



THE  
RAY SOCIETY.

INSTITUTED MDCCCLIV.



*This Volume is issued to the Subscribers to the RAY SOCIETY for the Year 1878.*

LONDON:  
MDCCCLXXIV.



# MONOGRAPH

OF THE

# BRITISH ANNELIDS.

PART I. CONTINUED.

THE NEMERTEANS.

PAGES 97—213*d*; PLATES XI—XXIII.

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REG. N. 964

S. PAULO, 11.11.58

LONDON:

PRINTED FOR THE RAY SOCIETY.

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2. *Muscles of the Body-wall.*

The longitudinal muscular coat (*a*, Plate XVIII, fig. 4), which is incorporated with the cutaneous layer (*d'*) at its commencement, is thick and powerful, and has a well-marked fasciculated aspect in transverse section. At the sides of the mouth, where it attains great development, and forms a strong lateral support, there is a very pretty radiate or somewhat arborescent arrangement of the interfascicular substance in transverse section (Plate XX, fig. 1). This appearance is due to numerous radiating fibres, which pass from the inner longitudinal layer through the circular coat, and then diverge widely in the great muscular mass (Plate XX, fig. 13). It is best seen in the neighbourhood of the lateral nerve, where the muscle is most developed, and especially in partially decomposed specimens. So thickly are these fibres placed, that they pass through the slightly coloured stroma surrounding the nerve. Such a condition permits great stretching in all directions without actual separation of the muscular bundles, and is thus eminently adapted for the functions of the parts. The intimate connection of the outer fibres of this layer with the adjoining coat is well brought out in some longitudinal sections of the body, which show the outer bundles of fibres quite separated from each other by rows of pigment- and other cells and granules, the whole having a curiously streaked appearance. Anteriorly this longitudinal layer becomes lost in the tissues of the snout. The next coat (*c'*) consists of a series of circular muscular fibres of considerable thickness, between which and the former the nerve-trunks are situated. It extends forward by the ganglia, and appears to merge into the wall of the passage for the proboscis in front of these organs. Within the last-mentioned coat is a layer (*e''*) of longitudinal muscular fibres, similar in structure to the corresponding stratum in the *Enopla*. It also passes the ganglia to become connected with the muscular channel for the proboscis in the snout. The several muscular layers retain nearly the same relative proportions towards the posterior end of the worm (Plate XVIII, fig. 11).

The cutaneous and muscular coverings of *Lineus sanguineus* are thinner than in *L. gossereus*, but conform exactly to the same type. The only peculiarities observed in the muscular coats of *Lineus marinus* are the very evident transverse streaks of the external longitudinal (Plate XVIII, fig. 6, *c*), and the presence of certain cellular masses in it and the next outer layer. These bodies (Plate XXII, fig. 5, *a*) lie in definite spaces (*b*), and consist of groups of rounded cells filled with granules. In the contracted state of the animal, as after preservation in spirit, the circular coat in longitudinal sections has a wavy aspect (*e'*, Plate XVIII, fig. 6), apparently from the extreme shortening of the parts. In *L. bilineatus* the circular muscular layer is thicker than in *L. gossereus*, a condition probably connected with the somewhat rounded form of the worm. The enormous muscular layers in *Borlasia Elizabetha* (Plate XXI, fig. 4) have a fine red hue, so that the resemblance in this respect to the muscles of the higher animals is striking. The reddish coloration is most intense on each side of the circular coat all round, especially at the region of the nerve-cords, which are paler than their investments. The circular muscular coat is less tinted than the others, and forms a distinct line of separation between them. In this species, also, the fixing of the longitudinal fibres by the interfascicular substance is very favourably seen. In certain *Lineidae* from Shetland the inner longitudinal muscular layer

surrounds the sheath for the proboscis (Plate XXI, fig. 3), a feature of considerable physiological importance.<sup>1</sup>

In spirit-preparations of *Micrura fusca* the anterior third, especially if distended by the proboscis, is rounded, but the rest of the body has on each side a prominent thin margin, which in transverse section presents a great contrast to the same parts in *L. gessevensis*. The muscles on the whole are thicker, and the body more depressed in contraction. The circular muscular coat forms a flattened ellipse. The inner longitudinal layer is much diminished opposite the nerves, increases in bulk near the central dorsal region, and again abruptly tapers on each side of the median line, so as to form a broad wedge for the arch of the proboscidean sheath. It also increases in thickness towards the centre of the ventral surface, only a slight concavity occurring at the median point. The external longitudinal coat, however, presents the most typical deviation, for at each side, opposite the nerve-trunks, it extends outwards in the form of a prominent triangular process (in transverse section), the layer being then gradually narrowed towards the dorsal and ventral surfaces. In *Micrura fasciolata* the brownish-red pigment on the dorsum penetrates even to the circular muscular coat, but at other parts it is confined to the region without the external longitudinal muscular layer.

The posterior end of the body in *Micrura* requires special mention, since there is superadded a peculiar attenuate and contractile style. This appendage (Plate XVII, fig. 21) seems to be formed by a prolongation of the cutaneous and part of the muscular (longitudinal and circular) textures of the body-wall of the animal. The entire organ in contraction has a granular appearance, the coarsest granules, and occasionally a few circular masses of brownish pigment, being at the tip. Within is a central chamber (*a*), which undergoes various alterations in size, and contains a transparent fluid. This cavity is not connected with the digestive tract, which opens by a terminal pore (*z*) at the base of the process, nor can proboscidean discs be seen therein. I have not as yet ascertained with what system it communicates, but its connection with the circulatory appears most probable. The style is richly ciliated externally, and undergoes many and varied motions, now forming a verrucose knob, now stretched to an extreme degree of tenuity, and apparently assisted in the latter action by the fixing of the tip, the warty formations of which seem to perform the functions of suckers; for the animal may be observed progressing with a loose style, then the tip of the latter suddenly becomes fixed upon the clean and smooth glass, and the whole organ is gradually elongated. The fixed portion at the tip is usually more dilated than the succeeding part of the style. Prof. Grube thought the caudal process of certain Nemertean might be due to reproduction of the tail, but, of course, this view is inapplicable to the foregoing.

*a. Body-wall in the Carinellidæ.*—In *Carinella annulata* the cuticular cells or areolæ are smaller (Plate XVII, fig. 17), but they have the same arrangement, and retain much of their shape after mounting (Plate XXI, fig. 3). The characteristic opaque-white dorsal and lateral pigment-stripes pass throughout the entire dermal tissue, while the white specks on the sides (apparently corresponding with the openings of some of the genital sacs) do not traverse the whole thickness, but lie towards the inner border.

There are only two muscular layers, an external circular coat (*e*, Plate XXI, fig. 3), and an

<sup>1</sup> The animal in the British Museum termed "*Gordiophis subterraneus*" is an ordinary example of the same family.



inner thicker longitudinal ( $e'$ ). The circular muscular fibres surrounding the digestive chamber, however, are unusually powerful. In a curious specimen from Balta, with a bifid proboscis and other peculiarities, the arrangement, which shows, perhaps, only an abnormality of this type, is as follows:—Externally (Plate XXII, fig. 2,  $d'$ ), beneath the basement-layer of the cutis (which in the fragmentary specimen was almost absent), is a coat of circular fibres ( $e$ ). Within the latter is a very powerful layer of longitudinal fibres ( $e'$ ), which (layer), however, is not continuous, as in the ordinary form, but has at least one very distinct point of separation. On approaching the middle line of the dorsum, this longitudinal coat becomes thinned, so as to end on each side, of the centre in a blunt point. In addition, a somewhat triangular portion ( $ea$ ) is cut off by interfascicular substance and fibres. The dorsal curve of the proboscidian sheath is closely applied to this central point of separation, apparently receiving therefrom a few fibres, which retain it in position, while other fibres pass downwards to join the circular layer ( $fa$ ), which here encloses the space for the digestive tract. The separation of the great longitudinal layer of the body-wall is marked externally by a distinct median line, which is rendered more conspicuous by the occurrence of the transverse striae of the dorsum on each side of it. There is also a slightly marked median fissure in this muscular coat inferiorly. A pale, cyclops species (*Carinella bicoloris*), from Lochmaddy, shows a similar arrangement, for the inner longitudinal layer in transverse section is narrowed towards the centre of the dorsum, with traces of a separation by interfascicular substance. The fasciuli of the longitudinal muscular coat in this species and *C. lineiformis* are arranged in a linear manner, the rows passing from without inwards.

b. *Body-wall in the Cephalothricidae*.—The dermal tissues of *Cephalothrix* are exceedingly transparent, the pigment, when present, being only developed in the snout in front of the ganglia as a rose-pink or reddish shading within the superficial portion of the cuticular layer. The action of the cilia is most vigorous in the cephalic region. The cutis ( $d$ , Plate XXI, fig. 2), composed of the usual granular cells and gelatinous matter in areolae, has on its inner margin a trace of a translucent homogeneous basement-layer. A very thin band of circular fibres ( $e$ ) comes next, the exact structure of which is best demonstrated in fresh animals, after the addition of a little dilute acetic acid. The fibres are also evident in fine longitudinal sections, but are not satisfactorily seen in transverse cuts on account of their tenuity. Beneath is a very powerful longitudinal muscular coat ( $e'$ ), the ends of the fibres having the usual fasciculated appearance,—the inner being somewhat coarser than the outer. At each side a distinct increase occurs at the region of the nerve, where the layer is separated into two portions by a septum of fibres from the circular coat, the nerve lying in the line of demarcation. This arrangement is quite characteristic, and the position of the nerve-trunk probably points to the compound nature of the great longitudinal layer, viz., as analogous to the two longitudinal layers in *Linous*, the circular muscular fibres cutting off only the lateral portions ( $e$ ), instead of dividing it completely. This genus shows the mobility of the race even in a greater degree than the others. In progression the long yielding snout is used as an exploratory or boring organ, which it stretches hither and thither with ceaseless energy, and by its aid pushes aside its own mobile body in any direction; while through a narrow loop of mucus the latter is drawn like a thread of semi-fluid, yet coherent substance. The animal also moves readily on the surface of the water. When tested with blue litmus-paper the skin gives a most vivid red stain.

DALL: Change sometimes only two muscular coats in his *Polla signaculus*, an outer of circular muscular fibres, and an inner of longitudinal. He does not notice the external longitudinal layer.

A similar omission is made by Huschke, in describing his *Notospermus drepanensis*, which he provided with an external longitudinal and an internal circular layer. H. Rathke gives *Borlasia striata* two coats—an epidermis and a corium—combining under the latter both the pale and the pigmentary portions of the skin. He has not noticed the external longitudinal muscular layer, and mentions only an outer circular and an inner longitudinal muscular coat. It is somewhat difficult to comprehend the views held by M. de Quatrefages with regard to the same structures, since his descriptions and figures do not seem to coincide with each other. He divides the skin into three coats, viz. the ciliated epidermis, cutis, and the fibrous coat. Moreover, the cutis has two layers—an outer, formed of a homogeneous transparent substance, presenting in its mass a number of cells or simple rounded vesicles, refracting the light, and an inner, of large elongated cells in a double row; but in his figure the muscular elements occupy a bulk so insignificant that some error appears to have been committed, especially as the third layer of the skin is stated to be a transverse fibrous one. It is at all events difficult to see how the enlarged transverse section in pl. 23, fig. i, agrees with his figures iv and v, pl. 18, of the 'Voyage en Sicilie.' Two muscular coats only are described by this author—an external longitudinal and an internal circular—the internal longitudinal being omitted, or rather considered an aponeurotic layer. He also commits a serious error in affirming that the structure of the dermal tissues in the Enopla corresponds with that in *Borlasia anglica*. Frey and Leuckart likewise describe only two muscular coats—an outer longitudinal and an inner circular. Prof. Kefenstein, while representing the cutaneous textures of *Cerebratulus* (one of the Anopla) with greater accuracy, also falls into the mistake of applying what he found in this animal to all the Nemertean. He describes two coats in the skin—a cuticula covered with cilia, and an inner thick, finely-granular layer which contains the pigment—a definition which is scarcely comprehensive enough for the nature of the parts in such as *Lineus marinus*. He mentions the occurrence of crystals of the form of arragonite in the pigmentary layer of *Cephalothrix ocellata*, but such have not been seen in the British forms, except under the action of chemicals, or after the evaporation of the salt water. He also refers to a "transverse" tactile papilla on the snout of his *Cephalothrix longissima*, which resembles a slight protrusion of the lining membrane of the canal for the proboscis. His statement, that in *Cerebratulus marginatus* there are four muscular coats—an external circular under the pigment-layer of the cutis, a longitudinal, a circular, and lastly an internal longitudinal—has already been noticed. No more than three muscular coats are present in the *Lineidae*. Lastly, Dr. Anton Schneider,<sup>1</sup> in his remarks on the muscles of worms, and their importance in the system, states that in *Nemertes* the following layers occur:—Circular, longitudinal, and circular, besides radiating muscles—a description that is unsatisfactory as regards the British species.

The elaborate system of muscles in the body-wall of these worms enables them to perform the most varied and complex motions, so that they have not inaptly been compared to a piece of living caoutchouc. When irritated, the larger species, such as *Lineus laeteus*, Mont., and *L. sanguineus*, suddenly contract in a spiral manner like a cork-screw or the stalk of a Vorticella, or twist their bodies into a rope of various strands. The great *Lineus marinus* may now and then be observed in its native pools extended between the Tuca of opposite sides in numerous loops, each several yards in length, and so intricately arranged that they can scarcely be unravelled

<sup>1</sup> 'Archiv für Anat.,' 1864, p. 595.

by other than the animal itself. The extreme stretching which the body undergoes before it snaps—as in attempting to secure a specimen in an intricate and inaccessible pool—and the extraordinary shortening on immersion in spirit, are only well-marked conditions into which the animal throws its yielding textures at will. *Borlasia Elizabethæ* contracts itself so firmly during life as to form a hard flattened mass, which somewhat resembles the siphonal process of a *Mya* (Plate VII, fig. 2). *Micrura fusca*, again, swims freely on its edge like a freshwater *Nepheleis*, or its own ally *A. putcher*, lashing the water with alternate strokes of its muscular and flattened posterior extremity. Sir J. G. Dalzell likewise noticed this edge-motion in his great "*Gordius fragilis* (*Cerebratulus angulatus*), but he was not sure whether it was a natural condition, or caused by the confined vessel. *Carinella annulata* secretes in captivity a beautiful silky sheath, within which it lies in comparative security, until, tempted perhaps by love of change, it searches for a fresh site, whereon to manufacture a new chamber for its protection. In unhealthy and slowly dying animals the skin becomes raised into pale bullæ, not only from corrugation, but from degeneration of the dermal textures.

### 3. Proboscidian Aperture.

A channel, ciliated for some distance, leads inwards from the terminal pore of the snout to the reflection of the proboscis just in front of the commissures. This channel, shortly after its commencement (Plate XVIII, fig. 7, *a*), is surrounded by an elaborate series of muscular loops (indicated at 2), which, while keeping it closed under ordinary circumstances, permit of rapid and easy dilatation. Immediately below is a series of longitudinal muscular fibres, which attain a more distinct development somewhat posterior to this point (*a*, Plate XVIII, fig. 8). A very beautiful group of circular and diverging fibres lies outside the first series (2, in the last-named figure), crossing each other in a striking manner superiorly and inferiorly, as well as less distinctly at intermediate points, and forming with the longitudinal and other fibres the intricate stroma of the snout. The terminal pore is furnished with a prominent papilla, covered with a fan-shaped brush of cilia, the whole being only occasionally extruded, and no doubt assisting the papillæ previously mentioned in the tactile functions of the snout. This central papilla is sometimes bilobed, each division being supplied with cilia. In spirit-preparations of large examples of *Lineus marinus* the proboscidian aperture is distinguished by a slight slit on the inferior surface immediately behind the tip of the snout, the minute anatomy and relations of which agree very closely with the same parts in *L. gessnerensis*.

### 4. Proboscidian Sheath and Chamber.

The proboscidian sheath forms a shut sac, as in the *Enopla*, from the bridge of the ganglionic commissures to the posterior end of the worm. The long proboscis glides smoothly in this chamber, the walls being united with it and other tissues just in front of the commissures. The other contents are the clear proboscidian fluid and its discs. The latter are circular granular bodies, similar to, though smaller than, those of the *Enopla*, and when seen on edge present a

fusiform outline, having a dilated middle and two tapering ends. There are also a few small granules and granular cells. The muscular wall and other parts of this chamber agree so closely, both structurally and functionally, with the same parts in the Enopla, that it is unnecessary to describe further than refer to the aspect of the parts in the living animal (Plate XIX, fig. 1, *o*); and to the various transverse sections, in which the wall of the chamber is lettered *v*, and the cavity *ao*. Sometimes near its diminished posterior end the latter shows a series of moniliform spaces, from internal bristles, and often does not quite reach the tip of the tail.

In *Carinella annulata* the proboscidian sheath is not continued to the posterior end of the worm, and it is an interesting fact that this absence coincides, as in the next group, with greatly enlarged lateral vessels.

The chamber is divided throughout its entire length in *Cephalothrix* by transverse bands of contractile tissue, so that during the motions of the worm the anterior region is occasionally thrown into many moniliform spaces. These contractile septa (though imperfect in the middle), doubtless prove of much service during rupture, an occurrence so liable in this slender animal. Moreover, the wall of the chamber is thin, and the circular muscular fibres of the body not much developed; hence the advantages afforded by these safeguards against the inconvenient distension of the chamber during the motions of the worm. The transparent liquid in the cavity contains flask-shaped bodies and minute clear corpuscles.

