *Rhynchodemus*.

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.

The pharynx is of the same simple cylindrical form as in Rhynchodemus, and is contained in a sheath or cavity just as in other land planarians.

The main mass of the generative organs is packed in an elongate cavity, with well-developed special walls situate just behind that containing the pharynx. Within this cavity the organs are further protected by a second investment of tough membrane which divides them up into four rounded masses disposed in a series or chain (Pl. XX, fig. 4, *a*, *b*, *c*, *d*.)

The organs consist of a bulbous vesicula seminalis situate most anteriorly in the elongate cavity, from which vesicula a tortuous and capacious ejaculatory duct leads to the large bulb of the penis. An accessory bulb or sac is present in connection with the penis and lower part of the male duct (Pl. XX, fig. 5, *x*), the exact relations of which to the penis were not determined.

The penis is protruded from the single generative aperture, and from this the vagina also opens, leading to the simple ovoid uterus which is situate most posteriorly in the cavity containing the generative organs.

In the four masses into which the generative organs are bound up by their immediately investing sheath the most posterior

mass consists of the uterus; the next contains the accessory bulb of the penis; the next the bulb of the penis itself and part of the ejaculatory duct; and the fourth or most anterior the vesicula seminalis and upper part of the duct.

There is a single pair of ovaries present, and these organs are situate at a distance from the anterior extremity of about one sixth the length of the body, on either side of the main digestive canal and close to the outside of its wall (Pl. XX, fig. 3, *o*). The oviducts spring from the outer sides of the ovarian sacs and pass directly down the length of the body to reach the uterus, maintaining a similar position in the deeper muscular structures to that which they hold in Bipalium and Rhynchodemus, as is seen in Pl. XX, fig. 8, *o*, *d*.

The testes consist of very numerous small ovoid bodies which are so dispersed as to form a band stretching from a point just posterior to the position of the ovaries to the level of the hinder end of the pharynx. A wide vas deferens, which is tortuous, as in Bipalium and Rhynchodemus, leads from the hinder end of the testes transversely inwards to the vesicula seminalis. The oviducts pass above the vas deferens in their course to the uterus.

Together with the two specimens of planarians Mr. Travers brought me preserved in the same spirit several of their egg capsules. These capsules were perfectly spherical and varied in diameter from 6 mm. to 4½ mm., being as large as an ordinary pea. Their walls were firm and resistant, and of a very dark brown or almost black colour. The walls are composed of a thin continuous sheet of a dark brown chitinous substance, which is highly elastic and rolls up into scrolls when torn into fragments. The brown substance shows no definite structure, but only fine granules partly scattered evenly through a homogeneous base, partly gathered into patches in it.

The egg capsules were found to contain from four to six embryos (Pl. XX, fig. 7), which lay quite free within the cavities of the capsules, and closely packed together, being curved up to accommodate themselves to the confinement. In one capsule the embryos were in a comparatively early stage. They were in form much wider in proportion to their length than the adults, and flatter, resembling more in form aquatic planarians.

In the more advanced stages the embryos were of nearly the same form as the parents, and had their oral apparatus already well developed. Each had further a pair of broad dark stripes on its dorsal surface, the stripes being disposed so as to leave a mesial light band between them. This colouring does not correspond with that of either of the adult species which I examined. It may change with advancing development, or the egg capsules may have

belonged to another species. The method of reproduction of the land planarians thus is closely similar to that obtaining in aquatic forms, such as *Dendrocalum lacteum*, and is such as it was conjectured that it would prove to be ('Phil. Trans.,' l. c., pp. 139, 141).

Australian Land Planarians.

I have been able to find no published description of these forms, for the reception of which I have made the new genus *Cœnoplana*. They are remarkable for their length, one species, *Cœnoplana subviridis*, attaining to a length of 17·5 cm., and in this respect they form a step towards the Manilla Dolichoplanas from the Geoplanas, which they resemble in the arrangement of the eyes. 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 single pair of larger eyes.

The specimens procured were found in New South Wales, at Parramatta and at Camden Park. They were found during the day coiled up in cavities under fallen logs, and at night, observed with a lantern, crawling in the trunks of Eucalyptus trees, especially about wounds from which sap was exuding.

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. The blue colour changes to red when the pigment is acted on by acids, but the red colouring matter of *C. sanguinea* does not become blue, as might possibly have been expected, when acted on by alkalies.[1]

At Aru, Ke, and Amboina, land planarians were not found, though searched for carefully.

At Ternate one specimen of the form of a Ceylon Rhynchodemus was met with under the bark of a tree at an elevation of about 2000 feet. The planarian was of a bright yellow, with a single, median, narrow, dorsal, black stripe, extending the entire length of the animal. It was more lively than any land planarian which I have hitherto seen, wriggling out of a box or the hand with great quickness. The specimen, unfortunately, perished almost entirely from not having been placed in alcohol soon enough. Enough remained to show that it had a remarkable

[1] "On the Colouring Matters of Various Animals, and especially of Deep Sea Forms, dredged by H.M.S. Challenger." By H. N. Moseley, 'Quart. Journ. Micro. Science,' Vol. XVII, new ser., p. 1.

abundance of nematocysts, and that the mouth is simply elongate cylindrical, as in Rhynchodemus.