Professor Keferstein seems to have had no definite idea of this chamber as a cavity with special muscular walls, but speaks of the peculiar discs as floating in the body-cavity (Leibeshöhle)—an error of some importance. In his two transverse sections of *Cerebratulus marginatus* he appears to have confounded the wall of the tunnel with that of the proboscis. He is thus less correct than several of his predecessors, who noticed the sheath of the proboscis and its contents.

##### 5. *The Proboscis.*

The proboscis in the *Lineida* (Plate XIX, fig. 1, *a*) commences in the form of a somewhat slender tube just in front of the commissures, gradually enlarges, continues for a considerable distance of nearly equal calibre, and then, diminishing, terminates posteriorly in a long muscular ribbon ( $\psi$ , sometimes bifid), which, curving forward in the ordinary state of the parts, becomes attached to the wall of the proboscidian tunnel. Its cavity passes in front into the canal of the snout, and posteriorly terminates in a *cul-de-sac* at the commencement of the muscular ribbon. It differs from the organ of the Enopla in certain respects, such as the absence of stylets, its more slender proportions, and the shape of the glandular papillæ on its internal surface. Experience, indeed, generally enables the observer to distinguish by external characters the proboscis of the Anopla from that of the Enopla in spirit-preparations—by the abrupt diminution of the calibre at the posterior portion in the latter, caused by the presence of the stylet-region and globular reservoir; but where the organ is incomplete, a transverse section at once puts the question beyond doubt. There are, also, in the proboscis of the *Lineida* three longitudinal lines, the first of which corresponds to the intersection of the fibres at one pole, and the other two occur at the ends of the separate segment, hereafter to be described. In the living animal the organ is proportionally longer than in the Enopla, and when rejected is thrown into numerous screw-like coils.

In transverse section there is externally an investment (*a*, Plate XX, fig. 4, and Plate XIX, fig. 8) similar to that in the Enopla, apparently composed of homogeneous elastic tissue, yet showing some granular markings towards its outer border. This coat is tougher than any of the others, and often retains its integrity after they have ruptured. A powerful longitudinal muscular layer (*b*) lies within the former, its fibres in transverse section having the same histological characters as in the Enopla. At opposite or nearly opposite poles of the circle, however, a remarkable interposition severs the continuity of the layer (as seen at *g*, *g'*). At one pole, two symmetrical bundles of fibres spring from the succeeding circular belt, and, slanting outwards, cross each other, so as to disconnect the longitudinal coat just mentioned, and for a portion of its circumference wedge it between two bands of circular fibres. The outer or oblique bands of circular fibres become lost in the external coat of the organ. The longitudinal layer (*b*) is thus diminished to a blunt point on each side of the intersection of these peculiar fibres, and a region is formed externally which is occupied by a special and somewhat lozenge-shaped group of longitudinal fibres, through which the dotted line *g* passes. The longitudinal layer, especially near the wedge-shaped ends (where the fibres are often arranged in a thicker mass in these preparations), is marked in the centre by a faint linear streak, as if composed of two layers, but this does not continue all round, and is not apparent in every specimen, nor in *L. gesserensis*. At the other pole there is a variation, for it is found that an elongated portion (*g'*) is cut off without apparent intersection, the ends of the great longitudinal coat (*b*) being widely separated. It generally happens that towards this side the bulging of the contracted organ occurs, and, it may be, such forces the edges of the longitudinal fibres apart, and aids in causing the above appearances; but it would not account for them all. In contraction this coat is sometimes thrown into a silky belt of regularly waved fibres. Within the longitudinal layer is an equally powerful one of circular fibres (*c*) which, at opposite poles in the transverse sections, gives off the peculiar oblique bands previously mentioned. A basement-layer (*d*), better marked in *Micrura fusca* than in *Lineus gesserensis*, is situated on the inner surface of the circular coat. There is also present in the former species an incomplete belt of longitudinal fibres (*e*) within the basement-layer, and which is not evident in the latter. Attached to the inner surface of the basement-layer, or in the latter instance partly to the incomplete longitudinal, is the glandular mucous coat (*f*), which, from lengthened preservation, has in this case become somewhat altered. The glandular bodies are scattered chiefly towards its inner or free surface. In fresh preparations, *i. e.* in those made from the organ immediately after extrusion from the living animal, a regularly radiate arrangement of this coat is constantly observed, as if a series of explosions had occurred in the mucous substance so as to scatter the globules and gelatinous bands in a fan-shaped manner. Indeed, the aspect resembles thick and graceful tufts of grass with large spikes, for the granular glands are mostly at the tips of the streaks of mucus, a state probably due to their passage outwards under compression. Professor Kefenstein figures this in *Borlasia splendida*, but he does not refer thereto in his descriptions. In the fresh specimen the glandular papillæ are much smaller than in the Enopla, and widely different in shape (Plate XVII, fig. 20, and Plate XVIII, fig. 14), the former representing them in the extruded proboscis, the latter as viewed from without. Under ordinary circumstances they have an ovoid form, and vary from  $\frac{1}{15000}$ th to  $\frac{1}{20000}$ th of an inch in size. Under pressure they become either flattened circular bodies, or assume a cylindrical and slightly barred aspect; and, after escape into the surrounding water, the contents are club-shaped or rounded (Plate XVIII, fig. 12).

The usual cross of fibres occurs at one of the poles of the transverse section of the proboscis of *Lineus marinus* (Plate XXI, fig. 5), but the separate piece at the opposite pole is somewhat larger than in *L. gesserensis*. The proboscis of *Cerebratulus angulatus* (Plate XXIII, fig. 18) differs from the foregoing at one of the poles of the circle in transverse section. The layer of circular fibres is divided into two bands, one of which (the inner) passes continuously round, while the outer, after the usual intersection at one pole, diverges much more at the other, so as to make a triangular space between its fasciculi. In the space thus formed is situated a band of longitudinal fibres (*g a*). Further, in the outer angle of the cross, that is, in a position agreeing with the wedge of fibres at the opposite pole, a narrow belt of longitudinal fibres exists (*g b*). In the *Lineus acuticeps* of Dr. Baird, from St. Vincent's, West Indies (L. Guilding's collection, British Museum), the cross made by the fibres is entirely absent, and this coincides with a continuous and powerful longitudinal muscular layer within the circular coat. The latter (inner longitudinal coat) also occurs in an example of the *Lineidæ* collected by Dr. Cunningham in Elizabeth Island. The *Lineus nova-zealandicæ* of Dr. Baird, again, agrees with the ordinary British forms in regard to layers, but there is no cross of fibres at one pole. A small form from Greenland also shows no intersection of the fibres, but the circular coat is divided by a median line into two layers, and there is a complete inner longitudinal coat. In *Borlasia Elizabethæ* the white proboscis is extremely slender in proportion to the bulk of the animal, and, moreover, the walls are comparatively thin. Instead of the shrinking and condensation which usually occur on immersion of the organ in spirit, a considerable central cavity remains in this case. Externally in transverse section (Plate XIX, fig. 7) is a thin investment, which generally shows a central line, as if divided into two layers. Beneath is a coat of longitudinal fibres, and then a thin belt of circular fibres with the ordinary glandular lining. The papillæ of the latter are small, rounded, and minutely granular. *Meckelia asudeata* is distinguished from other *Lineidæ* by the structure of its proboscis (Plate XX, fig. 5), which has externally no distinct superficial layer. Its outer coat consists of densely woven spiral fibres, which at opposite poles in the sections cross each other more distinctly than at other parts. The next (inner) coat consists of a considerable layer of longitudinal fibres, upon which the glandular papillæ rest.

In *Micrura* the organ is furnished with somewhat slender papillæ, which assume various shapes under pressure. When viewed laterally, the rounded or flattened papillæ, that formerly seemed only granular, appear to be composed of a series of minute rods set closely together (Plate XVII, fig. 13). In some, however, the striæ are longitudinal. When extruded from the organ into the water, the cylindrical bodies in the papillæ cling together in some instances like fibrillæ; and the appearance in the prepared specimens is quite characteristic, the inner surface being covered with a vast number of these elongated structures. The latter are the bacillary bodies described by Dr. Max Müller, but I have never seen in the British species any of the urticating organs mentioned by this author. The anatomy of the organ in this section agrees with that in *Lineus*, and in spirit-preparations the shrinking causes a protrusion of tissue, at the separate segment opposite the intersection of the fibres.

In *Carinella annulata* the proboscis has externally a thin investment composed of two layers (Plate XX, fig. 6), the outer consisting of elastic and the inner of circular muscular fibres; then a thick layer of longitudinal fibres is met with, and, lastly, a coat of circular fibres, to which the glandular lining is attached. Rod-like bodies occur in the papillæ of the latter coat, as in other forms, and

seem to be analogous to the "stabförmigen Körperchen" of Professor Kölliker,<sup>1</sup> and other investigators of the structure of the Annelida. In the *Carinella* from Balta, the proboscis proceeds from the tip of the snout in the usual manner, but instead of the posterior end diminishing insensibly into the long muscular fasciculus, the organ divides into two nearly equal trunks (Plate XXI, fig. 9), each about as large as the entire portion, and terminating in a somewhat abrupt and dilated end, to which a long muscular ribbon is attached. The wall of this peculiar proboscis, so far as I could make out from the single and rather unfavourable example, had the following structure:—A circular layer showing a few granules on the outer margin in transverse section occurs externally; within is a powerful and apparently continuous longitudinal muscular coat, from the inner surface of which the granular papillary mucous lining projects. The inner or free margin of the latter is comparatively smooth, a result probably due to the minuteness of the papillæ. Each limb of the fork has the same structure as the anterior region, and the thick longitudinal coat, after bending inwards at the posterior end of the dilated termination, becomes continuous with the muscular ribbon. The proboscis thus differs from the ordinary form in the *Carinellidæ* in the bifurcation, and in having no distinct circular coat within the longitudinal. It has no closer analogy with any other type.

In *Cephalothrix* the papillæ of the proboscis are acicular, and longest anteriorly (Plate XVIII, fig. 15). In transverse section the walls present a simpler structure than in *Lineus*; but, though in the living animal an external circular and an internal longitudinal muscular coat are apparent, the tissues become so confused after mounting, that I have not satisfactorily unravelled them.

Under the action of powerful irritants, such as alcohol, the *Lineidæ* detach, in their spasms, both the anterior and posterior connections of the proboscis at once, so that the extruded organ remains in its ordinary condition when expelled, and is not everted. In *Cephalothrix*, again, it sometimes ruptures near the ganglia, and is drawn backwards by the ribbon of attachment and its own elasticity; the animal apparently being unaffected by the injury, which regeneration soon repairs. I have never seen the worm use the proboscis for any purpose; and though M. van Beneden has observed it extruded in *Cerebratulus Erstedii* (*Lineus bisneatus*), and threatening its prey, I fear it could not do much harm. The lifelike vermicular motions of this muscular tube, both *in situ* and when cast off, have misled Mr. Beattie and others, so that they described the organ as a young animal, and the possessor as viviparous, or even considered the expelled portion a parasite. This is at once apparent on examining Mr. Beattie's specimen of the supposed young animal in the British Museum. The proboscis is reproduced in the same manner as in the *Enopliæ*; and the discarded organ, if not ejected, may be seen waving in the proboscidian cavity amidst much granular debris. Sir J. Dalzell states that the usual colour of the proboscis in *Lineus marinus* is vivid red; our specimens have generally had white or faintly pinkish organs.

M. van Beneden does not mention the tissues to which the muscular retractor of the proboscis is attached in his *Nemertes communis*, and speaks of it as suspended freely in the cavity of the body, like the digestive tube of the Bryozoa. A farther remark with regard to the organ in

<sup>1</sup> Vide 'Kurzer Bericht über einige im Herbst 1864 an der Westküste von Schottland,' &c., pp. 12, et seq.

*Cerebratulus Örstedii* (*L. bilineatus*) makes his error still more apparent, for he says—"Toute la trompe se meut librement dans la cavité intestinale." Prof. Keferstein gives a small figure of a transverse section of the organ in *Cerebratulus marginatus* turned inside out; but, though he indicates the lozenge-shaped space formed by the intersection of the fibres, it is misplaced on one side, and the entire figure is too indistinct for reference.

## 6. THE DIGESTIVE SYSTEM.

### a. Mouth.

The mouth in *Lineus gesserensis* is a longitudinal fissure on the ventral surface, situated a short distance behind the ganglia, and varying in size according to the motions of the animal, and the degree of contraction or relaxation. Its ordinary appearance under examination is represented in Plate XIX, fig. 1, *vs*. Certain broad pale lines radiate from the lips of the fissure, an arrangement which led Dr. G. Johnston into the error of considering the mouth a nerve-ganglion and the furrows branches. These radiating lines or folds are due to the same structural cause as in the ciliated œsophageal region of the Enopla—viz., prominent longitudinal rugæ of the thick glandular texture of the organ, which, in this case, permit great dilatation of the parts during ingestion. The number of these rugæ varies, as may be observed by a comparison of the figures. When *L. gesserensis* is killed by immersion in fresh water the mouth frequently presents five or six somewhat triangular folds of the œsophageal structure, which fill up and distend the aperture. The mouth is very conspicuous in *Lineus marinus* (Plate XVIII, fig. 2). In *Lineus lacteus* it is situated very far back (Plate XIX, fig. 3), so that a long space intervenes between it and the ganglia; and there is a marked difference in this respect between the present species and *L. sanguineus* (Plate XIX, fig. 2).

In *Carinella* the oral aperture forms a longitudinal slit, somewhat less conspicuous than in *Lineus*. In *Valencinia lineiformis* the mouth is quite as distinctly marked as in any example of the latter, and placed far backwards.

In *Cephalothrix* the lips of the aperture are frequently thrust outwards in the form of a short funnel, so that the animal resembles an elongated Distoma. Some circular fibres are present round the mouth in this group, and probably exist also in *Lineus*.

### b. Œsophageal Division.

The mouth leads into a large ciliated œsophageal chamber (*j*), which commences anteriorly in the form of a *cul-de-sac* behind the ganglia and cephalic sacs, and nearly closes by its anterior wall the vascular lacunæ there, while it may be said to terminate posteriorly at a distinct incurvation of its wall, by becoming continuous with the digestive cavity proper. In transverse section (Plate XX, fig. 1), the anterior part of this chamber is seen under favourable circumstances as a thickly folded glandular mass (*j*), with the ventral slit (*w*) leading quite freely into it. The cavity has not yet attained its full size, and the mouth is severed at its anterior border. Superiorly, a



large space is occupied by the proboscidian sheath ( $\alpha$ ), and the great lacunæ ( $\delta$ ,  $\epsilon$ ), and indications of some other vascular meshes are seen at the sides. The margins of the mouth ( $w$ ) curve inwards, and gradually merge into the ciliated glandular texture of the cavity. A little further back the glandular substance is confined to the inner surface of the body-wall (though not closely applied thereto), leaving a large central space. In full perfection the chamber and glandular texture are seen in Plate XX, fig. 8. The minute structure of the wall of this portion of the digestive cavity is similar to that of the ciliated oesophageal region in the *Eupoia*, being composed of a thick layer of granular gland-cells and basement-substance, raised here and there into prominent rugæ, and possessing a rich coating of cilia on the inner surface. The incurvation of the borders of the region is an interesting circumstance, and demonstrates the distinction between it and the succeeding division, even from the earliest condition of the worm, without for the moment regarding the other cardinal facts relating to the peculiar arrangement of the circulating channels on the walls, the thicker texture of the latter, and the total absence of the gregariniform parasites. Moreover, it is only in this region that the cilia of the digestive cavity are apparent, probably because the greater firmness of the walls keeps the chamber somewhat distended. In certain lateral views of the animal (Plate XXII, fig. 4), the distinction between the oesophageal and the succeeding region is very evident, the point of junction being inflected in a characteristic manner.

Though in the various drawings of transverse sections of *Lineus* this chamber (oesophageal) is seen in its normal condition, it is well to remember that it undergoes very marked alterations in size, according to the condition of the proboscidian cavity in its vicinity, for the proboscis most readily distends the latter in this region, and bulges it so much that the walls of the former are pressed flatly together at the ventral surface. In the contracted condition of the worm, as after immersion in spirit, the communication between the oesophageal and the succeeding portion of the digestive system is almost obliterated.

#### c. Alimentary Cavity Proper.

The second or great division of the alimentary tube extends from the point of inflection previously mentioned to the posterior end of the worm, in the form of a ciliated chamber with glandular and sacculated walls; but the cilia, with the exception of a streak near the tip of the tail, are only well seen on making a transverse section of the living animal, though they are actually longer and more active than those on the cuticular surface. In pale species, such as *Lineus lacteus*, Mont. MS., the digestive canal is very distinctly divided, for the posterior region is not only more opaque than the oesophageal, on account of the greater development of its glandular elements, but its borders are crenate from the sacculations. The posterior aperture or anus is situated slightly in front of the tip of the tail, and is well guarded by the muscular structures surrounding it, as may be observed before granular matter escapes, for it requires the impulse of numerous waves of fluid before yielding under pressure. In some favourable specimens (Plate XIX, fig. 6) masses of cells and débris may be seen revolving within the dilated anus before extrusion. In various examples a distinct anal papilla (Plate XVII, fig. 22), furnished with a tuft of longer cilia, projects posteriorly.

In transverse section (Plate XXI, fig. 1), the encroachment made on the cavity by the ovaries, during the period of their activity, is well shown, and also the gregariniform parasites,

which often occur so abundantly in these worms. When the animal, after spawning, has regained condition in its native haunts, the granular cells of the digestive chamber become largely developed, so that in transverse section the body is rounded (Plate XX, fig. 3), and the entire middle region filled up by the mass, with the exception of an irregular fissure in the centre; whereas considerable atrophy of these elements occurs during long confinement, or the exigencies of reproduction. Towards the posterior end of the worm the tract is much diminished, and, in the living animal, more evidently ciliated when viewed from above. The minute structure of the wall of the cavity (Plate XVIII, fig. 16) bears much resemblance under pressure to that of the ciliated cesophageal region in *Amphiporus*, having a basement-substance, in which are imbedded a vast array of granular glands, and with the inner surface richly ciliated. The contents of the glands (Plate XXI, fig. 7) consist of granular cells and globules, which readily escape from the free border of the organ, and are often ejected per anum.

In *Carinella* and *Valencinia* this and the previous region agree so closely with the arrangement in *Lineus* that no special description is necessary.

The ciliation of the entire digestive canal is more apparent in *Cephalothrix linearis* than in *Lineus*. It has a similar arrangement in transverse section (Plate XXI, fig. 2), and the same gregariniform parasites and an *Opalina* occur. In structure the first or cesophageal portion has a much more lax and cellular aspect than the succeeding densely granular region; and from the translucency of the animal the distinctions between the divisions are more exaggerated. In one specimen sent from St. Andrews in April, the digestive chamber was coloured of a fine pea-green (Plate IV, fig. 5), instead of the usual pale pinkish hue, a state due to the uniform tinting of the cellular elements, it may be from the nature of the food, such as the deep-green ova of *Phyllodoce*.

Ehreberg, De Quatrefages, Girard, and Stimpson considered the mouth to be the genital orifice, the former observing that a large quantity of mucus was discharged therefrom. Mr. H. Goodsir thought the canal common to the respiratory, digestive, and generative systems. "In *Serpentaria*," he observes, "it acts almost as an organ of digestion, while in *Nemertes* there is a trumpet-shaped exsertile proboscis, which, contrary to the opinion of Rathke and other naturalists, and according to the opinion already expressed by Ehreberg, is the intestinal canal." He agreed with Ehreberg in supposing the ova escaped into this chamber. His views were rather erroneous, such as imagining the first region of these worms to be composed of a single annulus; but the succeeding or terminal of many, each about an  $\frac{1}{4}$ th of an inch in length; moreover, that each of the separate annuli contained all the elements of the perfect or original animal, viz., a male and female generative apparatus, the cavity common to the generative, digestive, and respiratory functions, and a small dorsal vessel analogous to the intestinal canal of *Nemertes*. *Serpentaria*, therefore, he explains, "is a composite animal, each perfect individual consisting of numerous and apparently still unformed or imperfectly formed individuals." Modern researches do not support any of these suppositions. Amongst the British zoologists who have examined these animals, Dr. Williams, while admitting the digestive nature of this chamber, misinterprets its true relations. He considers the organ a closed sac filled with a milky fluid, and having many diverticula, into which the nutritive matter passes by exudation from the proboscis. He appears thus to have drawn up his description from one of the Enopla, which possessed no large slit leading into the chamber. He denies the existence of a proper anus. While thus deviating from the true structure of the parts, he is correct at least in viewing the chamber as digestive, and quite independent of the generative system placed to its exterior.

Sir J. G. Dalyell, whose untiring scrutiny of the habits of such animals is worthy of all praise, saw a *Lineus* (his *Gordius gesserensis*) feeding by the ventral slit, which he therefore correctly termed the mouth. Dr. Johnston in his 'Catalogue' observes:—"There is another and much larger aperture in front, behind and underneath the head. Long mistaken for the mouth, this has been usually described of late as genital, but the orifice is doubtful." He terms the alimentary canal the general cavity of the body. M. van Beneden does not demonstrate that the so-called biliary elements are simply constituents of the wall of the digestive cavity, and not special cæca attached to the sides of the canal. In *Lineus bilineatus* (his *Cerebratulus (Erstedii)*) he states that the nutritive chamber is divided into three compartments—the first short, and corresponding to the œsophagus; the second twice or thrice the length of the former, and representing the stomach; the third extending to the posterior extremity of the worm and constricted at regular intervals, and equivalent to the intestine. I have not yet noticed this in the British examples, which agree with the typical *Lineidae* in the structure of the organ, although the external aperture or mouth is somewhat smaller. Prof. Kefenstein's description of the cavity as applied to *Lineus*, though brief, is good, and his criticism of Van Beneden's view, in regard to the "liver" in the same group, fair.

#### 7. Nervous System.

The cephalic ganglia or central organs form two large and conspicuous pale red masses situated a short distance behind the snout of the worm (Plate XIX, fig. 1). They differ in shape, as seen under slight pressure, from the same organs in the *Enopla*, each half being narrower and more elongated, so as to cause the entire arrangement to have the appearance of a horseshoe-magnet. In some specimens, instead of being more deeply tinted than the rest of the cephalic tissues, they are paler, on account of the deep red coloration of the latter; while in others they can scarcely be distinguished under the dense blackish-green coating of cutaneous pigment. They are surrounded by the usual fibres of the region, besides the proper sheath of the ganglia. The inferior commissure, often of a deep red hue, is well marked, and placed quite at the front. The curves of the ganglia do not bulge so much forward on each side as in the *Enopla*, and thus the anterior margin of the system forms a nearly uniform transverse line. The superior commissure is smaller and less distinct; indeed, it is with difficulty seen in the living animal as a transparent preparation. Each ganglion is composed of a superior and an inferior lobe; and in minute structure the nervous matter agrees with that in the *Enopla*. The inferior lobes and commissure rest upon the solid tissues of the snout (Plate XVIII, fig. 9) instead of having the buccal cavity beneath them, as in the latter. On making a transverse section of the ganglionic mass just behind the commissures (Plate XXII, fig. 1), the superior lobe is found to be more rounded than the inferior, and to communicate with its fellow of the opposite side by the superior commissure. The inferior lobes are somewhat ovoid, connected by the great commissure, and give off the lateral nerve-trunks posteriorly. In front the two lobes are soldered together, but towards the posterior part a section is now and then found, which shows the posterior end of the upper lobe separated from the inferior. This severance of the end of the upper lobe is not to be confounded with the free rounded sac which lies close behind, as demonstrated by a section in which the knife has cut the left ganglion somewhat further back than the

right, and so indicated this separation on that side. The presence of the trumpet-shaped mouths of the ducts of the cephalic sacs in such a preparation shows that these bodies are posterior and not yet reached by the instrument. Longitudinal sections of the head of the worm exhibit the positions of the ganglia and the cephalic sacs with great clearness, each of the former often presenting different appearances on the respective sides from obliquity of section, but the posterior borders are always distinctly separated from the sacs (Plate XVIII, fig. 10).

In all sections of the ganglia a peculiar change occurs after mounting in chloride of calcium, the oily matter of the tissue collecting in curious streaks and circles, and apparently at some parts resisting the penetration of the fluid.

Considerable difficulty is experienced in making out the anterior branches of the ganglia, from the opacity of the snout; but three or four trunks of note are occasionally apparent—two large branches superiorly, and one or two smaller beneath. Some twigs seemed to proceed in the direction of the eye-specks, but their ultimate distribution could not be traced.

Each great nerve-trunk (Plate XIX, fig. 1, *n*) leaves the posterior end of the inferior lobe as in the *Enopla*, proceeds along the side of the body, and terminates at the tip of the tail. The calibre of the cords slightly diminishes as they course backwards; and their position is nearer the ventral than the dorsal surface. Branches probably exist, but only faint traces of such are seen in the longitudinal sections, for the opacity of the textures in the living animal prevents their being satisfactorily made out. The trunks are imbedded in a fibro-granular matrix (Plate XXI, fig. 6, *n*) of the same reddish hue, and have, in addition, the proper sheath (*neurilemma*) of the nerve. In some pale species they are marked externally as two pinkish dorsal streaks. These trunks, as already indicated, have a very different position from the nerves in the *Enopla*, being situated outside the circular muscular layer, and between it and the great longitudinal. Two muscular coats (circular and internal longitudinal) thus intervene between the nerves and the body-cavity and its contents, whereas in the *Enopla* the nerves are within all the muscular layers.

The general arrangement of the cephalic ganglia in *Carinella annulata* agrees with that in *Lineus*, so that a special description is unnecessary. The lateral nerve-trunks lie between the basement-layer and the external (circular) muscular coat of the body-wall (Plate XXII, fig. 2, *n*). In *Valencinia lineiformis* a variation is observed, since the nerves do not quite reach the external border of the great longitudinal muscular layer.

The chief peculiarity of the ganglia in *Cephalothrix* (Plate XIX, fig. 9), as first pointed out by Prof. Kieferstein, is the advance of the almond-shaped upper lobes, so that the superior commissure is quite in front of the inferior. The lateral nerves are placed between an isolated longitudinal fasciculus and the great longitudinal muscular coat of the worm (Plate XXI, fig. 2).

Mr. H. Goodsir criticises the description given by M. de Quatrefages of the nervous system in *Serpentaria* and *Nemertes*, and, like Ersted, denies its existence altogether, averring that microscopically the so-called nerve-trunks show no nervous elements at all, but are the testicles of the worms. I fear, however, this worthy naturalist depended rather upon analogy than actual observation in this case. He accounts for the nervous fibres seen by Rathke (the first who correctly described the ganglia in *Lineus*) passing from the cephalic ganglia to the narrow slits on each side of the head, by supposing them to be seminal tubes on their way to the furrows (his seminal apertures). M. de Quatrefages confines his examinations chiefly to the ganglia of the *Enopla*. Frey and Leuckart, again, confound the cephalic sacs with the posterior part of the

ganglia. M. van Beneden makes a curious remark in regard to his *Nemertes Quatrefagi*—viz., that the “collier œsophagien” is peculiar for its red colour, which hue, he says, is less marked in the other species of *Nemertes*. This colour, he explains, is not due, as believed for a long time, to the nerve-ganglia, but to the vessels which surround them, and it can easily be understood how the ganglia were confounded with the vascular trunks. Nothing akin to this has ever come under my observation, and the minute anatomy of the region is adverse to the view. Prof. Grube had previously made the same remark in describing *Nemertes purpurea*, Johnston, a species which (judging from the descriptions) seems to differ very materially from *Nemertes Neesii*, and is apparently one of the Anopla, but I have not yet seen any British representative. Prof. Kieferstein is scarcely accurate in affirming that the ganglia in this group are larger than those of the Enopla. In his figure of the parts viewed from the dorsum (Taf. vii, fig. 1), the cephalic sacs are not discriminated.

#### 8. Cephalic Fissures.

On each side of the head in the majority of the Anopla is situated an extensive fissure (Plate XIX, fig. 1, and Plate XVIII, figs. 3, 5, 9, *b*), which commences as a shallow groove at the anterior border of the snout, and terminates, in the form of a reddish pit, somewhat abruptly, just beyond the entrance to the cephalic sac. A distinct constriction of the anterior region occurs behind the fissures in *Linceus gessnerensis*, thus marking off the cephalic boundary. There is nothing special in the anatomy of these fissures, for they are formed by a simple extension of the cutaneous elements superiorly and inferiorly, as represented in the transverse section (Plate XVIII, fig. 9). Their entire surface is covered with very active cilia, which, as before mentioned, I have often seen cease abruptly, and again begin to play vigorously. The vapour of chloroform, if applied in sufficient quantity, causes them to stop entirely, but they again commence vibration on the partial recovery of the animal. Örsted and others have considered that these fissures perform a respiratory function, but of this there is no sound evidence. Mr. H. Goodsir thought they were the apertures of the male generative system, a supposition, as mentioned, scarcely requiring refutation. Prof. Kieferstein gives a very good summary of the views of previous observers, but, while agreeing with none, he advances no new interpretation of these structures. He concludes by criticising M. van Beneden's statements, to which he objects, but he has scarcely reviewed them at sufficient length. M. van Beneden observes that the cephalic fissures are furnished posteriorly with a pit leading into a ciliated funnel, and that the lateral vessels when they approach the ganglia swell out into vesicles (“ils se renflent à en vesicules”), which simulate the ganglia, and convey their contents to the exterior by the ciliated funnel just mentioned. He considers that the central point of this apparatus lies immediately beneath the ganglia on each side; and he has seen, under compression, the pit of the lateral slit adjoin a large canal, which terminates exteriorly by a sort of funnel, and this leads into a pouch behind the nerve-ganglia. He did not see any vibratile movement within the vesicle; and states his conviction that this apparatus is similar to that in the Trematoda and Cestoida. Thus, as Prof. Kieferstein says, he has nearly retrograded to the time of Husehke, who thought these fissures connected with the lateral nerves, which he took for canals. In his enlarged figure, however, he represents the position of the cephalic sacs fairly, but he has a large blood-vessel running exterior to the

nerves, and extending to the tip of the snout; this, of course, is at variance with a true interpretation of the structures in the Anopla.

The cephalic fissures, as characteristic of the typical *Lineida*, are absent in *Carinella annulata*, their places being supplied by two pale curved grooves on the dorsal and two continuous transverse furrows on the ventral surface of the snout. The depressions are richly ciliated. In the remarkable form from Balta, the snout is surmounted by two curious frilled processes (Plate XXI, fig. 9, *b*), which terminate posteriorly in a long filament. Whether the latter, however, is a structure *sui generis*, or only some normal constituent of the body (such as a nerve) in a peculiar position, the state of the specimen forbids our determining.

The cephalic fissures and furrows are entirely absent in the family *Cephalothricida*.

#### 9. Cephalic Sacs.

At the posterior end of each lateral fissure, a funnel-shaped tube (*m'*, Plate XIX, fig. 1) leads into a large globular structure (*m*), often of a pinkish or reddish hue, and the apparent homologue of the cephalic sac in the Enopla. The globular body lies over the origin of the great nerve-trunk on each side, and abuts so closely on the posterior prominence of the upper lobe of the ganglion, as to have led some observers into the error of supposing it only a continuation of the ganglionic texture. Very careful preparations and examinations of the adult animal, as well as observations on the young at various stages, remove all doubt on this subject, and show that these globular structures belong neither to the nervous nor the circulatory system. The funnel-shaped duct (*m'*) is richly ciliated, and the cilia may be traced to the sac, wherein they are continued as a linear streak along its outer border, but its general mass is not furnished with these organs. The ciliated curve along the external margin is well seen in young specimens, but its exact superficial extent is difficult to determine. In favourable examples the walls are observed to contain finely granular cells, which have a clear and distinct nucleus. These cells are most evident on the inner and posterior curves, the outer curve being pale. The sacs project posteriorly into two large cavities—continuations of those indicated in Plate XX, fig. 1, *s, s*, on each side of the proboscidian tunnel, and are thus laved by the circulating fluid, which rushes forward from the walls of the digestive cavity; but there is nothing to support M. van Beneden's views as to their continuity with the circulatory system. Their relations to the ganglia have been adverted to already, and are well shown in some horizontal sections, where one sac has been severed considerably lower than the other.

Just in front of the external border of the curved dorsal groove on the snout of *Carinella annulata* (Plate XVII, fig. 24) is an ovoid body apparently homologous with the foregoing, but I have not yet been able to trace its anatomy, on account of the opacity of the cutaneous tissues in this animal.

The sacs are absent in *Cephalothria*.

The function of these bodies may be excretory. Their gradual advance in position, and proportional diminution in size in the developing animal, are interesting features in this respect. Prof. Kefenstein does not enter into structural detail with regard to these organs in this group, but states that they lie at the posterior end of the lateral fissure. In *Lineus sanguineus* he mentions they are in connection with the under surface of the ganglia, whereas they are situated

distinctly above the latter. In his figure no separation is made, and the dilated organ is confounded with the posterior part of the superior lobe of each ganglion, the duct or ciliated canal running beneath. The development of these sacs in the very young Nemertean inside the *Pygidium*, as recently narrated by E. Metschnikoff, confirms all our views of their relations.

#### 10. *Eye-specks.*

These are simply masses of black pigment, arranged on the sides of the snout with greater or less regularity, and without any special optical structure. The textures of the head and nerve-fibres themselves are so unfavourable for observation that I have had difficulty in making out nerve-branches thereto. A more definite structure is observed in the Enopla, both as regards nervous elements and complexity of organization. Some of the Anopla have no eyes (a remark, however, which does not apply to *Lineus marinus*), or have them only temporarily in their young state, like the Tornaria-larva of *Balanoglossus* or developing oysters and *Terebratulæ*, while all the known Enopla possess them. It is a curious fact that in transverse sections of the snout (such as Plate XVIII, fig. 7) considerable pigment-specks are seen towards the ventral surface.

#### 11. *Vascular System.*

The circulation in *Lineus* diverges considerably from that in the Enopla, the vessels differing in definition, size, coiling, and contents. The main trunks, indeed, somewhat resemble long cavities, with contractile walls, within which floats a transparent fluid with corpuscles. I have termed this system the circulatory, but the current is driven by the contraction of the vessels now backward, now forward, so that it is rather a kind of oscillation.