Its wriggling motion seems to point to the occurrence in it of greatly developed external longitudinal muscular bundles all over the body surface, as in Dolichoplana.

Land Planarian of Manilla—Dolichoplana striata.

I obtained three specimens of a land Planarian, for which I propose the above name, at Manilla, from a resident in the city. The Planarian is most remarkable for its great length and proportionately small breadth. The longest specimen of the three in the contracted condition in spirit was 19·5 cm. in length, and the shortest 12 mm.; while the average breadth of the specimens was only 3·5 mm., and the thickness 2 mm.

The Planarians are long, narrow, flattened and band-like, tapering rapidly to a blunt point at either end. The measurements of the three specimens, showing the position of the mouth and generative aperture, are as follows:

	a.	*b.*	*c.*
Anterior extremity to mouth. Distance	5·25 cm.	5·5	6·5
Mouth to generative aperture. Distance	5·5 „	6·1	4·7
Generative aperture to tail. Distance	9·25 „	5·5	4·7
Total lengths	20·0	17·1	15·9

The relative positions of the organs thus vary very much in the different specimens, probably because of unequal contraction due to the action of the spirit.

The bottle containing the specimens unfortunately got broken on board the ship in a gale of wind, and the specimens dried up, and are now unfit for anatomical examination; but some few sections had been prepared before the accident, and thus some facts as to the anatomy were determined.

Notwithstanding the extreme length of the body the ovaries are situate near its anterior extremity, as in Rhynchodemus, and hence the oviducts have to traverse an enormous distance in order to reach the uterus. They must be 9 or 10 cm. in length.

A single pair of eyes only is present, as in Rhynchodemus. These are placed laterally, close to the anterior extremity.

The genus is especially remarkable for the extraordinary development in it of the external longitudinal muscular layer which occurs all over the body, being especially marked in the dorsal region, as will be seen from Plate XX, fig. 25. The longitudinal muscular fibres form very compact well-defined bundles, which are conspicuous in transverse sections of the animals, and are separated from one another by stout radial muscular bundles. The

bundles of external longitudinal muscles are especially large in the lateral regions of the dorsal and ventral surfaces of the body. They are less fully developed at the actual lateral margins of the body and about the middle line of both dorsal and ventral surfaces. The bundles on the dorsal surface are more fully developed than those on the ventral, the exact reverse thus here occurring to the condition obtaining in the New Zealand land planarian, the arrangement being, however, very like that occurring in the Australian form of the group.

A broad, pale band on the ventral surface of the animals seems to represent an ambulacral line, but I have not found special internal muscular structures corresponding with it. Possibly the band is due to the presence of long cilia. In a transverse section of the body a zone occupied only by radial muscular fibres, succeeds the layer of external longitudinal muscles internally. Within this zone, in the ventral region of the body, is a mass of internal longitudinal muscular fibres, irregularly disposed (Plate XX, fig. 25, *ilm*); at the ventral edge of which mass is a row of specialised bundles of longitudinal fibres, resembling those of the external longitudinal layer (fig. 22, *a*). This row of bundles extends to beyond the region of the ovary on either side. Some transversely directed fibres intervene between the row and the external longitudinal bundles in the region of the ambulacral line (fig. 25, *b*). There seem to be hardly any longitudinal muscles developed in the dorsal region of the body besides those of the external layer.

Strong bands of transversely directed muscles pass across the body immediately above and below the digestive cavities, strengthening their floors and roof (fig. 25, *trm*). These transverse fibres, which must be regarded as representing the internal circular muscular system, lap round the outer ends of the diverticula with a few of their fibres, as seen in fig. 25. Strong vertical fibres pass on either side of the main digestive canals and traverse the interspaces between the internal longitudinal muscles to join the radial fibres, with which they are continuous, in the dorsal and ventral regions of the body.

The lateral organs (Plate XX, fig. 25, *x*) are very like those of Rhynchodemus in structure. The position of the oviduct with regard to them is the same as in all other Land Planarians; as is also that of the testis.

The digestive diverticula were observed to ramify very freely in the fore part of the body, apparently to a greater extent than they do in Rhynchodemus.

Land Planarians of South Africa.

Two species of Land Planarians were obtained at the Cape of Good Hope, a region from which they had been supposed to be absent, Grube having laid stress on their absence from Africa, and consequently supposed correspondence in distribution with the land leeches.[1]

The Planarians were found in the grounds of the Astronomical Observatory at Wynberg, Cape of Good Hope.

Sections of the fresh tissues were examined. When a vertical section was pressed slightly under a covering glass, elongate, rod-like bodies were shot out from the surface of the skin, and seen to project from it in great numbers. Amongst the rods also were seen masses of slime ejected by the slime glands, which I have described as existing in the Rhynchodemus and Bipalium ('Phil. Trans.,' l.c., p. 121), and which I here observed in action (Pl. XX, fig. 24). The long rods (Pl. XX, fig. 23) are contained, when quiescent, within ovoid transparent cells, in which they are coiled up in an irregularly spiral manner.