There are three great longitudinal trunks—confining the description at present to the region behind the cesophageal division of the digestive tract—a dorsal (*y*) and two lateral or ventral, *r*, *r*, in the various transverse sections, and in Plate XIX, figs. 4 and 5. These three vessels in *Lineus* were first mentioned by Rathke. The dorsal is a large trunk situated immediately outside and to the ventral surface of the proboscidian sheath; while the ventral, also considerable trunks, lie on a lower plane, and nearer the middle line than the nerves. Indeed, when the three vessels are distended in *L. gesserensis* and *L. sanguineus*, they occupy almost the entire breadth of the worm under gentle pressure. They are frequently dilated in various ways, sometimes irregularly moniliform, crenate, or simply distended as long palc spaces. The three trunks are intimately connected by an array of simple and rather large transverse anastomosing branches (*y*, Plate XIX, fig. 4), some of which are forked. The transverse branches have special contractile walls, and are not mere random chamels, as may be seen in the longitudinal sections of the worms (Plate XVIII, figs. 6, 4). They are subject to the various changes of form noted in the larger trunks. The great longitudinal vessels are further connected at the tip of the tail (Plate XIX, fig. 5). The dorsal generally contracts from behind forward, and drives the corpuscular fluid, not only to the front, but also through the transverse branches into the lateral trunks. The latter propel their contents in both directions.

At the posterior end of the cesophageal division of the alimentary canal the three great

vessels, for the most part, lose their individuality, and, so far as I have observed, form an elaborate vascular meshwork between the œsophagus and the inner muscular layer of the body-wall (*u, u*, Plate XIX, fig. 1, and more clearly in Plate XX, fig. 2), again meeting in the lacunæ (*s, s*) in front of the cavity, and bathing the bulbs of the cephalic sacs which lie therein. These lacunæ or channels pass forward to unite at the ganglionic commissures, and the granules of the contained fluid may be seen rushing forward in the one and backward in the other. In addition to the smaller meshes surrounding the œsophageal region, there are two larger spaces on each side of the proboscidian sheath in transverse section, which may be held as the continuations of the dorsal vessel. The reticulations formed by this system are noticed under favourable conditions in the living animal (*ex. g.* as represented in Plate XIX, fig. 1), as well as in numerous transverse sections. I have not been able to see any blood-vessel in the tissues of the head in *Líneus*. A distended pale portion may often be observed in the central line between the snout and the ganglionic commissures, as if the animal had gulped water by the aperture for the proboscis, so as to distend the channel, but this has no connection with the circulatory system. Transverse section demonstrates that there is no other channel in the snout in front of the ganglia than that just referred to.

In *Borlasia Elizabethæ* a reddish coloration is frequently observed in the living animal on the ventral surface at the white belts, showing that some contained fluid tints the dermal tissues during its passage. On puncturing the dilated anterior end, for example in removing the proboscis, a copious exudation of a reddish-brown fluid occurs. This presents many fusiform or clavate corpuscles, probably from the proboscidian fluid; but there are also present a vast number of minute granules of a yellowish colour by transmitted light (reddish in mass), which probably belong to the blood proper (Plate XVII, fig. 23). Many of the latter bodies show a contraction in the middle, so as to resemble a figure of eight.

In attenuate pale species, such as *Líneus lacteus*, Mont., MS., the intervention of an elongated region between the posterior end of the ganglia and the anterior border of the œsophageal region renders a special modification of the circulatory channels necessary. Accordingly, it is found that after the fluid collects in the spaces in front of the alimentary organ, it is conveyed by two long vessels forward to the ganglia, where the same ending occurs as in the other species. These channels seem to be simple elongations of the ordinary lacunæ, and are represented in transverse section in Plate XXII, fig. 3; thus forming an intermediate link between *Líneus gossuerensis* and the still more extended post-ganglionic region in *Cephalothrix*.

In *Carinella annulata* two great longitudinal vascular trunks (Plate XXI, fig. 3, *r*) lie within the inner or longitudinal muscular coat opposite the nerve-trunks, and they are peculiar on account of their large size and the granular nature of their contained fluid. They form a coarse network in the œsophageal region, as in *Líneus*, and are continued forward just within the border of the snout to meet in a vascular arch.

In the fragmentary specimen from Balta transverse section of the anterior region (Plate XXII, fig. 2) shows a large ovoid and probably vascular tube (*r*) placed at the inner border of the great longitudinal muscular coat on each side, while the nerve-trunk (*n*) lies outside the latter. The cavity is partly filled in the preparation with minute granular cells. This agrees with the arrangement in *Carinella*.

*Cephalothrix* has also two great longitudinal vessels (Plate XXI, fig. 2, *r*) situated nearly opposite the nerve-trunks (*n*), from which they are separated by the chief longitudinal muscular



coat. There is thus in this system also a deviation from the type of the *Lineida*. The size of the vessels is proportionally larger than in the latter, and their transparent fluid contains a number of minute corpuscles. In the living animal each lateral vessel contracts regularly and swiftly from before backwards, sending a wave of fluid towards its posterior end, at which the contraction ceases. A reversed movement by-and-by takes place, the contents being propelled towards the snout. Anteriorly the two vessels course forward by the side of the œsophageal portion of the alimentary canal without subdivision, pass along the sides of the proboscidian sheath in special cavities (*v*), as in *Lineus lacteus*, in front of the former, and reach the ganglia, where they communicate. A junction has not actually been seen posteriorly, but analogy would lead us to suppose its existence. There appears to be little regularity or rhythm in the movement of the fluid in these vessels, both occasionally contracting from before backwards at the same time. Generally, however, the contractions are alternate.

Whatever special function the œsophageal region may perform in regard to digestion, it is clear the circulatory fluid bathing its outer wall is placed in a favourable condition for oxygenation, as the mouth now and then must give entrance and exit to sea-water, under the influence of the powerful ciliary currents caused by the entire surface of this division. Besides, it is evident that during the varied actions of the oral aperture (*e. g.* during feeding) the circulation would sometimes be much interfered with if such a *rete mirabile* did not exist. The special branchial apparatus in the homologous region of *Balanoglossus* (*vide postea*) also gives further weight to our interpretation of the structure of the parts in this group.

Dr. G. Johnston, Ersted, and Dr. Williams mistook the ganglia for hearts, and the inferior commissure for a connecting vascular trunk. The blood, says the latter author, derived from the cutaneous system of capillaries, is poured by a dorsal vessel into one of the chambers of the heart (the dorsal). From the latter it is sent into the ventral cavity, and thence distributed over the integumentary and intestinal systems. He, moreover, says the blood is red, and always devoid of corpuscles. Such remarks are not based on correct observations. E. Blanchard in his examination of *Cerebratulus liguricus*, describes the nervous centres as lodged in a cavity into which the vascular trunks open, and this can only refer to the post-ganglionic lacunæ, though such do not by any means encircle the ganglia. I have not seen any vascular space surrounding the "trompe" in front of the commissures, as described and figured by this author; and the fluid of the proboscidian cavity could only have been noticed there during the ejection of the proboscis. He found numerous branches proceeding from the longitudinal trunks in his *Cerebratulus liguricus*. I cannot agree with M. van Beneden's views of the circulation in *Lineus*, for he describes the lateral vessels as swelling into vesicles when they approach the ganglia, their contents being conducted to the exterior by a ciliated funnel. The erroneous nature of this supposition has already been noticed under 'Cephalopoda.' He also mentions that each lateral trunk communicates only with that of the opposite side posteriorly, and concludes doubtfully thus:—"Le long des parois du tube digestif, on voit en outre plusieurs vaisseaux, mais dont les aboutissants sont difficiles à découvrir." Another deviation from accuracy is apparent from his remark (under *Cerebratulus Erstedii*) that "En arrière un gros vaisseau très-large, à parois très-contractiles, qui paraît et disparaît par intervalles, occupe la ligne médiane et semble s'ouvrir au bout de la queue." A reference to his figure and its explanation at once makes it apparent that he has mistaken the proboscidian sheath for a blood-vessel. Prof. Keferstein again does not enter into detail with regard to the circulation in *Lineus*, and his figures and descriptions

apply to the Enopla, with two exceptions, which represent transverse sections of *Cerebratulus marginatus*. In that through the anterior part of the body five circular vessels at least are transversely cut in the meshes round the œsophageal region, and, moreover, they are joined by a pink band in the figure, apparently from a connecting trunk. I fear the author has been misled by the carmine used in the preparation, for in the British examples of "*Cerebratulus*": the arrangement characteristic of the *Lineida* is found.

## 12. ORGANS OF REPRODUCTION.

The sexes in the known *Lineida* are separate, and the ova and spermatozoa developed in their respective sacs between the inner muscular layer of the body and the digestive cavity. The glandular elements in the walls of the latter, indeed, undergo a certain amount of atrophy during the period of reproductive perfection (Plate XXI, fig. 1). Both ova and spermatozoa escape by pores a little above the lateral nerve-trunks, the apertures being frequently indicated by pale specks (Plate IV, fig. 2). In *Carinella annulata* they are often boldly marked by white spots (Plate VII, fig. 5). In this species also, as well as in *L. gesserensis* (Plate XVIII, fig. 11), the rudimentary condition of the generative organs may be seen in transverse section as a series of small globular or pyriform sacs, filled with granules and globules, and situated above the nerve-trunk on each side of the body.

### a. Male Elements.

In *Lineus gesserensis* the spermatozoa (Plate XXI, fig. 10) have the aspect of slender rods, with a scarcely perceptible enlargement at the end from which the filiform tail proceeds. When a mass is taken from a living animal, groups often adhere to a point by one end, and, spreading in a radiating manner, lash the surrounding water with their tails. The spermatozoa of *L. sanguineus* (Plate XXI, fig. 11) are more minute than the former, and somewhat resemble an awl-handle in shape, with the filament projecting from the butt, which is thus frequently agitated, while the tapered end is comparatively still. In *Lineus marinus* the outline of the body of the spermatozoon (Plate XXI, fig. 12) is less regular than in the foregoing, and seems slightly crenate in some specimens. A very long filament is attached to the larger end. In *Micrura fasciolata* there is likewise a slight constriction in the middle of the spermatozoon, and the tail proceeds from the larger extremity. The reproductive elements were nearly perfected in the large Zetlandic variety of this form in August, the sperm-cells being filled with slightly curved rod-like bodies, having one end less tapered than the other.

### b. Female Elements.

The ova occupy similar positions to those of the Enopla. They are few and large in *Lineus gesserensis*, smaller and more numerous in *L. sanguineus*.

13. *Mode of Deposition of the Ova.*

Instead of being deposited as free circular bodies, the ova in *Lineus gesserenis* are placed within a flask-shaped membrane, with one end narrowed to a fine point, and the whole enclosed in a tough covering of gelatinous mucus, which is fixed either to stone or glass, in the form of a bulky cord, as noticed by Örsted. When a female specimen is about to spawn, she seeks the water-line, or a space above it, and quietly settles along the vessel. By-and-by a copious exudation of tough translucent mucus takes place, which envelopes the entire animal. In this mucus (Plate IV, fig. 3), which, when fresh, is crowded with small ovoid granular corpuscles from the cutis, the ova are deposited in flask-shaped capsules, each of the latter corresponding to an ovary, and containing all its ova, viz. from one to seven. Hence, by the nature of the parts, the ova are arranged in a somewhat irregular double row along each side, the extremities of the cord—corresponding on the one hand to the head and oesophageal portion of the digestive tract, and on the other to the extreme tip of the tail—being free from ova. In some instances the posterior end of the animal is curiously frilled and grooved on the ventral surface during deposition. When newly exuded the mucus is softer and less tenacious than it afterwards becomes, and the same may be said of the membranous flasks. The solidification of the mucus is analogous to what takes place, under similar circumstances, in the egg-capsules of certain mollusks, e. g. *Buccinum undatum*. If one end of the animal be disturbed from its original site on the glass before the ova are all deposited, four rows will be found instead of two, for sufficiently obvious reasons. The ova of *Lineus gesserenis* are of two shades, viz. white and pale brownish; and though the dark greenish examples often lay white eggs, they do not seem to do so always. Each ovum measures from  $\frac{1}{10}$ th to  $\frac{1}{8}$ th of an inch in diameter. The deposition takes place in January and February in those long confined; but some specimens sent from the rocks at St. Andrews towards the end of April likewise deposited ova, so that some latitude in regard to date is necessary. The American examples spawned in January, and those from Cuxhaven in March; but the *Nemertes communis* of M. van Beneden only did so in September. It is often observed that impure water causes recently captured animals to lay their ova rapidly, as if from a kind of abortion.

## 14. DEVELOPMENT.

The development of the ova of *Borlasia obscura*—a species apparently identical with our *Lineus gesserenis*—has been described by E. Desor up to the period of the extrusion of the young from the capsules; and Max Schultze and Krohn have also investigated the subject, especially the former, so that I shall dwell only on such points as have not been elucidated. The British forms seem to offer great facilities for these investigations, and I have had no difficulty in rearing the *Lincidae* a long distance from the sea.

The ova on deposition in the flask-shaped capsules (Plate XXIII, fig. 2) are uniformly granular and opaque; and when broken up, are found to be composed of a granular oily matter, which forms streaks and rounded masses, and is not cellular, as described by E. Desor. The clear, semi-transparent spot mentioned by the latter as occurring in the ova after deposition is seldom visible, though the germinal vesicle (*a*) and dot (*b*) are apparent enough in the centre of

a pale oleaginous space, while yet in the body of the female (Plate XXIII, fig. 1). The flask enveloping them is composed of a fine hyaline membrane, that assumes many silky folds in the collapsed condition, and evidently contains a fluid which, with the semi-solid yolks, may be thrust out into the mucus. The cleavage of the vitellus generally commences on the second day, when in some it is found divided into two and in others into four parts (Plate XXIII, fig. 3). As first pointed out by Max Schultze, Desor was in error when he stated that the irregularity of the divisions of the vitellus distinguished this species from other animals. The divisions proceed regularly and somewhat rapidly; for ova which presented four lobes at 9 a.m. were found at 1 p.m. broken into a number of rounded masses, so that each had a nodular or mulberry-aspect (Plate XXIII, figs. 5 and 6). No clear spot is observed in the centre of the secondary masses (Plate XXIII, fig. 4). During the next four or five days the changes consist chiefly of subdivisions of the vitellus. There is now a pale spot in the ovum, and a few free granules and cells in the flask, as noticed by Desor. Each likewise assumes a smoother outline from subdivision of the vitellus, and only a few nodules appear here and there on the otherwise even circumference. E. Desor found the ova ciliated on the twelfth and fourteenth days, Max Schultze on the eleventh and twelfth, and I have struck the average amongst the British examples on the latter date. The ova, again, which had been left entirely above the water-line did not develop so quickly. At first the ciliation does not cause the mass to revolve, but subsequently this motion takes place with vigour (Plate XXIII, fig. 7). They continue in this condition about a month, and then a further change ensues in the contents of the flasks (Plate XXIII, fig. 8); and the latter drawing will explain E. Desor's discovery, as well as enable me to correct a slight inaccuracy into which he has fallen. The opaque ciliated mass previously noticed by-and-by shows a double outline under pressure, caused by the development of the young *Lixæus* within the ciliated coating; indeed, at an advanced stage, as in the middle of the flask represented in Plate XXIII, fig. 8, the embryo seems to be shrouded in a layer of fatty cells and oil-globules (*b*), within which it distinctly moves. In such a condition the animal readily escapes from its investment, and at the upper part of the same flask a free example (*a*) is seen. E. Desor falls into a slight error in his excellent description, when he states that the cells in the interior of the embryo are the "residue of the vitellus destined for the support of the animal;" they are nothing else than the cells in the developing wall of the alimentary canal. The large dark ciliated mass (*c*) at the lower part of the flask, and the scattered cells and granules, are portions of the discarded external covering of the embryo; and it is to be observed that the cilia on this texture are somewhat longer than those on the free young animal, though their motion is less vigorous. The "cells" of which this rejected covering is made up are entirely of a fatty nature (Plate XXII, fig. 6)—in short, an aggregation of fatty granules, with an oil-globule or two, and capable of changing form accordingly. It is a fact that this debris after a time quite disappears from the flask, and therefore it probably acts as nourishment for the young (being swallowed by the mouth, as in the case of the embryo of *Purpura lapillus*) just as the yolk-sac, by a different mode, does in other animals. In escaping from the flask, the young animals, in many cases, seem to have thrust themselves along the narrow apex, dilating it and bursting through. For a considerable time afterwards, both in captive and littoral cases, they crawl in swarms among the gelatinous mucus, so that the latter has a strange aspect,

E. Desor makes the following remark about the young *Lixæus*, when removed from the flask:—"It appears perfectly motionless, and on being brought about, and within

being filled, in addition, with the transparent flasks from which they have escaped, and a few undeveloped ova. Moreover, it is a common practice for the adults to creep through these masses, and several are generally coiled in proximity. The number of undeveloped ova is extremely small, showing how easy it is to rear these animals, even with very limited supplies of sea-water.