Three or four rods are present in each cell, and the rods are shot clear of the cell when it ruptures and ejects them. There is hence no further point of resemblance here brought out between the rod-cell and the nematocysts of Cœlenterates (Pl. XX, figs. 19 and 20). The ends of the rods when free show a tendency to bend over and curl up. Rod-cells also occur in these species of Rhynchodemus, as in all aquatic Planarians in which the rods are short and straight, and not twisted spirally.

Diagnosis of two new genera and nine new species of Land Planarians.

Genus Geoplana.

1. *Geoplana flava*, sp. n. (Pl. XX, fig. 10).—Body elongate, flat beneath, only slightly convex above, attenuate at both extremities, the anterior terminating bluntly. Body of a clear light yellow colour on the dorsal surface, shading into burnt sienna colour at the two extremities and the lateral margins. A glistening white stripe passes along the entire length of the back along the middle line, reaching to the tip of the head. Four narrower similar stripes are present on either side of the mesially placed one, and extend along the body parallel to it. Eye-spots are present in two elongate, irregular patches, one on either side, near the anterior extremity, and scattered sparsely on the lateral margins for the entire length of the animal.

[1] Ed. Grube, 'Ueber Land-Planarien, Jahresbericht der schlesischen Gesells. für Vaterländ. Kultur,' 1866, p. 61.

Under surface pale yellowish. Length, 3 cm.; breadth, 5 mm. Mouth at about the centre of the under surface.

Bahia, Brazil.

2. *Geoplana Traversii*, sp. n.—Body elongate, flat beneath, slightly convex above, bluntly pointed posteriorly, more gradually attenuated anteriorly; broadest in the centre. Mouth central in position. Generative aperture situate at little less than half the distance between the mouth and posterior extremity. Ambulacral line absent, the whole under surface acting as a sole.

Eye-spots forming a single row of ten or so on the front of the anterior extremity, and an elongate patch composed of two or three rows on the lateral margin of the body, just behind the anterior extremity; also present, sparsely scattered, on the lateral margins of the body for its entire length.

Body of a pale yellow on the lateral margins, with a broad mesial stripe on the dorsal surface, extending for its entire length, of a dark chocolate colour, and four narrow, ill-defined, and somewhat irregular similarly coloured stripes on either side of it, extending to the lateral margins of the body. Under surface pale yellow.

Length of largest specimen contracted in spirits, 3 cm.; extreme breadth of same, 8 mm.; length of pharynx of same, 3·5 mm.

N.B.—The above description applies to two specimens received at Wellington from Mr. Locke Travers, in spirits.

Two other specimens, obtained from him at the same time, also in spirit, agree with the above description in all respects, excepting that they have, curiously enough, a pair of well-defined, dark, longitudinal stripes, on the under surface of the body.

Further, two living specimens of a Geoplana were obtained at Wellington by collectors from the 'Challenger,' which were each 2·5 cm. in length. They were of a fine rich yellow colour along the sides, with a broad mesial longitudinal stripe of very dark chocolate on the back, which was seen by the aid of a lens to consist of reticularly arranged pigment, denser along a narrow median line towards the head and at the verges of the broad band. The under surfaces were pale yellow with reticulations of pale brick-red pigment. These latter may have been the young of *G. Traversii*, and the specimens with striped soles varieties of the same. Or two further species may be here represented. The egg capsules obtained seem to have been certainly of a distinct species from *G. Traversii*, since the embryos contained in them have a light mesial dorsal stripe bounded by dark stripes on either side. It is hoped that some resident New Zealand naturalist may investigate the species of Land Planarians of the island.

Genus Cænoplana—Gen. nov., Moseley.

Body long and wormlike, 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.

Habitat.—New S. Wales.

1. *Cænoplana cærulea*, sp. n., Moseley. Entire body of a dark Prussian blue colour, somewhat lighter on the under surface of the body and with a single, narrow, mesial, dorsal, longitudinal stripe of white. Length 5 cm., extreme breadth 4 mm., mouth central; generative aperture 8 mm., posterior to the mouth. Parramatta, near Sydney. Under the bark of a species of Eucalyptus.

2. *Cænoplana sanguinea*, sp. n., Moseley.—Closely resembles C. Cœrulea, with the exception that it is coloured of a uniform light red, which is lighter upon the under surface of the body. Actual length when living 7 cm.; breadth 4 mm. Parramatta, near Sydney. Amongst earth at the roots of a Eucalyptus stump.

3. *Cænoplana subviridis.*—Ground colour of the body greenish yellow beneath. In the mesial line of the dorsal surface is a broad band of the ground colour, bordered on either side by a somewhat narrower but very sharply defined intensely black band. Beyond the black bands externally on either hand lie bands of the ground colour of equal breadth to them; and beyond these again is a very broad band which extends outwards nearly to the lateral margin of the body, which band is composed of a shading of fine longitudinal streaks of reddish brown, and is bordered on either side by a narrow dark, nearly black, margin, the inner border being more intensely pigmented of the two. The bands and lines become narrower and more indistinct towards ths posterior extremity, and eventually blend. The immediate anterior extremity of the animal is of a bright burnt sienna colour, darker towards the tip. Length of largest specimen when living and crawling 16 cm.; breadth 4 mm.; length of smaller specimen when crawling 12·5 cm. Camden and Parramatta, N. S. Wales. Under dead logs and on bark of Eucalyptus trees.