The young *Linei*, at the stage previously mentioned, are visible to the naked eye as small elongated worms, somewhat tapered at the ends, pale, or rather translucent in front, and opaque-whitish posteriorly (Plate XXIII, fig. 9), while in structure they now closely approach the adult. The whole surface of the body is richly coated with cilia, which are especially active in the cephalic fissures, and still more so at the openings of the cephalic sacs. The ganglia are indicated by a pale space (*h*) on each side, but their actual outline is indistinct. There are in all cases at least two well-marked eyes. The cephalic sacs (*m*) are large and well defined, indeed very much larger proportionally than they are in the adult; and from their present position with respect to the ganglia, demonstrate the true form of the latter, as well as the error into which those authors have fallen who have confounded the sacs in the mature animals with posterior ganglionic enlargements. The sacs open by their ducts at the posterior part of the cephalic fissures (*b*), and the ciliary action can be traced inwards from these points. The oesophageal division (*j*) of the digestive canal is distinguished by its pallor, more evident ciliation, and the well-defined border of the succeeding opaque region (*f*). The proboscis (*a*) is marked by a central streak of papillæ, and, after tapering posteriorly, curves forward, and disappears. The proboscidian sheath (*o*) is banded here and there anteriorly by transverse bristles, and a clear line is occasionally visible on each side of the opaque alimentary tube, as if from circulatory undulation. An anal papilla (Plate XVII, fig. 22), with a ciliated line connecting it with the digestive cavity, is also apparent.

Shortly after hatching the degree of development shown in Plate XXIII, fig. 9, the young *Linei* leave the gelatinous masses, and congregate at the water-line. Hundreds now perish from want of sufficient food, which in their native haunts is probably both abundant and suitable, while in the artificial circumstances and confined vessel it is denied them. Ten weeks afterwards the young animals are found still of the same whitish hue, and possess only two eyes, rarely an additional pigmentary fragment. The proboscis has much increased in size; indeed, at this time it has attained a comparatively larger development than the digestive cavity, which is its active use, since the young animal is entirely dependent on its own exertions for a supply of food. The oesophageal region is very distinctly marked, though its dimensions are proportionally small when contrasted with the length of the head; at present it is not a quarter the length of the latter, whereas in the adult it is several times longer. Its space is also considerably encroached on by the large cephalic sacs.

At a further stage of development the animal is much elongated (Plate XXIII, fig. 10), yet still possesses only two eyes. In this condition it has been mistaken for the representative of a different genus, and is probably that referred to by Dr. Johnston, under the name of *Cephalothrix* (*Vermiculus lineatus*, Dalyell).

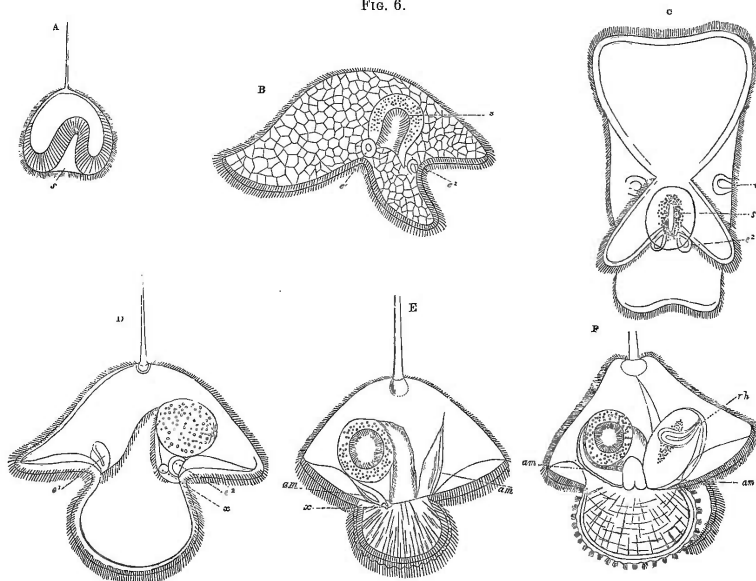
A vast cord of ova, about a foot long and half an inch in diameter, and which in all probability pertained to *Lineus marinus*, was brought from the deep-sea fishing off St. Andrews Bay about the end of June. The capsules are arranged in the gelatinous mucus in somewhat

against different objects, one might suppose it endowed with a certain amount of curiosity; sometimes, also, I saw them shake themselves convulsively, as if they had a chill."

indistinct transverse rows. Each ovoid flask (Plate XXIII, fig. 11) has a process as in *Lineus gesserensis*, but it is much smaller; and in the same manner contains several yolks. Unfortunately, from defective arrangements and the very hot weather, all the embryos were dead, only a little isolated ciliation being observed on certain cells. The embryos were furnished with black eye-specks.

In the remarkable development of the Nemertean from the *Pygidium*-form, as first described by Kröhn and the celebrated J. Müller, afterwards by Busch, Gegenbaur, Leuckart, and Pagenstecher, and recently by Metschnikoff, the phases mentioned in the foregoing pages are considerably increased in complexity. E. Metschnikoff finds that in the egg of a whitish *Lineus* from Messina the usual changes ensue after impregnation, resulting in the formation of a ciliated embryo, which by-and-by assumes the shape of a *Pygidium* (woodcut, fig. 6, A), having a depression of the

FIG. 6.

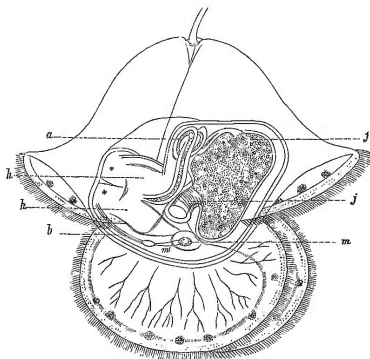


*Pygidium-development.* (After Dr. E. Metschnikoff.)

- A.—Young *Pygidium* on its escape from the egg;  $\sigma$ , the oral involution.  
 B.—Profile of a *Pygidium*, showing the early condition of the caecal stomach ( $\sigma$ ), with its collulo-granular coating;  $\sigma^1$   $\sigma^2$ , the anterior and posterior pair of processes from which the future Nemertean is developed.  
 C.—The same *Pygidium* viewed from the under surface.  
 D.—Profile of an older *Pygidium* with the processes developing, and after the appearance of the cephalic east ( $\sigma^3$ ).  
 E.—Another *Pygidium* showing the elongated leaves developed from the original processes, with the elementary amnion ( $\sigma m$ ).  
 F.—A further stage in the process, the young Nemertean being now outlined;  $\sigma h$ , the proboscis.

body corresponding to the mouth (*s*) and future digestive tract, and the usual long tuft of cilia. The involution is next differentiated into an œsophagus and cœcal stomach, the lining membrane being furnished with cilia and the wall with cellulose-granular elements (*h*). About this time the

FIG. 7.



*Pylidium* showing the young Nemertean and most of its internal organs.

*Pylidium* leaves the egg, and swims freely in the water. The second stage is the formation of the Nemertean in the interior of the *Pylidium*. The first step towards this end consists in the appearance of four round thickenings of the skin (*b*, *c*, *e*, *e'*), two larger in front of the lobes of the helmet-like *Pylidium*, and two behind,—the four corresponding to the “suckers” of J. Müller. The anterior pair soon increase in size and become divided into a thicker and a thinner half, the former, moreover, making two folds. A “Seitenorgane” (*x*) (cephalic sac) appears in front of each of the posterior processes (*e''*), which grow into two elongated vesicles, each with a thicker and a thinner portion. A commissure and the proboscis (*r/h*) develop anteriorly, and other changes ensue both there and in the posterior processes; part of the latter investing the stomach, the thicker fold being directed towards the mouth of the *Pylidium*, while the thinner, coloured somewhat brownish, becomes converted into a very fine membrane, which forms a border to the thicker portion. These two processes (anterior and posterior), which are separated only by the atricle (Bläschen), become subsequently more closely arranged; so that the Nemertean embryo forms a semicircular mass. Further changes occur in the anterior and posterior processes, and the various parts of the Nemertean become differentiated. A membranous envelope, *am* (Amnion), is developed, in which currents are caused by the ciliated coating of the young worm. The ganglia, the ducts of the cephalic sacs, and a caudal style also appear, and the œsophagus and digestive sac assume a Nemertean type, the body of the young animal closing round the latter cavity. Finally, an almost complete young worm is found in the interior of its envelope (wood-

cut, fig. 7), and by-and-by it assumes a free existence. In the species described by Leuckart and Pagenstecher from Heligoland, no caudal styloform process was observed; but in J. Müller and Metschnikoff's forms this was present, and such may in all probability be the young of *Micrura fasciolata* (as mentioned by the former) or some other closely allied species.

E. Metschnikoff's summary of the development of the Nemertean in the *Pygidium* is as follows:—

1. The commencement of the Nemertean body is in the form of two pairs of cutaneous processes, which not only develop the body of the worm, but also the amnion.

2. Two median vesicles are produced, which at a later period become connected with lateral ducts.

3. The four structures developed from the cutaneous processes, which represent the future germ-fold, appear to be fashioned from two germ-leaves. From the outer leaf is formed the epidermis and central nervous system, from the inner the muscular coat (and perhaps also the circulatory system).

4. Through the coalescence of these four processes, primitive folds representing the future ventral surface, together with the head of the Nemertean, are developed; whilst the dorsal coverings are formed subsequently.

5. The proboscis is developed in the form of a simple process at the anterior part of the germ-streaks.

The reproductive organs of *Notospermus flaccidus* are correctly represented by Ersted, but his drawing of the spermatozoa is inaccurate, since he shows a simple spindle-shaped body without a filament. M. de Quatrefages observes that the reproductive organs are digitate in *Borlasia anglica*, and figures them after this manner; but such is scarcely a correct definition; neither have any cilia been detected in connection with these structures. Indeed, he has probably mistaken the digestive canal and its sacculations for the reproductive system, as he mentions that out of season the cæca are filled with a fluid more or less opaline. M. van Beneden found the ovisacs to contain from one to a hundred ova in his *Nemertes communis*; but though deposited in a membranous sheath in September, no change had ensued in November. His figure of the spermatozoa of this species is incomplete, as no tails are present, and he describes them as simple rods. He makes the interesting statement, that in the same animal he found the embryos in some ova covered with vibratile cilia even in the body of the parent, while others were only fecundated during or after deposition. The young Nemertean described by Dr. Busch, under the name *Alaridus caudatus*, would seem to have some relation to *Micrura*, since it possesses a very distinct style at the posterior extremity.

Although I am not quite free from doubts concerning the exact position of the curious larval animal mentioned by Mr. Alex. Agassiz<sup>1</sup> as a further stage of the type first noted by the distinguished zoologist of Stockholm, Prof. Lovén, it may be well to conclude the present section by a few observations thereon. In the early stages it is a somewhat club-shaped animal, having a circle of long cilia anteriorly, and another posteriorly in front of the anus. Behind the anterior ring of cilia, the mouth opens into an œsophagus, followed by a stomach and intestine. As the animal gets older two eyes and a pair of short cephalic tentacles appear, while the body becomes much elongated and distinctly segmented. At a further stage a remarkable retrograde metamorphosis ensues, whereby it loses the anterior and posterior ciliated rings, the tentacles, and

<sup>1</sup> 'Ann. Nat. Hist.' 3rd ser., xix, p. 208.



the segmented condition of the body, and assumes the outline of a Nemertean, that is, has an elongated vermiform body without segments or appendages, a head furnished with two large eyes, and a mouth apparently opening behind the ganglia. The observations at present recorded, however, are not sufficiently decisive to satisfy us. Thus no mention is made of the important fact as to the presence of cilia on the general surface of the body, both before and after the shedding of the anterior and posterior circlets of long cilia. While it is true no bristles or other diagnostic structures connecting the form with the majority of the higher Annelids appear, it is equally evident that the essential Nemertean anatomy is wanting. Nothing is said of the characteristic cephalic ganglia and sacs, the lateral nerve-cords, the proboscis, or the structure of the cutis—points that are recognized in every known Nemertean long before it has reached the development and age of *A. Agassiz's* form. The latter thinks, also, that it approaches the *Nareda* of Stimpson, but this is doubtful, since the somewhat meagre description and the figure would indicate *Nareda superba* to belong to the division of the Enopla, whereas the young form has its mouth apparently opening behind the ganglia. Our judgment must therefore be reserved with regard to the particular type to which this interesting animal belongs.

The development of *Carinella* has not yet been observed.

In *Cephalothrix* the ova and spermatozoa are developed in a dense series of sacs (that give the animal a transversely barred aspect), which commence a short distance behind the mouth and continue nearly to the tip of the tail. The males are distinguished by their somewhat pale aspect when the reproductive organs are fully developed, viz. towards the end of January and during the subsequent months of spring. The spermatozoa (Plate XXI, fig. 13) consist of short flattened spindles with rounded instead of pointed ends, that to which the tail is attached being somewhat smaller than the other. In swimming the two ends appear as clear dots. Though the animal is extremely elongated, the bodies of the spermatozoa are comparatively short. The mature female presents a dusky or slightly fawn-coloured aspect, the ova, under gentle pressure in the living animal, being arranged in dense transverse rows in each ovary. The total number of ova produced by a single example must be very great. In transverse sections they occupy a large ovoid space on each side of the alimentary canal, upwards of twenty ova—very prettily arranged in a concentric manner—occurring in a single thin slice. The space of the digestive canal in these preparations had thus assumed the form of the letter *x*, the walls approaching each other in the middle, but diverging superiorly and inferiorly; while a wedge-shaped fold from the dorsum below the proboscis, and another from the ventral surface, completed the resemblance. This was the more marked if the proboscis had been ejected. The ova are deposited from the beginning of February till June; either adhering together in irregular masses by their edges or a little accidental mucus, or scattered about the vessel in detached groups. In several instances, however, they were enclosed in a translucent sheath of mucus. On deposition they have a granular structure throughout (Plate XXIII, fig. 12), with a clear spot and globule, and measure about  $\frac{1}{30}$ th of an inch in diameter. The ova pass rapidly through the usual stages, and on the 11th February the embryos revolve actively in the egg by aid of their cilia, and in some cases are hatched. The extruded animal (Plate XXIII, fig. 13), under moderate pressure, has a globular form, but assumes various shapes when free, the ordinary one being that of an apple—the long ciliary process representing the stalk, while the body slightly tapers towards the posterior end. It is opaque and granular, with the exception of the margin, which is somewhat translucent, from the slight

differentiation of the cutaneous textures. Externally it is coated with long cilia, by aid of which it executes rapid motions, a tuft anteriorly having the form of a long whip-like process, and resembling a single mobile thread during the progress of the animal. The outline is sometimes pitted at the origin of the latter, while a slight papilla projects at the posterior end. When fixed between glasses the cilia are soon thrown off, and the body resolves itself into a number of cells and granules (Plate XXI, fig. 8). In two days the animal is somewhat elongated (Plate XXIII, fig. 14), and the mouth (*a*) is in the form of a strongly ciliated slit placed nearly in the centre of the body, which, with the above-mentioned exception, is still uniformly granular. A longer tuft of cilia at the anus is now more evident. Two days later considerable increase has occurred in the length of the body (Plate XXIII, fig. 15), and from the anterior position of the mouth, it is apparent the chief increment has taken place in the posterior region. The outline is now pear-shaped, the snout being much less tapered than the tail. The cutaneous textures are more distinctly marked, and the cells, with their refracting contents, very apparent; there is also a corresponding advance in the growth of the granules of the alimentary canal, its ciliation, and the posterior sacculations. The whip-like tuft on the snout is somewhat shorter, and there now exist a few longer cilia on the side of the head, the posterior group of which (*c*) are evidently the precursors of the long ciliary tuft, which by-and-by appears. There is yet no trace of eye-specks. A few cylindrical papillæ are observed on the snout and tail, and one or two along the sides, which processes do not seem to result from pressure. A day or two afterwards some are furnished with one and others with two eye-specks; moreover, the tuft of cilia on the snout is gradually diminishing, while the lateral cilia (*c*) before mentioned are becoming longer. During a period stretching from March to the beginning of June, the various vessels swarmed with successive broods of young (from different individuals), which in the form of minute white specks darted about most actively. They did not crawl along the bottom, but, like the young of *Phyllodoce* and other Annelids, swam freely throughout the water after the manner of *Infusoria*, or danced to and fro like *Ephemera* in the air. Externally at this further stage of advancement they still have a coating of very long cilia (Plate XXIII, fig. 16), which serve as natatory organs, the tuft (*c*) on each side being about thrice as long as the rest, while the anterior whip has disappeared. There are two large well-defined black eyes, no doubt provided by nature for the exigencies of the youthful state, just as the young of certain mollusks and cirripedes are similarly furnished. The mouth (*a*), the cesophagus, and succeeding region of the digestive cavity are all richly ciliated. The whole animal is soft and delicate, and few of my specimens survived this stage. Those which outlived the others became more elongated, and had a little reddish pigment developed in the snout. After the disappearance of the eyes (in October) they have the form of slender reddish bodies, with a conspicuous mouth a short distance behind the anterior margin. The cilia on the snout are very much longer than on the rest of the body, and project like a long brush or fan, so as to give the animal the aspect of an infusorial animalcule.