Genus Dolichoplana, gen. nov., Moseley.

Body extremely long and narrow, flattened, and band-like-tapering to a blunt point at either extremity. Mouth situate at a distance from the anterior extremity of about one third the length of the body. Generative aperture at about the same distance posterior to it. Eyes two only, as in Rhynchodemus. External longitudinal muscular bundles very much developed all over the body, but especially in the dorsal regions, where they are the only longitudinal muscles present. Ambulacral line slightly indicated. Lateral organs as in Rhynchodemus.

Habitat.—Philippine Islands.

Dolichoplana striata, sp. n., Moseley. Body of a light olive-brown colour, with two narrow black longitudinal stripes on the dorsal surface. The pair of bands nearest the middle line are sharply defined and are separated from one another by a broad mesial band of the ground colour of the animal.

The outer pair of bands is less distinctly defined. The bands are placed on the lateral margins of the body and are separated by wide intervals from the inner pair.

Three spirit specimens varied in length between 19·5 cm. and 15·9 cm., and in breadth measured about 3·5 mm.

Three specimens only, found in the neighbourhood of Manilla, were obtained in spirit from a resident in that city.

Genus Rhynchodemus, Leidy.

1. *Rhynchodemus flavus*, sp. n. Moseley (Pl. XX, fig. 20).—Body of the usual form but much attenuated anteriorly, of a uniform light yellow colour, with a narrow jet black, wavy mesially placed dorsal line. Length about 4 cm. The Observatory Grounds, Cape of Good Hope.

2. *Rhynchodemus fuscus*, sp. n., Moseley (Pl. XX, fig. 19).—Body rather blunt-ended anteriorly, of a flesh colour, with a pair of broad bands of mottled brown placed on the dorsal surface so as to leave between them a narrow mesial light stripe, with a light patch at the anterior extremity. The bands do not extend quite to the lateral margins of the body. Length, about 1·5 cm. The Observatory Grounds, Cape of Good Hope.

Genus Bipalium, Stimpson.

Bipalium unicolor, sp. n., Moseley. Body of the usual form, but with the semilunate anterior expansion of moderate development only. The entire body of a uniform orange-yellow colour, lighter on the ventral surface. The anterior margin of the semilunate expansion dark, almost black. Length of spirit specimen, 6·5 cm. Greatest breadth, 7 mm.

Zamboangan Mindonao Philippines.

Catalogue of the species of Land Planarians at present known.

Group.—Monogonopora, Stimpson.

Family.—Leimacopsidæ, Diesing.

Genus Leimacopsis.—Diesing, Revision der Turbellarien, Abtheilung Dendrocœlen, Sitzbt. Akad. Wiss., Wien, 1861, p. 488.

Leimacopsis terricola.—Diesing, l. c.

Prostheraceus terricola.—Schmarda, 'Neue Wirbellose Thiere,' Th. 1, 1—30, Tab. VI, fig. 69.

With a pair of true frontal tentacles beset with numerous eyes. Occurs high up in the Andes at the pass of Quindiu, above the region of mountain palms.

Family Geoplanidæ.

Genus Polycladus.—Blanchard, Historia Fisica y Politica de Chile por Claudio Gay, Fauna Tomo tercero.' Paris, 1854, p. 6.

1. *Polycladus Gayi.*—Chile. Blanchard, l.c. Pl. Annilados, No. 3.

The body is much flattened. Blanchard gives some details of anatomy, but he mistook the head for the tail of the animal. The generative organs are situate further from the mouth than in Geoplana N. Zealandiæ. It is possible that this genus of the Western side of the Andes may prove a natural and distinct one.

2. *Polycladus Andicola.* — Schmarda, 'Neue Wirbellose Thiere,' 1, 1—15, Tab. II, 31 and 31 *a*.

Schmarda refers this Andean species to the genus. The body is flat and oblong. He is evidently in error in speaking of two generative apertures as present in front of the middle of the body.

Genus Geoplana (Stimpson and Max Schultze). Stimpson, Prodromus descriptionis animalium evertebratorum quæ in expeditione ad Oceanum Pacificum Septentrionalem, &c. Pt. 1, Turbellaria Dendrocœla, Proc. Acad. Philad., 1857, p. 19.

Max Schultze, Beiträge zur Kenntiss der Land-Planarien nach Mittheilungen des Dr. Fritz Müller, in Brasilien und nach eigenen Untersuchungen, Halle Abdhn., 1856, p. 20.

1. *Geoplana vaginuloides.*—Rio Janeiro. Darwin, 'Ann. and Mag. Nat. Hist., vol. xiv, 1844, p. 241 = *G. elegans*, Brazil, Fritz Müller and Max Schultze, l.c.

2. *Geoplana elegans.*—Rio Janeiro. Darwin, l.c.

3. *Geoplana pulla.*—Montevideo and Maldonado. Darwin, l.c. = *G. olivacea*? or G. Maximiliana? Brazil, Fritz Müller and Max Schultze, l.c.

4. *Geoplana bilinearis.*—Montevideo and Maldonado. Darwin, l.c.

5. *Geoplana nigrofusca.*—Montevideo and Maldonado. Darwin, l.c.

6. *Geoplana pallida.*—Valparaiso. Darwin, l.c.

7. *Geoplana tristriata.*—Brazil. Fritz Muller and Max Schultze, l.c.

8. *Geoplana octostriata.*—Brazil. Fritz Muller and Max Schultze, l.c.

9. *Geoplana Schultzei.*—Brazil. Diesing, l.c.=*G. pallida*, Fritz Müller and Max Schultze, l.c. (not *Planaria pallida* of Darwin).

10. *Geoplana atra.*—Brazil. Fritz Müller and Max Schultze, l. c.

11. *Geoplana Mülleri.*—Brazil. Diesing, l. c.=G. elegans, Fritz Müller and Max Schultze, l. c. (not *Planaria elegans* of Darwin).

12. *Geoplana marginata.*—Brazil. Fritz Müller and Max Schultze, l. c.

13. *Geoplana rufiventris.*—Brazil. Fritz Müller and Max Schultze, l. c.

14. *Geoplana olivacea.*—Brazil. Fritz Müller and Max Schultze, l. c.

15. *Geoplana nephelis.*—Brazil. Fritz Müller and Max Schultze, l. c.

16. *Geoplana Maximiliani.*—Brazil. Fritz Müller and Max Schultze, l. c. (= G. pulla, Darwin ?).

17. *Geoplana marmorata.*—Brazil. Fritz Müller and Max Schultze, l. c.

18. *Geoplana pulchella.*—Brazil. Fritz Müller and Max Schultze, l. c.

19. *Geoplana Burmeisteri.*—Rio Janeiro. Max Schultze.

20. *Geoplana flava.*—Bahia, sp. n., Moseley.

21. *Geoplana Traversii.*—Wellington, New Zealand, sp. n., Moseley.

22. *Geoplana elongata.*—C. Tres. Montes. Darwin, l. c.

23. *Geoplana semilineata.*—Chonos Islands, to the north of C. Tres. Montes. Darwin, l. c.

24. *Geoplana maculata.*—Valdivia. Darwin, l. c.

Note.—Numbers 22, 23, and 24 are placed by Diesing in Blanchard's genus *Polycladus*, but until their structure is known it seems as well to retain them here.

25. *Geoplana lapidicola.*—Island of Loo Choo. Stimpson, l. c.

With eyes few in number, scattered on the margins of the head and three or four larger ones on either side on the frontal margin. This will possibly prove allied rather to *Rhynchodemus.*

26. *Geoplana Tasmaniana.*—Tasmania. Darwin, l. c. This will possibly prove allied to the Australian genus *Cœnoplana.*

Genus.—*Geobia,* Diesing, l. c.

Geobia subterranea.—Brazil. Diesing, l. c., *Geoplana subterranea,* Fritz Müller and Max Schultze, l. c.

Long and narrow, with rounded extremities, eyeless, and colourless. Lives under ground in the holes of *Lumbricus corethrurus,* and preys upon that annelid.

Genus.—*Cœnoplana,* gen. nov. Moseley.

1. *Cœnoplana cœrulea.*—Parramatta, N.S. Wales, sp. n. Moseley.

2. *Cœnoplana sanguinea.* Parramatta, sp. n. Moseley.

3. *Cœnoplana subviridis.*—Parramatta. sp. n. Moseley.

4. *Cœnoplana ?* sp. ?—Ternate Moluccas. Moseley.

Genus.—*Dolichoplana,* gen. nov. Moseley.

Dolichoplana striata.—Manilla, sp. n. Moseley.

Genus.—*Rhynchodemus,* Leidy, Proc. Acad. Nat. Sci. Philad., vol. v, 1851.

1. *Rhynchodemus terrestris.*—Europe, O. F. Müller and others.

2. *Rhynchodemus sylvaticus.*—N. America, Leidy, l. c.

3. *Rhynchodemus bistriatus.*—Samoan Islands, Grube. 'Novara, Exp. Zoologischer Theil.,' Bd. ii, "Anneliden," p. 45.

4. *Rhynchodemus quadristriatus.*—Samoan Islands, Grube, l. c.

5. *Rhynchodemus Nietneri.*—Ceylon, Humbert, Mém. Soc. Phys. Genève, 1861, p. 306.

6. *Rhynchodemus Thwaitesii.*—Ceylon, Moseley, Phil. Trans. R. Soc., 1874, p. 107.

7. *Rhynchodemus flavus.*—Cape of Good Hope. Moseley, l. c.

8. *Rhyncodemus fuscus.* Cape of Good Hope. Moseley, l. c.

9. *Rhynchodemus Tannayi.* Brazil. Ferussac, Ann. Gen. Sci. Phys., t. viii, 1821, pp. 90-92, tab. cxvi, 2 et 3.

It seems probable that this will prove to differ in structure from the Indian and Cape forms.

10. *Rhynchodemus* (*Geodesmus*) *bilineatus.* Mecznikow, Bull. Acad. St. Petersburg, 1865, vol. ix, p. 433.

There is no certainty as to how far the above genus is a natural one. The anatomical structure of the Ceylon and Cape species and of *R. bilineatus* only is known, and it seems doubtful whether the latter of these should be referred to the same genus as the former, its generative organs not having been sufficiently determined.