We have thus in *Cephalothrix* a certain resemblance to the development of M. van Benedon's *Nemertes carcinophila*, already described (see p. 93), and the phases of the growth of the present species likewise corroborate everything that has been advanced in contradistinction to the interpretations of the Belgian author. His views in regard to the *scotæ* and *proglossis* receive no support from the foregoing observations, for all the changes that occur are only the gradual and very perceptible shedding of certain cilia, and the general advance in organization as shown by the differentiation of tissues and the appearance of pigment in the eye-specks. The moulting of

the long anterior tuft of cilia by the young *Cephalothrix* has its analogue in the loss of the ciliated ring by the young *Phyllodoce* and others, in the shedding of the temporary bristles noticed by Busch and Leuckart in the young of a *Nerine*, and by M. de Quatrefages in the young stages of *Hermella*. I think there can be no doubt that the remarkable tuft of cilia occurring in the young *Cephalothrix* on each side of the snout, and which attains its full development after the long anterior whip has ceased to be conspicuous, is connected homologically with the entrance to the cephalic sacs in the *Enopla*, and the fissures of the *Lineidae*, as well as with the ciliated ring of *Phyllodoce* above mentioned. It is an embryonic type of a structure which disappears entirely in the adult. The delicacy of the young at the period of the full development of the eye-specks is an interesting feature; but it prevented my observing their growth into perfect animals.

Thus, so far as development goes, *Cephalothrix* is nearly allied to the *Enopla*, especially to *Tetrastemma dorsalis*, *Nemertes carcinophila*, and probably to others of the group not yet investigated; while, in the structure of its digestive system, circulatory apparatus, and the unarmed proboscis with its bridled sheath, it leans rather towards the *Lineidae*. Prof. Kefenstein in his proposed classification of the Order rightly places the genus in a special Family, called *Gymnocephalidae*, the chief characteristics described by him being:—Absence of cephalic fissures; brain like that of *Polia* (*Amphiporus*), but the superior ganglion covers the inferior much less, and is advanced in front of it. He bases his statement of the relationship to the *Enopla*, as it appears to me, on somewhat questionable grounds, for the ganglia are by no means closely allied in form and structure to those of that group.

### III.—REPRODUCTION OF LOST PARTS.

In the Nemerteans, as in the Annelida proper, the reproduction of rejected parts and the repair of wounds take place with accuracy and considerable rapidity. If but a fragment is left behind the head, a new body and tail are reproduced in the majority. The severed posterior half of the animal, or other headless fragment, seldom perfects a head in confinement, but remains alive for a year or more, slowly turning round when irritated, and, moreover, developing the generative products in its interior. Thus a specimen of *Lineus marinus*, sent from St. Andrews in September, broke into pieces on the journey; yet six months afterwards most of the fragments were alive, although the sea-water had not been changed more than once. The head and anterior portion of the worm, which at first scarcely measured two inches, had now grown a body and tail that when progressing extended at least seven inches, and of course was capable of much greater elongation, so that it looked like an independent animal; and this was accomplished without the aid of any food, except perhaps what it might have acquired from the fragments of its own body in the neighbourhood. Some of the latter measured about a foot in length, and all were coiled in various ways, with the ends puckered, and in most cases fixed by a whitish cicatrix, which was firmer at one end than the other, and

occasionally tapered. One of the most interesting features was the gradual development and elaboration of the products of the generative organs (in this case the male elements) in the headless fragments, so that when in February they were placed in clean sea-water, some gave exit to milky clouds of perfect spermatozoa. This would seem in these animals to be the main aim of such a provision, since their very length and softness, if not fragility, apparently court dis-severance. They display greater vitality in this respect than the majority of the Annelida, and it is not necessary that the sea-water be changed for years, or that fragments of their own bodies or other débris be present. In one species, moreover, each of the numerous fragments into which its lengthened and fragile body breaks becomes a perfect animal.

In captivity, specimens of *Lineus sanguineus* (Plate V, fig. 2) have often a great tendency to rupture into many pieces. These fragments lie on the bottom of the vessel, and, in the majority, consist of the body-wall, its nerve-cords and vessels, the central alimentary chamber, and the dorsal sheath for the proboscis. Numerous parasitic gregariniform bodies, as well as the peculiar ova to be described subsequently,<sup>1</sup> may also be seen in them; and the new animals are thus supplied, *ab initio*, with such structures in their digestive tracts, without being subjected to the earlier stages in their development. For some time after separation the large aperture of the digestive chamber existing at each end remains closed by firm contraction of the circular muscular fibres of the body-wall; but by-and-by new cell-growth occurs at both extremities, especially the anterior. At the latter the parts firmly contracted by the primary muscular spasm gradually become more or less consolidated by a cicatrix. This new growth steadily increases in bulk, distinguishing the anterior end of the fragment, even in the early stages, by its conspicuous pallor. The appearance of this extremity in a specimen, probably about three weeks after rupture, is shown in Plate XXII, fig. 7. The head is represented by the pale, sprouting mass in front of the alimentary tract, and there is no further differentiation of organs than the separation of the exterior (cutaneous) elements from the inner mass, and the ciliated aperture (*a*) leading into the sheath for the proboscis. The three contractile circulatory channels of the body course forward to the pale developing region, and apparently communicate with each other without passing into it; they are connected by the usual transverse branches throughout their course. The posterior end of the fragment shoots into a conical tail (Plate XXII, fig. 8), with a well-formed anus (*s*) in its proper position, and through which, under pressure, a prolapsus of the wall of the digestive chamber occasionally occurs, or an escape of one or more gregariniform parasites.

In the next stage (Plate XXII, fig. 9) the anterior end has assumed a more conical form, and there is a greater differentiation of organs. The cutaneous elements are distinctly marked, and a miniature proboscis (*a'*) occupies its sheath, both springing from a point some distance behind the tip of the snout, and corresponding to the commissure of the developing ganglia (*h*), which latter, however, are scarcely apparent. The proboscidian sheath contains a clear fluid and granules, which now and then distend the front as in the figure. The proboscis (*a'*) is quite free posteriorly. The cephalic fissures are indicated on each side by slight superficial grooves, very strongly ciliated. Besides the faint contour of the ganglia, which spring from the anterior ends of the nerve-trunks, the cephalic pits and glands (*m*) are outlined. The circulation in the vessels extends only to the posterior border of the white snout. The digestive tract presents no subdivision into regions.

See also 'Journ. of Micros. Science,' 1867, "Trans. Micros. Soc.," p. 40.

A more advanced condition of the head is found after two or three months (Plate XXII, fig. 10). The snout is very much elongated both before and behind the commissures. In some eye-specks now appear in their usual position, and there is a distinct channel leading inwards to the enlarged proboscis; the ganglia approach the normal shape, and the cephalic pits, with their ducts passing into the posterior end of the cephalic fissures, are well marked. The anterior part of the alimentary tract has assumed a rounded form behind the ganglia, with the mouth (*w*) in the usual position. In those best developed (*es. g.* Plate XXII, fig. 11), the first or œsophageal division of the canal is differentiated from the succeeding portion; and in the ordinary fragments it is apparent that the former consists, for the most part, of new texture. Such examples, however, do not always possess eye-specks. The circulation now scarcely differs from that in the adult.

The motions of those with reproduced heads (Plate XXII, fig. 11) are not so active as usual in young *Lineæ*, and the animals are at once distinguished by the pointed nature and pallor of their snouts.

The formation of a complete individual, and the prolonged retention of certain functions by the headless fragments, under circumstances so adverse as the above, may give some idea of the powers of regeneration and vitality possessed by these worms in their native haunts; for it is to be remembered that they were at a great distance from the sea-coast, had no food (except what they might obtain from microscopic animals or the fragments of their own bodies), and had a very limited supply of salt water.

Moreover, besides the application of the ordinary laws of natural and sexual selection (if such exist in these forms), we have thus the additional (fissiparous) operation by which mere fragments of the body of the animal are capable of reproducing the entire organism and all its complex parts.

In like manner very serious wounds made in removing the proboscis are easily repaired, without leaving a trace of the injury after the pigment is fully developed in the cicatrix. Portions may also be removed from the posterior end of long species for microscopic purposes, while the rest of the animal lives and thrives for further observations.

The reproduction of the proboscis is referred to under the anatomy of that organ in the *Enopla*.

Comparatively few abnormalities of external form are met with in the Nemertean. An example of *Lineus sanguineus*, found at Lochmaddy, had a curious diverticulum about the posterior end of the œsophageal region. This process was covered by all the coats of the body, and, in the preparation, contained a knuckle of the proboscis. The accompanying woodcut (fig. 8) represents the anterior part of the specimen during life.

FIG. 8.



*Lineus sanguineus*, with a diverticulum of the body (shown) enlarged.

## IV.—PARASITES.

A very common parasite in the Nemerteans is a *Gregarina*, which frequents the alimentary chamber of *Amphiporus lactifloreus*, according to Mr. Lankester, and is found abundantly in the same region of *Lineus gesserensis* and its allies. The presence of such animals in the Nemerteans appears to have been first noticed by Dr. G. Johnston, who in 1837 described them in *L. gesserensis* (with an accompanying figure) in the first volume of the 'Magazine of Zoology and Botany,' thus :—'When pressing a portion of the body between the plates of glass, I have occasionally seen some bodies escape, of a curved fusiform shape, acute at both ends, and marked with a pale circular spot. They have shown no signs of life, nor can I say what they are, though it has occurred to me that they may be the embryo-young; and that the worms may in fact be ovo-viviparous.' This excellent naturalist thus misinterpreted their true character. Prof. Kölliker<sup>1</sup> in his contribution to the genus *Gregarina*, in 1848, more clearly defines their nature, and describes them under the name *Gregarina Nemertis*, from the alimentary canal of *Nemertes delineaatus* (*Polia delineaata*, D. Ch.). Frey and Leuekart, Max Schultze, Van Beneden, and other authors have also noticed their presence.

The *Gregarinae* occur in swarms in many examples, and consist of elongated comma-shaped bodies (Plate XIX, figs. 10 and 11), having a transparent investment filled with minutely granular contents, and each has a large pale nucleus, measuring from  $\frac{1}{10}$  to  $\frac{1}{8}$  of an inch upwards, according to the size of the specimen. The nucleus shows faint markings when the parasite is first extruded, but a distinct nucleolus is not very apparent, though from the recent excellent observations of Ed. van Beneden,<sup>2</sup> it is probably present. In perfect specimens the snout is pale, very faintly granular (and quite diaphanous), bluntly rounded, and marked by a slight swelling of the body at its base, from which prominence the snout gently tapers. There is no trace of rough points or other apparatus for attachment. Sometimes, as when the investment has received injury, the surrounding water seems to pass inwards and separate at certain parts the contained granules from the sheath, a fact which shows a certain degree of cohesion in the contents *in situ*, or the presence of another layer. A favourable opportunity of examining the parasites is occasionally afforded by the spontaneous rupture of some of the Nemerteans. The *Gregarinae* then project from the granular parenchyma throughout their entire length, with the exception of the snout, by which they adhere. Indeed, this may often be seen in the perfect worm, for the waves of fluid bend hither and thither the free bodies of the parasites. After remaining for some time in the previously mentioned position (under pressure) a few separate themselves, and move through the salt water with a slow gliding motion like that of a diatome. On careful scrutiny the contour of the snout in a living specimen is observed now and then to vary. The motion of the body is not due to currents between the glasses, as it passes through mucus in the same manner. After remaining in salt water for eight or ten hours all movement ceases, and in some the body becomes club-shaped (Plate XIX, fig. 11); at the same time the clear portion at the snout is almost obliterated by encroachment of the granules. Occasionally one of the *Gregarinae* is observed in a degenerating condition, forming an ovoid body in which the bent and atrophied parasite is scarcely distinguishable.

<sup>1</sup> 'Zeitsch. für wiss. Zool.' Bd. I, pp. 1 and 2, Taf. I, fig. 4 b.

<sup>2</sup> 'Bulet. de l'Acad. Roy. de Belg.', 2me sér., tome xxxi, No. 5, 1871. See also 'Quart. Jour. Micro. Sc.' July, 1872, pp. 211 *et seq.*

The large number of the *Gregarina* in some examples of the Nemerteans must give them a position of importance in the economy of the worms. They likewise occur in the Planarians and in the true Annelids.

The small hodies shown in Plate XX, fig. 10, were extruded in multitudes with the *Gregarinae* from *Lineus gesserenis* and *L. lacteus*. They were generally of an ovoid or pyriform shape—a few being circular, and contained many granules. Their diameter is about  $\frac{1}{1000}$ th of an inch, or rather more. They appear to be pseudo-navicella.

Accompanying the gregariniform parasites certain ova are sometimes ejected from the alimentary chamber, enveloped in mucus, and in the form of an elongated cordon (Plate XX, fig. 11), the latter being rather more than the breadth of two ova, which are loosely scattered in the slightly granular gelatinous matrix. These ova (Plate XX, fig. 12) measure about  $\frac{1}{1000}$ th of an inch in diameter, and each contains an embryo that, for some time after the extrusion of the egg, makes very evident movements. They have two coats, and the embryo is finely granular, with a large pale nucleus. I have not seen the embryo hatched in a perfect state, but it is probable that these ova are connected either with the parasite of the muscles hereafter to be described, or with an unknown trematode-larva.

Another curious parasite is found burrowing in the body-wall of *Lineus gesserenis*, its presence being readily recognised by the perforated and honey-combed appearance of the dorsum of the affected animal, whose textures seem to be the seat of the workings of a microscopic *Tomicus typographus*. When highly magnified the affected region appears to be covered with a vast network of pale, minutely granular channels, which contain numerous opaque ovoid granular masses. On rupturing the body of the worm a large number of the peculiar structures (Plate XVIII, fig. 17) slide out of the channels, and swim through the surrounding water, generally, though not always, with the upper end (in the figure) first. Externally they are coated with long cilia, whose activity in the free state is of somewhat short duration, for after a time the animals remain quiet and they drop off. The body is distinctly segmented, and tapers slightly towards the posterior end; while the surface is marked by very fine longitudinal striæ, as in *Opatina*, though in a much more minute degree. Anteriorly is a conical portion (*a*), composed of three rather indistinctly marked segments. Two evident annuli (*b*) succeed, the posterior part of the last being narrowed, so as to cause a constriction of the body-wall. Behind are six nearly equal divisions (*c*), each often appearing double, that is, has a broad anterior and a narrow posterior annulus. The posterior region (*d*) consists of three indistinct segments. The body is minutely granular throughout, and an internal cavity is apparent from the fourth segment to the last, commencing in the former by a rounded end, and terminating just within the border of the latter. No aperture is observed at either end. The opaque ovoid granular hodies (Plate XVIII, fig. 18), scattered profusely throughout the infected portions of the *Lineus*, are evidently early stages in the development of this species, and they too are ciliated. On subjecting them to gentle pressure (fig. 19) transverse segmentation is apparent, the number of segments varying according to the degree of advancement. The parasites are very delicate structures, and in the free state soon break up into cells and granules, after discarding their cilia as above mentioned. Transverse section of the affected worms shows that they occur both in the skin and in the walls of the digestive tract, their ravages in the pigmentary layer of the former tissue causing the curious appearances which led to their detection. It is a somewhat difficult point to determine whether the skin, muscles of the body-wall, or digestive canal, constitute the common area of this

creature's depredations; whether it is piercing the former on its way to the surface, or passing towards the alimentary cavity to be voided per anum. The characteristically segmented condition of the full-grown specimens, and their internal structure, exhibit a higher type of organization than the ordinary *Opalina*. Prof. Keferstein<sup>1</sup> found a very similar parasite in the stomach of *Leptoplana tremellaris*, but he did not describe it further than simply mention, under the explanation of the Plate, that it is an enigmatical structure. The centre of the body is occupied by a double row of large cells in his figure.

In the external longitudinal muscular layer and the region to the exterior in *Lineus marinus*, certain parasitic or adventitious cellular masses are found (*a*, Plate XXII, fig. 5). They lie in definite spaces (*b*), and consist of rounded cells filled with granules.

Another parasitic structure occurred in a large male specimen of *Amphiporus lactifloreus* in the shape of an oviform body enveloped in a granular lobulated mass, lying close behind the ganglion of one side (Plate XVII, fig. 11), to the exterior of the proboscidian sheath, and altogether unconnected with the oesophagus. Externally is a distinct hyaline capsule or cyst (*γ*), to which certain fragments of the fibro-granular lobulated covering adhere. The embryo (Plate XVII, fig. 12) is furnished with a very conspicuous opaque granular mass, and two discs; while the general stroma is cellulo-granular, here and there closely streaked by minute lines, apparently from its external investment. No motion of the included animal is observable, except an alteration in the size and aspect of the pores and discs after a period of eight or nine hours (Plate XVII, fig. 13). This is evidently a trematode-larva in its capsule, and by rupturing the latter a complete view of the embryo is obtained (Plate XVII, fig. 14). The oral sucker (*c*) is considerably smaller than the ventral (*β*). The oesophageal body (*d*) appears as a distinct swelling near the oral disc, and from the tube behind the former the alimentary cæca (*e, e*) branch off and become lost in the cellular tissues posteriorly. The opaque mass of cells and granules at *a* may be connected with the testicles, and the two circular granular bodies, *f* and *g*, are probably associated with the ovaries. A trace of the excretory tubes appears at the oral sucker.

In a specimen of *Cephalothrix filiformis* several examples of an *Opalina* occurred, but such on the whole seem rare in the Scottish Nemerteans.

#### V.—CLASSIFICATION.

As might have been expected in the case of animals whose anatomical structure was either unknown or much misunderstood, great diversity has prevailed in the classification of the Nemerteans. The early writers, such as O. F. Müller, O. Fabricius, and Gmelin generally placed them amongst the Helminths or intestinal worms (under the genus *Planaria*); and even Cuvier associated them with the same group. Others, such as Oken and Fleming, ranged them near *Gordius* and *Lumbricus*. De Blainville, again, established the family *Terebularia* for their reception, the title being founded on the external appearance of the animals. Ehrenberg next

<sup>1</sup>Der K. Gesellsch. der Wissensch. vorgelegt, am 4, Januar, 1868.



constituted the class *Phylozoa Turbellaria* for them and the Planarians, as described in detail in the 'History.' Other authors, such as Quoy, Gaimard and Macleay, placed them under the group "Vers Apodes," without any definite basis of classification. Dr. G. Johnston first pointed out the important fact, that one group of the Nemerteans had and that the other had not stylets, and thus he has partly the credit of the classification promulgated by Max Schultze. They constituted, again, the *Annelosi Polici* of Delle Chiaje; and the fourth sub-order (Cestodina) of the *Apoda* of Ersted. Kölliker's division of the Nemerteans, according to the presence or absence of a sheath for the proboscis, rests upon a misunderstanding, as the sheath is present in all. De Quatrefages adopted Ehrenberg's classification with amendments, placing the Nemerteans under the third order *Miscala*, and founding his subordinate groups on the position (lateral or sub-lateral) of the nerve-trunks, and the situation of the mouth. Von Siebold ranged them as the first order of his ringed worms (Apodes), and separated them from the Planarians by the intervention of the Rotatoria. Blanchard formed the term *Aplocala* for the group, and thought the term Nemerteans should be restricted to a tribe or family, but the author was misled as regards the true alimentary organ. Diesing's arrangement is sufficiently alluded to in the Zoography, and rests on no secure basis. Girard wished to class them with the mollusks, an idea which found no other supporter. Max Schultze divided Ehrenberg's class Turbellaria into the sub-classes *Approcta* and *Proctucha*, the Nemerteans being grouped under the latter. This author afterwards split the order Nemertinea into the *Enopla* and *Anopla*, according to the armed or unarmed condition of the proboscis. Stimpson's classification was based on the presence or absence of the ventral fissure, and other external characters, and therefore failed where it was most wanted. The same may be said of Schmarda's arrangement, where the characters of the sub-orders are founded on the "respiratory" fissures. Keferstein establishes the primary division of the order on the same basis as Max Schultze, but enters much more minutely into the subject. His families rest on characters derived from the fissures of the head and the arrangement of the ganglia. There is little new matter in the classification adopted in the Catalogue of the British Museum. In his 'Handbuch der Zoologie,' J. V. Carus arranges the Nemerteans as the first division (Turbellaria) of his fifth class (Platyelminthes) of the VERMES, the second division being formed by the Trematoda, to which he states the Planarians lead, and the third division by the Cestodes. Similar views prevail in several text-books of zoology.

The inquiry into the structure of the British Nemerteans rendered it apparent that considerable modifications of the existing schemes would be requisite, yet great care has been taken to interfere only where absolutely necessary.

With these brief remarks on the chief classifications already in existence, I may now proceed to explain the appended scheme.

CLASS TURBELLARIA. <sup>1</sup>					
Order.	Sub-Orders.	Families.	Sub-Families.	Genera.	
NEMERTINEA	ENOPLA .	AMPHIPORIDÆ .	{ <i>Amphiporinae</i> } { <i>Nemertinae</i> . }	I. Amphiporus.	
				II. Tetrastemma.	
					III. Proserhocmus.
	ANOPLA .	LINEIDÆ			V. Lineus.
					VI. Borlasia.
				VII. Cerebratulus.	
				VIII. Micrura.	
				IX. Meckelia.	
	CARINELLIDÆ			X. Carinella.	
	CEPHALOTHRICIDÆ			XI. Valencinia.	
				XII. Cephalothrix.	

The characters of the order NEMERTINEA may be concisely described as follows:—Worms with more or less elongated, soft, ciliated bodies; nervous system composed of two conspicuous ganglia connected by a double commissure and two main lateral trunks; digestive system a ciliated canal with two apertures; circulatory system consisting of a series of closed contractile vessels. The proboscis forms the most typical organ in the group, is surrounded by a special muscular sheath, within which it glides in a corpuscular fluid, and passes in front between the commissures of the ganglia, while the digestive tract is placed inferiorly. Sexes separate in the majority, oviparous or ovo-viviparous.

The order may most naturally be divided into two great *sub-orders*, distinguished from each other by the presence or absence of stylets in the proboscis or typical organ of the group; the former being called after Max Schultz (but with amended characters) ENOPLA,<sup>2</sup> and the latter ANOPLA.<sup>3</sup>

The sub-order ENOPLA is characterised further by the globular and somewhat double nature of the nerve-ganglia, and by the fact that the lateral nerve-trunks are placed within the proper muscular walls of the body. The mouth, moreover, opens on the ventral surface of the snout in front of the commissures of the ganglia. The blood-vessels are more differentiated than in the ANOPLA. The young, so far as known, do not undergo any noteworthy metamorphosis in their growth.

In the ENOPLA there exist one great group and a subordinate one, which latter, however, retains so many of the characters of the former that it conveniently forms a sub-family. In the chief division (AMPHIPORINÆ) of the family AMPHIPORIDÆ the animals have two muscular layers in the body-wall, an external circular and an internal longitudinal; the proboscis is composed of three divisions, anterior, middle, and posterior, the former having in the typical species seven coats, viz. external elastic, external longitudinal, reticulated, inner longitudinal, circular, hæmose and

*Turbella*, a little bustle or turmoil, referring to the ciliated integument of the animals.

<sup>1</sup> η and \*Οπλα, arms.

<sup>3</sup> α and \*Οπλα, without arms.

glandular layers. The middle region bears the stylets, and the posterior forms a long sac with two muscular coats, external circular and internal longitudinal. There are three great longitudinal vascular trunks, two lateral and one median, besides a cephalic arch. The cephalic sacs or glands are accompanied by long tubes or ducts. The animals as a whole have comparatively short and thick bodies, with proportionally large proboscides.

The sub-family NEMERTINÆ has the characters of the foregoing, with the exception of the last, since they possess more or less elongated bodies, and proportionally short proboscides.

It is right to mention that I have not been able to procure a specimen of *Prorhynchus*, but from the diminished size of the proboscis and other particulars, it would seem to follow closely on *Nemertes carcinophila*, Kölliker, one of the species in the previous sub-family.

The sub-order ANOPLA, again, is further distinguished by having the nerve-trunks generally placed between the muscular layers of the body-wall. The mouth opens on the ventral surface behind the commissures of the ganglia. The blood-vessels are somewhat less differentiated than in the ENOPLA. The young in the most conspicuous families undergo a remarkable metamorphosis.

This second sub-order has several families, the most typical of which is that of the LINEIDÆ, characterized by the more or less elongated shape of the ganglia (the arrangement with the commissures having the form of a horseshoe). The muscular covering of the body is composed of three layers, external longitudinal, circular, and internal longitudinal. The proboscis is furnished with five coats, viz. external elastic, external longitudinal and accessory band, circular, basement and glandular layers. The circulatory system consists of three great longitudinal trunks, two lateral and a dorsal, which frequently anastomose by transverse branches, form a *rete mirabile* in the œsophageal region, and unite in lacunæ behind the ganglia. The head has a deep lateral fissure on each side in connection with the cephalic sac, which is rounded, and devoid of long tubes or ducts posteriorly.

The curious specimen from Herm forms the type of a group that would perhaps require to be raised to the rank of a sub-family, but as no more than one specimen has yet been found, it is thought advisable to postpone this at present, and distinguish it only generically. In this animal the proboscis is extremely slender in proportion to the bulk of the body, and differs from the typical LINEIDÆ in having no accessory band cut from the longitudinal layer. Externally the organ has an elastic investment, then a longitudinal, a thin circular and a glandular coat. The reddish colour of the muscles of this species, and the tinted circulation, are likewise quite characteristic.

A more distinct sub-family of the *Lineidæ* than the foregoing, perhaps, might be formed by *Mechelidæ*, but for the present generic separation will suffice. The anatomy of the body-wall agrees with *Lineus*, but there are no cephalic fissures. The structure of the proboscis is also peculiar, for there is externally no distinct superficial layer, the outer coat consisting of spiral muscular fibres closely interwoven, within which lies a longitudinal layer, with the glandular coat on its inner surface.

The CARINELLIDÆ are a very characteristic family. The general structure of the nervous system agrees with *Lineus*, but the lateral nerve-trunks are placed between the basement-layer and the circular (external) muscular coat of the body-wall, that is, quite without the two muscular layers in the typical form, and just within the circumference of the outer muscular layer in the other. There are no cephalic fissures. The circulatory system consists of two great

lateral trunks. The proboscis has externally a double elastic layer, a thick longitudinal coat, and lastly, a glandular layer.

The family of the *Cephalothricidae* deviates still more from the typical group. The arrangement of the ganglia differs, and the commissures are separated by a considerable antero-posterior interval. The lateral nerve-trunks lie between the longitudinal muscular coat and an isolated inner band of fibres having the same direction. The proboscis is supplied with acicular papillæ, and seems to have an external circular and internal longitudinal layer. The snout is devoid of fissures. The circulatory system is composed of two great longitudinal trunks, whose contents communicate behind the ganglia and at the tail. Oviparous; the young undergoing no distinct metamorphosis, though they have eyes, whereas the complete animal is generally eyeless.

#### VI.—SYNOPSIS OF FAMILIES, GENERA, AND SPECIES.

*Order*.—NEMERTINEA.

*Sub-Order*.—ENOPLA.

Proboscis furnished with stylets.

*Fam.* I. AMPHIPORIDÆ.—Ganglia rather rounded. Lateral nerves within the muscular layers of the body-wall. Mouth opening in front of the ganglionic commissures.

*Sub-Family*, AMPHIPORINÆ.

Proboscis proportionally large.

*Genus* I. AMPHIPORUS, Ehrenberg.—Eyes more or less numerous, hut never arranged in a square. Body rather short, sometimes flattened.

1. *A. lactifloreus*, Johnston.—Eyes grouped in two series on each side; body white, roseate, or greyish.
2. *A. gulcher*, Johnston.—Eyes well defined and numerous, irregularly grouped on each side. A central reserve-stylet in the proboscis. Cephalic furrows slightly branched.
3. *A. spectabilis*, De Quatrefages.—Head spatulate, peculiarly narrowed posteriorly. Eyes forming two long rows on each side. Cephalic furrows conspicuously branched. Longitudinally striped with brown on the dorsum.
4. *A. hastatus*, n. s.—Snout short and hastate, with a grooved dorsal ridge. Eyes indistinct. Brownish-yellow, with white grains on the snout.
5. *A. bioculatus*, n. s.—Snout acutely pointed, with a cephalic furrow—forming an angle directed forward on the dorsum—at its posterior boundary. Two eyes at the tip of the snout.

*Genus* II. TETRASTEMMA, Ehrenberg.—Eyes four; arranged so as to indicate a square or oblong.

1. *T. melanocephala*, Johnston.—A large black pigment-mass between the anterior and posterior pairs of eyes. Marginal stylet-sacs placed somewhat in advance of the central apparatus.
2. *T. Robertianæ*, n. s.—Head furnished with a brown collar, which sometimes hides the posterior (smaller) pair of eyes. Body longitudinally striped with two brown and a median white line.
3. *T. candida*, O. F. Müller.—Head flattened, wider than the rest of the body; eyes distinct. Stylets large. Pale yellow, greenish or reddish brown.
4. *T. vermicula*, De Quatrefages.—A longitudinal dark patch between (and connecting) the eyes of the respective sides.
5. *T. flavida*, Ehrenberg.—Head not wider than the rest of the body. Anterior and posterior pairs of eyes widely separated.
6. *T. dorsalis*, Abildgaard.—Body short, thick and rounded; speckled with yellow and brown; sometimes with a pale median stripe on the dorsum.

*Genus* III. PROSORHOCHMUS, Keferstein.—Eyes four; not forming a square. Snout dimpled and furnished with a transverse superior lobe. Ovo-viviparous.

1. *P. Claparedii*, Keferstein.—Snout blunt; eyes placed far back, the space between the anterior pair being widest. Yellowish.

*Sub-Family*, NEMERTINÆ.

Proboscis proportionally small.

*Genus* IV. NEMERTES, Cuvier.—Body more or less elongated, while the proboscis is very much diminished, the anterior region especially being shortened so as to cause the stylets to approach the ganglia.

1. *N. gracilis*, Johnston.—Eyes numerous. Snout broader than the rest of the body. Central stylet with a very long basal apparatus. Greenish or olive.
2. *N. Neesii*, Cirsted.—Eyes numerous. Stylets short and grooved. Streaked on the dorsum with purplish brown.
3. *N. carcinophila*, Kölliker.—Eyes two. No marginal stylet-sacs. Body pinkish.

*Sub-Order*.—ANOPLA.

Proboscis without stylets.

*Family* II. LINEIDÆ.—Ganglia elongated. Muscular layers of the body-wall three in number, viz. external longitudinal, circular, and internal longitudinal. Proboscis furnished with five coats, viz. external elastic, longitudinal and accessory bands, circular, basement and glandular layers. Snout with a deep lateral fissure on each side.

*Genus* V. *Lineus*, Sowerby.—Body more or less elongated, rounded or somewhat flattened, and tapered posteriorly. Head distinct, spatulate, and generally truncate in front. Eyes numerous, arranged along the sides of the snout anteriorly; rarely absent. Mouth in the form of a conspicuous longitudinal slit on the ventral surface. Other characters as in the Family.

1. *L. marinus*, Montagu.—Eyes numerous, deeply set in a marginal row on each side of the snout. Of a dull olive or blackish colour, more or less distinctly striped longitudinally.
2. *L. gesscransis*, O. F. Müller.—Eyes numerous, marginal. Snout distinctly wider than the rest of the body. Greenish-olive or reddish-brown.
3. *L. sanguineus*, Jens Rathke.—Eyes more regularly arranged than in the former; snout narrower. Body more elongated, and of a reddish or reddish-brown hue. Regenerates easily.
4. *L. lacteus*, Montagu, MS.—Snout similar to the foregoing, but the mouth is separated from the ganglia by a much longer interval. Body reddish anteriorly, pale posteriorly.
5. *L. bilineatus*, Delle Chiaje.—Snout rounded anteriorly; eyeless. Body of a pale brown or dull pinkish colour, with a white stripe on each side of a dorsal median line.

*Genus* VI. BORLASIA, Oken.—Characters as in *Lineus*, but the proboscis is extremely slender, and has only four coats, viz. elastic, longitudinal, circular, and glandular.

1. *B. Elizabethæ*, n. s.—Snout pointed anteriorly; eyeless. Body generally contracted into a rugose mass posteriorly. Head pale, faintly streaked with greenish brown. Body marked with deep madder-brown.

*Genus* VII. CEREBRATULUS, Renier.—Body generally flattened, and thinned at the margins. Eyes in the usual position, but obscure. Proboscis with a cross of fibres at each pole in transverse section.

1. *C. angulatus*, O. F. Müller.—Snout somewhat pointed. Body much flattened; brownish.

*Genus VIII. MIRONURA*, Ehrenberg.—Characters as in *Lineus*, with the addition of a soft, filiform caudal process, capable of attachment.

1. *M. fusca*, n. s.—Eyes small, from four to eight on each side; body much flattened and thinned at the edges; caudal process often moniliform; colour pale brown or yellowish, speckled with brownish grains, especially in front.
2. *M. fasciolata*, Ehrenberg.—Eyes marginal, placed towards the anterior part of the snout; body various shades of brown, generally barred with white belts.
3. *M. purpurea*, Dalyell.—Eyeless. A bright yellow patch at the tip of the snout; body of a uniform rich dark brown colour.
4. *M. aurantiaca*, Grube.—Eyeless. A white patch at the tip of the snout; body rounded and of a fine brick-red hue.

*Genus IX. MECKELIA*, Leuckart.—Structure of the rounded body-wall as in *Lineus*. Cephalic fissures absent. Proboscis furnished with only three coats, viz. external spiral, longitudinal, and glandular.

1. *M. asulcata*, n. s.—Eyeless. Body thick and round; of a uniform pinkish hue.

*Family III. CARINELLIDÆ*.—Lateral nerves placed between the basement-layer of the cutis and the external (circular) muscular coat of the body-wall, or in the substance of the longitudinal layer close to the circular. There are only two muscular coats. The proboscis has four layers, viz. external elastic, circular, longitudinal and glandular.

*Genus X. CARINELLA*, Johnston.—Body elongated, tapering from the front backwards. Snout wider than the rest of the body, bluntly rounded in front; mouth sometimes small.

1. *C. annulata*, Montagu.—Eyeless, with a white patch on the snout; body round, of a rich red colour, striped longitudinally and banded across at somewhat regular intervals with white belts. Rarely pinkish throughout.
2. *C. linearis*, Montagu, MS.—Eyeless. Head spatulate, somewhat pointed in front; milk-white.

*Genus XI. VALENCINIA*, De Quatrefages.—Structure of the proboscis as in *Carinella*. The lateral nerves lie in the longitudinal muscular coat of the body-wall. The snout is shaped as in *Lineus lacteus*, and furnished with a row of eyes on each side. The mouth forms a distinct fissure a considerable distance behind the ganglia.