Genus.—Bipalium. Stimpson, Silliman's Journal of Science, May, 1861, second ser., xxxi, p. 134.

1. *Bipalium Phœbe.* Ceylon. Humbert, l. c.
2. *Bipalium Diana.* Ceylon. Humbert, l. c.
3. *Bipalium Proserpina.* Ceylon. Humbert, l. c.
4. *Bipalium Ceres.* Ceylon. Moseley, Phil. Trans. Roy. Soc., l. c.
5. *Bipalium Dendrophilum.* Ceylon. Schmarda, l. c., p. 36.
6. *Bipalium lunatum.* Bengal. Gray, Zool. Misc., p. 5, 1835, cit. Silliman's Journ., 1861, p. 135.
7. *Bipalium Ferudporense.* Bengal. Wright, Ann. and Mag. Nat. Hist., 1860, vi, p. 54.
8. *Bipalium Cantori.* China. *Dunlopea Cantoria,* Wright, l. c. Chinese Repository, Canton, 1832 *et seq.*, vol. x, p. 434; Calcutta Journal of Nat. Hist., No. 5, p. 436.
9. *Bipalium Grayi.* Chusan. Cantor, Ann. and Mag. Nat. Hist., 1842, ix, p. 277; *Dunlopea Grayia,* Wright, l. c.
10. *Bipalium Stimpsoni.* China, Hong Kong. Diesing, l. c.; Stimpson, Prodromus Animalium, &c.; Proc. Acad. Philad., 1857, pp. 30, 31.
11. *Bipalium virgatum.* Loo Choo. Stimpson, l. c.
12. *Bipalium maculatum Ousimon.* Stimpson, l. c.
13. *Bipalium fuscatum.* S modu. Stimpson, l. c.
14. *Bipalium trilineatum.* Jesso. Stimpson, l. c.
15. *Bipalium univittatum.* Madras. Grube. Novara. Exped. Zoologischer Theil, Bd. ii, p. 45.
16. *Bipalium Everetti.* Borneo. Rev. W. Houghton, Ann. and Mag. Nat. Hist., 1870, p. 255.
17. *Bipalium Houghtoni.* Borneo. Houghton, l. c.
18. *Bipalium unicolor.* Zamboangan Mindonao Philippines, sp. n., Moseley.
19. *Bipalium,* sp.? New Zealand. Hutton, l. c.

Summary.

The results of the present paper may be briefly summarised thus:

Land Planarians are now known to exist in nearly all temperate

and tropical regions, and probably exist in all. They may be placed in two families:

(*a*) Leimacopsidæ, with eye-bearing frontal tentacles. 1 genus. 1 species at present known.

(*b*) Geoplanidæ. Without tentacles. 7 genera. 62 species.

The structure of Leimacopsis is not known, but it seems probable that it may differ very much from that of the Geoplanidæ.

Of the Geoplanidæ, the complete anatomy, including that of the generative organs, is known as yet only in the case of certain species of Rhynchodemus, and Bipalium from Ceylon, and in *Geoplana Traversii* of New Zealand. The arrangement of the muscles and of the lateral organs (nervous systems, or primitive vascular systems?) of the Rhynchodemus of the Cape of a Geoplana of Brazil, of the Australian Cœnoplanas, and Manilla Dolichoplanas, has been determined, and it appears that the Geoplanidæ form a very natural family, although it remains to be seen how far the European forms at present placed in the genus Rhynchodemus conform to the type. In all the Geoplanidæ the external sets of circular and longitudinal muscles are more fully developed than in the aquatic species in conformity with the requirements of motion on land. In Geoplana and the Australian genus this condition is more marked than in Rhynchodemus and Bipalium, and is carried to excess as far as the longitudinal bundles are concerned in Dolichoplana, in which form locomotion is probably principally muscular and annelid-like. In all the Geoplanidæ further the generative organs show a tendency to specialisation higher than that of most aquatic forms. In *Geoplana Rhynchodemus* and Bipalium, and in Polycladus, as appears from Blanchard's figures (Blanchard, Hist. de Chile, l. c.), the ovaries are reduced to small simple piriform sacs, which are placed near the anterior extremity of the body, and have long simple oviducts leading for more than half the length of the body to the uterus. This condition is conformed to even in the enormously long Dolichoplana. The intermittent organs and reservoirs are closely similar in all the genera examined. The Geoplanidæ are all monogonoporous. In all the uterus is simple and situate just posteriorly to the penis. The highest specialisation of the generative organs appears to occur in Bipalium. In the concentration of these organs and special development of the muscular systems the Geoplanidæ seem to form a step from the aquatic forms towards the leeches.

From the facts of anatomy, at present ascertained, it appears that the New Zealand forms are most closely allied to the S. American, whilst the Cape species are related to the Indian land planarians—a conclusion which is borne out by other facts of distribution of species. The Australian Cœnoplanas form a step

between the Geoplanas and the Dolichoplanas of Manilla. The occurrence of Bipalium in New Zealand seems a very remarkable fact, and it is hoped that the species will be carefully described.

The curious rod-cells of land planarians are remarkable structures. Several long hyaline rods occur coiled up together in each cell, and these rods are shot forth on irritation of the animal. The rods are, however, unconnected with the cell-wall, and their structure does not afford further evidence of relationship between rod-cells and nematocysts. It would be interesting to test the surface of a living land planarian with the tongue and ascertain whether any sensation of urtication is produced. The rod-cells of *Rhynchodemus bilineatus* are very similar to those of other land planarians, but the long rods seem to differ in that case in being tapered at either end.

The discovery of the mode of reproduction of land planarians is of much interest. The chitinous capsule containing several ova, and eventually embryos, which are entirely free in its cavity, is closely similar to that of, *e. g.*, *Dendrocœtum lacteum*, but necessarily much larger. No metamorphosis appears to occur in the progress of development.

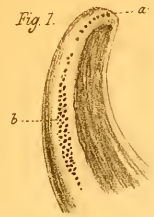

Fig. 1.


Fig. 2.

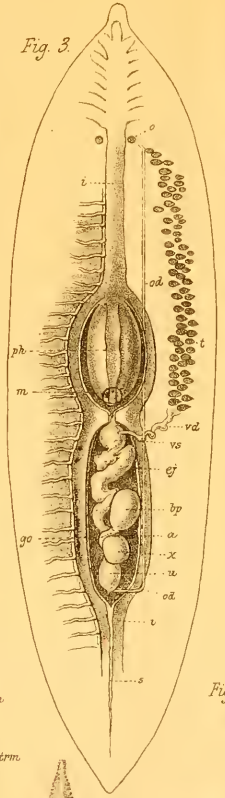

Fig. 3.


Fig. 6.


Fig. 7.

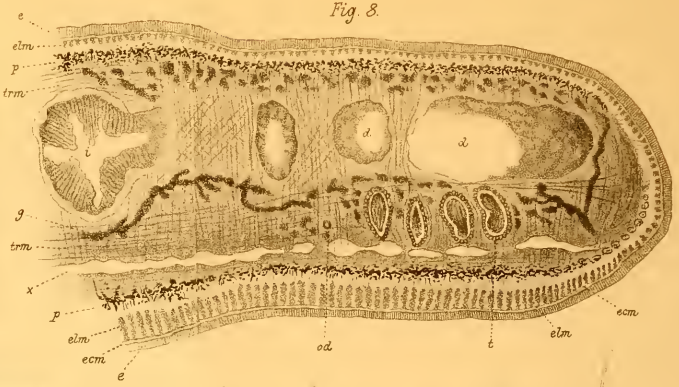

Fig. 8.

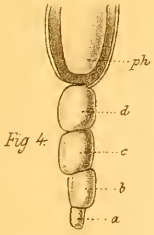

Fig. 4.

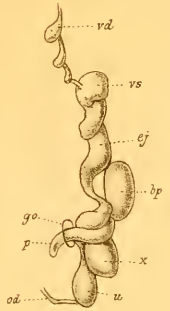

Fig. 5.


Fig. 11.


Fig. 13.


Fig. 15.


Fig. 17.


Fig. 18.


Fig. 19.


Fig. 20.


Fig. 22.


Fig. 12.


Fig. 14.


Fig. 16.


Fig. 21.


Fig. 23.

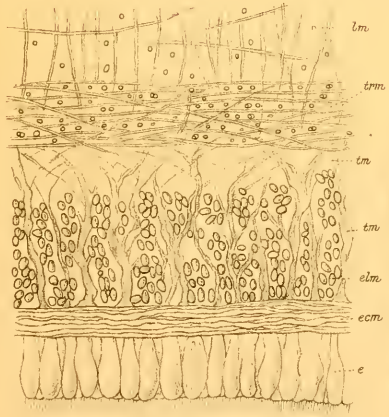

Fig. 9.


Fig. 10.

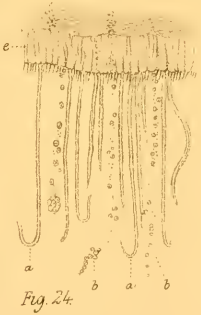

Fig. 24.

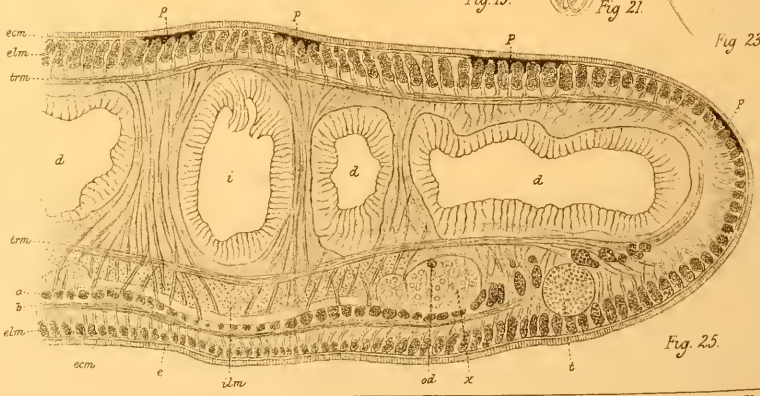

Fig. 25.

F. Huth, Lith. Edin.

DESCRIPTION OF PLATE XX,

Illustrating a Paper on the "Structure of Various Land Planarians." By H. N. Moseley, M.A., F.R.S., Fellow of Exeter College, Oxford.

FIG. 1.—Anterior extremity of *Geoplana Traversii* viewed from the side to show the arrangement of the eye-spots.

a. Elongate patch of several rows of eye-spots. *b*. Single row of eye-spots on the anterior tip of the body. Enlarged.

FIG. 2.—Three of the eye-spots of the same more highly magnified to show the oval spaces clear of pigment in which they lie.

FIG. 3.—Diagrammatic representation of the arrangement of the viscera in the same as viewed from the dorsal aspect. The integument and muscles are supposed to be removed from the dorsal surface so as to expose the viscera *in situ*. The sheath or sac of the pharynx and that of the generative organs are laid open. The diverticula of the digestive tract are traced for a short distance on the left side of the body only.

m. Circle showing the position of the mouth or aperture of exit of the pharynx. *ph*. Pharynx lying within its sac or sheath. *i i*. Intestine, a single mesially placed tube in the anterior region of the body, but double in the hinder part, forking at the root of the pharynx, the two tubes thus formed passing one on either side of the sheath of the pharynx and generative organs. *s*. Septum, separating the two intestinal canals in the hinder extremity of the body. *o*. Ovary. *od*. Oviduct. *u*. Uterus. *t*. Testis. *v d*. Vas deferens. *v s*. Vesicula seminalis. *e j*. Ejaculatory duct. *b p*. Bulb of the penis. *x*. Accessory bulb. *a*. Cavity of the common sac containing the generative organs. The special coverings of the various generative organs are dissected away. *g o*. Position of the generative outlet.

FIG. 4.—Generative organs of the same with their special coverings intact.

a. Sac containing the uterus. *b*. That containing the accessory bulb. *c*. That containing the bulb of the penis and part of the ejaculatory duct. *d*. That containing the vesicula seminalis and upper part of the duct.

FIG. 5.—The generative organs of the same, seen from the side removed from their sheaths and coverings.

v d. Vas deferens. *v s*. Vesicula seminalis. *e j*. Ejaculatory duct. *b p*. Bulb of the penis. *x*. Accessory bulb. *p*. Penis. *g a*. generative aperture. *u*. Uterus. *od*. Oviduct.

FIG. 6.—View of the lateral wall of the main digestive canal of the same, showing the manner in which the diverticula open into the canal.

FIG. 7.—Egg capsule of the same, cut open to show four fully formed embryos within. In two of these the projecting pharynx is seen and one embryo has been removed from the capsule.

FIG. 8.—Transverse section of the body of the same, at a point a little anterior to the position of the pharynx.

e. Epidermis. *e c m.* External circular muscles. *e l m.* External longitudinal muscles. *p.* Pigment layer. *g.* Glandular structures. *i.* Main digestive canal. *d d.* Diverticula of the same. *t r m.* Transverse muscular fibres. *x.* Lateral organ. *od.* Oviduct. *t.* Testis.

FIG. 9.—Portion of the foregoing section, much enlarged to show the arrangement of the muscles in the inferior region of the body.

e. Epidermic layer, with its cilia. *e c m.* External circular muscular layer. *e l m.* External longitudinal muscles, cut across. *r m.* Radiating muscles. *t r m.* Transverse muscles. *l m.* Internal longitudinal muscles, cut across.

FIG. 10.—*Geoplana flava* from Bahia, viewed from the dorsal surface. × 2.

FIG. 11.—Amœboid cell from the same.

FIG. 12.—Various tissue elements of the same.

FIG. 13.—Vertical section of the mucous membrane of the digestive diverticula of the same, showing the ciliation and component cells.

FIG. 14.—Rod-cell from the same. Actual longer diameter ·035 mm. in length.

FIG. 15.—Similar cell containing partly coiled-up rods.

FIG. 16.—Young rod-cell of the same, containing developing rods.

FIG. 17.—Long rods of the same, which have emerged from their cells.

FIG. 18.—*Rynchodemus flavus*, viewed from the dorsal aspect. × 1½.

FIG. 19.—*Rynchodemus fuscus*, viewed also from the dorsal aspect. × 3.

FIG. 20.—Rod-cell of *Rynchodemus flavus*, showing coiled-up rods within.

FIGS. 21 and 22.—Similar cells, with the rods partially protruded from the cell.

FIG. 23.—Rods of the same, which have emerged from the cells.

FIG. 24.—Section of the outer surface of the body of the same, as seen in fresh condition after slight pressure has been exerted on the section and the rods have thus been caused to be shot out.

a a. Protruded rods. *b b.* Contents of slime glands discharged. *e.* Epidermis, with short cilia.

FIG. 25.—Vertical section in the region of the body, anterior to the position of the pharynx of *Dolichoplana Philippensis.*

e. Epidermis. *e c m.* External circular muscles. *e l m.* External longitudinal muscles. *p p.* Pigment patches. *t r m.* Transverse muscles. *r m.* Radiating muscles. *i l m.* Internal longitudinal muscles. *a.* Special layer of internal longitudinal muscles. *b.* Special layer of transverse muscles. *l.* Main digestive canal. *d d d.* Diverticula. *od.* Oviduct. *t.* Testis. *x.* Lateral organ.