1. *Valencinia lineiformis*, n. s.—Roseate in front, yellowish white posteriorly.

*Family IV. CEPHALOTHRICIDÆ*.—Commissures of the ganglia separated by a distinct antero-posterior interval. Lateral nerves placed between the longitudinal muscular coat and an

isolated inner band of fibres. Proboscis has an external circular (or elastic), an internal longitudinal, and a glandular layer supplied with acicular papillæ.

*Genus XII. CEPHALOTRICH, GErsted.*—Head nearly cylindrical, slightly tapered in front; eyeless, or with a few obscure pigment-specks. Cephalic fissures and sacs absent.

1. *C. tincar*, Jens Rathke.—Body extremely attenuate. Of a pale yellowish or skin-colour, often with reddish grains towards the tip of the snout.

#### VII.—HOMOLOGIES.

The majority of the early investigators of the Nemerteans correctly associated them with the Planarians, and generally linked them to the Intestinal worms, *Lumbrici*, or *Gordi*, as a single genus—*Planaria*. Other animals, however, which had no affinity either in form or structure, were grouped with them, often in a perplexing manner. Lamarck thought the Nemerteans approached the leeches, while Cuvier amalgamated them with his Entozoa. Ehrenberg, again, while he took the wise step of forming a class (*Turbellaria*) for them and the Planarians, does not seem to have had a very definite idea of their relationship to other animals, and, more especially, to other *Vermes*. This author's class appears to me to be a very natural one, and though a considerable hiatus exists between the Planarians and Nemerteans, as will afterwards be pointed out, the gap is very much less than that which separates the *Turbellaria* from the other groups of animals, and especially from the Trematoda. Delle Chiaje considered they had certain homologies with the leeches, on account of the structure of the "alimentary canal," but that in regard to the form of their bodies they approached the Planarians. Dugès, De Quatrefages, and Frey and Leuckart, were inclined to link on the *Turbellaria* to the Trematoda, though the second author was of opinion that further researches as to the vascular system of the Planarians were needed to render the relationship distinct. In his report on the memoirs of De Quatrefages, M. Milne-Edwards observed that the Nemerteans approached the Annelids by the general disposition of their vascular system, the leeches by the structure of their buccal system and other parts of their organization, but that their reproductive and digestive organs were homologous with those of the helminths. He compared their nervous system to that of the "Lingules." The statement with regard to the digestive system, however, is founded on erroneous observations, since both reviewer and reviewed mistook the proboscis for the alimentary canal, and thus instead of the latter forming a blind tube, it is open at both ends, and very different from that of any helminth. GErsted, again, placed them after the Leeches, while M. Blanchard, misled by the observations of M. de Quatrefages, exaggerated the gulf between the Nemerteans and the Planarians so much that he thought their affinities lay rather with the helminths than with the latter. Dr. Thomas Williams considered his closed alimentary chamber (digestive canal) the homologue of the spongy mass in *Tœnia*, but this is open to doubt. He



also drew a resemblance between the Nemertean reproductive organs and the "ovarian or female series" in the leeches. So struck was this author by the differences between the Nemerteans and the Planarians (which he affirmed were only allied by the ciliated integument), that he proposed to separate the former from the "true Turbellaria" under the name of the Cestoid Annelids. I think, however, that we are scarcely warranted on structural grounds in making so radical a change.

Amongst recent writers, Dr. Cobbold, it appears to me on somewhat insufficient data, has grouped the Turbellaria under the class *Helmintha*, which he conveniently widens to allow them, as he thinks, to be near their allies the Trematoda. But it is to be observed that, while the Planarians perhaps do approach the Trematoda, the Nemerteans diverge so much that the relationship is very difficult to discover. The outline of the ovate and flattened Planarian somewhat resembles that of the Distomes and their allies; but there is nearly as much similitude between the former and an *Elysia* or *Limnospira*, or again between a *Sagitta* and a Fish. The cutaneous texture of a Trematode (for instance, *Fasciola hepatica*), according to Dr. Cobbold, is covered with minute chitinous processes or spines, and is composed of an outer transparent epidermis, and an inner fibrous cutis. In the Planarian, on the other hand, we have the ciliated epidermis and the characteristic soft, cellular cutis, so conspicuous for its secretion and its tendency to diffuse under examination. "In the *Fasciola* the next layer is composed of numerous bands of muscular fibres, in which four separate groups may be recognized more or less distinctly. They have been described as so many layers, but they are not readily separated from one another." Such is the description this author gives of the muscular system. In the Planarian the muscular layers form distinct coats, which cannot be confounded, and moreover they seem to be formed after a different type. I would, however, remark that in a transverse section of *Campula oblonga*, Cobbold, a Distome from the bile-ducts of the Porpoise, there is below the chitinous cutis a delicate layer of circular fibres—slightly indented by the bulbs of the chitinous spines, and having a thin coat of longitudinal fibres underneath. Such therefore agrees with what Prof. Owen found in *Distoma clavatum*. Dr. Cobbold also speaks of soft parenchymatous tissue filling up the general cavity of the Fluke, and though not averse to such a disposition as a proof of further divergence of type, yet in the Distome just mentioned (*Campula oblonga*) transverse and longitudinal sections show a complex arrangement of fibres and cells—only inferior to the more differentiated muscular bands, fibrous tissue and cells, the presence of which in the Planarian is so intimately connected with the physiology of the parts. In the case of the digestive system there is apparently some analogy in form, since both Planarians and Flukes have branched, caecal, alimentary organs, but then *Vortex*, and the whole of the Nemerteans to which the Planaria *Dendrocoela* are linked, deviate in a still greater degree from the parasites. The oral sucker of the fluke has little homology with the protrusible proboscis of the Planarian, and still less with the mouth of *Vortex* or the Nemertean. Moreover, the microscopic structure of the digestive ramifications of the Planarian agrees very closely with the same organ in the Nemertean, while it differs entirely from that of the fluke, with its "fibrous wall" and "columnar cells," or, as I should call them, papillae. Such differences probably depend much on the divergent character of the food. Dr. Ehlers, in his arrangement of Worms, separates the NEMERTINEA (Class V) from the Turbellaria, Ehrenberg, s. str. (Class IV), and interpolates the round worms and Gephyrea between them and the Annelida. It is doubtful if the Gephyrea are higher type than the Nemertinea, and they certainly do not approach the true Annelida

more closely. Prof. Huxley, again, groups the Nemerteans amongst the SCOLECIDA, characterising the "water-vascular system" of this heterogeneous class as having ciliated tubcs throughout. This, of course, cannot apply to the Nemerteans, and not even to the Planarians.

The branched water-vascular system (which Prof. Owen regards as excretory) of the Fluke has no counterpart in the Planarian, and cannot be supposed to be closely allied to the vessels of the Nemerteans.

A decided difference is apparent in regard to the nervous system, which is much more conspicuous in the Planarian than the Fluke; indeed, observers who are familiar enough with other parts of the structure of some species of the latter have not seen such at all. It is described by Prof. Owen in *Distoma clavatum* as in the form of a pair of cephalic ganglia connected together by a thin commissural filament above the pharynx, and giving off two main lateral nerves. Two much larger ganglia occur in the Plaurians, connected by a broad commissure, and the branches to the surrounding parts are more distinctly arranged. Prof. Owen states that pigment-specks, called "eye-specks," are present in the Polystoma of the urinary bladder of the toad and frog, as in the locomotive ciliated larvæ of most Trematoda; but as a whole the special organs of sense are much more highly developed in the Planarian.

In regard to reproduction there is some resemblance between the groups, both Flukes and Planarians having male and female organs developed in the same animal. Both are oviparous, and the ova produce ciliated embryos; but the young of the fluke soon lose the cilia, and represent only the first stage of a series of metamorphoses which occur before reaching maturity. The embryo of the Planarian, while, perhaps, undergoing metamorphoses in some cases, comes out of the egg in others nearly in the same form as the adult, and never loses its cilia at any period. Besides, too much reliance cannot be placed on this common metamorphosis, for we may as readily arrange the Echinoderms with the Nemerteans on account of the *Pilidium*-development, as class the Planarians with the Trematoda on this account.

The habits and motions of the two groups, it is well known, are widely different.

Having thus indicated some of the chief points of divergence and affinity between the Planarians and the *Trematoda*, we may now examine the relationship between the former and the animals with which we have more particularly to deal, viz. the Nemerteans.

In regard to the general structure of the cutaneous textures there is much resemblance. Both have a ciliated cuticle, a soft, easily disintegrated cutis, chiefly composed of cells and areolæ, and capable of secreting abundant mucus. In the skin of no Nemertean, however, have I seen any urticating or "stabförmigen" bodies.

The muscular coverings are similarly grouped into definite layers of longitudinal and circular fibres. On the ventral surface of the Planarian, however, we sometimes have an inner layer not represented on the dorsum, a fact that has been overlooked by Professor Kieferstein in his recent valuable remarks on the Planarians.<sup>1</sup>

The digestive systems, though apparently divergent, are really allied in an intimate manner. The mouth in the Planarians follows the habit of the organ in the Anopla in opening behind the ganglia, but more posterior in position. The large proboscis in the Planarians is probably homologous with the œsophageal division of the digestive tract in the Nemerteans; and in the typical *Linceida* amongst the latter the œsophageal region is frequently everted during feeding in the form

<sup>1</sup> Beiträge zur Anat. u. Entwicklung. einiger Seeplanarien, &c., 1868.

of a rugose prehensile organ. The ramose nature of the digestive cæca, which are all connected with a central cavity, is but a modification of the pinnate organ in the Nemerteans, the pinnæ in certain of the latter being even slightly branched. Moreover, the microscopic structure of the walls of this system (with perhaps the exception of the inner coating of cilia) is similar, and in both cases appears to combine the biliary with the intestinal system proper. In the Planarians, however, there is no anus, while such is present in all the Nemerteans. The system as a whole shows a higher degree of advancement in the latter, the connecting links apparently occurring in the Anopla, whose mouth opens behind the ganglia as in the Planarians.

The nervous systems of the groups are also related. The cephalic ganglia are two in each, but those of the Nemerteans are connected by two commissures, a dorsal and ventral, whereas in the Planarians there is only a single large commissural band, which is homologous with the ventral of the Nemerteans. The separation of the ganglia in the latter is more distinct than in the former, though this does not necessarily imply a higher type; indeed concentration of nervous matter is generally considered to be so. The senses in the groups are somewhat similar; over the entire surface touch is as exquisite in the one as in the other; the organs of vision consist of two well-marked series in each, viz. those with and those without apparent lenses or capsules, so that the pre-eminence in this respect is hard to adjudge, though I am inclined to give it to the Nemerteans. There is some doubt about auditory corpuscles or otolites in either group, though Gräfe and Keferstein mention their occurrence in certain Nemerteans. I have never seen such. The function of the special cephalic pits and neighbouring glands in the same animals is involved in obscurity. They may represent the segmental organs of the higher Annelids, or, perhaps, with greater probability, may be taken as the homologues of the water-vascular system.

In the circulatory system the Nemerteans much excel the Planarians. In none of the latter is there any circulation in distinct vessels, while in the former group all possess such, the vessels being filled with a more or less corpuscular fluid. It is true that a water-vascular system is described by O. Schmidt in certain freshwater Turbellaria, and that Max Schultze mentions a system of canals in *Thyanozoon* and *Polycelis*, but I agree with Professor Keferstein, after a careful examination of spirit-preparations, in considering further investigation necessary, and that in the present state of our knowledge we cannot admit this in the ordinary Planarians.

Considerable divergence occurs between them in regard to the organs of reproduction, the Planarians being hermaphrodite, while almost all the Nemerteans have the sexes separate. In regard to the complexity of the sexual system the former excel the latter, whose organs consist simply of a series of sacs placed along the sides of the body—for the development of ova or spermatozoa. Moreover, where hermaphroditism appears, as in *Borlasia hermaphroditica* and *B. Kefersteinii*, respectively described by Professor Keferstein and A. F. Marion, one part of the body has its sacs filled with spermatozoa and another with ova, or the male and female elements occur in the sacs without definite order as regards position, so that the type of structure remains unaltered, and essentially different from the arrangement in the Planarians.

The development of the young in the two groups has certain features in common, others at variance. Thus the ova of the Planarians in some instances produce ciliated embryos that have at birth more or less the form of the parent,—which form they retain throughout. The group Enopla of the Nemerteans agrees with the former; while in the division Anopla the young either emerge from a ciliated covering inside the egg-capsule, or they are produced from the *Pygidium*-form in the free state. Moreover, some of both great Nemertean groups are viviparous, the ova being

long enough retained in the ovisacs to develop their contents, after impregnation through the lateral (sexual) pores.

In the homologics of no organ, however, does the separation between the Planarians and Nemerteans become more apparent than in those of the proboscis, which, with all its adjuncts, appears to be a structure purely Nemertean.<sup>1</sup> Its definite aperture in front, its relation to the ganglionic commissures (between which it passes), its remarkable microscopic structure, and distinct muscular sac or sheath containing the highly organized corpuseular fluid, all point it out as an organ *sui generis*, and apparently without prototype or homologue in the Planarians or their allies. As already mentioned, I am inclined to consider the proboscis of the Planarian as the analogue and homologue of the cesophageal division of the digestive tract in *Lineus* and *Amphiporus*, and the "Schlund" of *Vortex*. The diminished size and atrophied condition of the proboscis in *Prorhynchus* seem to lead on the Nemertean type to certain of the Rhabdocæla.

Both groups are characterized by great recuperative powers after injury, new parts and organs replacing those that have been cut off; while mere fragments not infrequently grow into perfect animals.

Both consist for the most part of predatory and carnivorous creatures, that, notwithstanding their general deprivation of organs of offence and defence, manage to prey on animals much higher in the scale of organization than themselves, such as the Annelida. Their habits are also in many respects similar.

#### *Bipalium*.

I thought that considerable light might be thrown upon the affinities of the Planarians and Nemerteans by an examination of *Bipalium*, whose elongated body and central mouth indicated the probability of its intermediate position.

In *Bipalium*<sup>2</sup> there is externally (in the preserved condition) a rather dense cellular cutis, similar in structure to the same coat in the Planarians and Nemerteans, though less defined from the subjacent investment, which consists in this case of a thin belt of circular museular fibres. There next occurs a longitudinal museular layer, split into isolated fasciculi, between which certain pigmentary and cutaneous elements and connecting fibres lie. Thus the coat in transverse section presents a barred appearance, especially in the dorsal region, where the pigment is most marked, the dark band being interrupted by the pale longitudinal fasciculi. In superficial longitudinal sections, also, the same aspect is caused as in *Lineus* by the intrusion of the pigmentary and cutaneous elements amongst the museular. The intermediate region below the coat just mentioned has numerous cells and grauaules amongst the fibres which connect it with the next layer and the general stroma of the body-cavity. There are also many cells, often of a flask-shape, with the narrow end external, filled with long and somewhat spindle-shaped

<sup>1</sup> It is probable some further light will be thrown on the homologics of this organ in the anatomy of the Annelida.

<sup>2</sup> I am indebted to Prof. E. P. Wright, of Dublin, for the opportunity of examining this form, which was kindly placed in my hands along with many foreign Annelida collected by himself. His genus *Dunlopa* is synonymous with *Bipalium*.

filamentous processes, which are termed by Schmarda "stäbchenförmigen Körpern." The most prominent features of the complex muscular arrangement filling up the body-cavity after the full bulk is attained are the following:—Within the intermediate layer all round the body are many longitudinal muscular bundles clasped in isolated fasciculi by divergent or curved fibres. Thus, with the exception of the central digestive cavity, the whole mass of the body is filled up by these interlacing, longitudinal, and other fibres.

For some distance at the tip of the snout the stroma quite fills the region, but shortly a differentiation ensues, caused by the prominence of three transverse bands of muscular fibres, which pass across the snout at a distance from each other, so as to leave spaces occupied by fibres which have more or less a vertical direction. At first the arrangement is merely indicated, but it steadily gains so distinct a character that at last a series of spaces is left in transverse section in the dorsal division. In their fully developed condition these spaces have a thick layer of cellulo-granular matter, forming an inner lining or investment, which is so consistent that, in some fine sections which have been torn, it remains as a ring, with a well-marked outer margin. There is much opaque granular matter, also, between the vertical fibres. The channels—now larger and better defined—become continuous with the anterior part of the digestive chamber. They are about twenty in number in the snout.

The long pale area (in transverse section), which forms with the preceding in the snout, though streaked by the vertical granular bands, presents a much more translucent appearance. Towards the tip it is a simple transverse pale belt, wider in the middle, tapering at the ends, and passing entirely across the snout, the usually opaque cutaneous margin being more translucent opposite the ends in such a view. At first it is more conspicuous than the dorsal belt, but after the three vertical bands previously described appear, the two areas are nearly equal in breadth. No aperture, however, occurs in that now under consideration. It becomes gradually more transparent and wider in the middle; and by-and-by there is a tendency to enlargement on each side of the median line, while the vertical fibres forming the latter increase in prominence. A pale ventral region also makes its appearance, at first faintly marked, then more distinctly; the cutaneous textures, moreover, being included in the pallor. This causes the translucent region on each side of the median line to assume a long club-shape, and then—as an increase of the opaque fibro-granular matter occurs in the centre—a wedge-shape. The central septum afterwards (proceeding backwards) gets wider, a ventral prominence becomes distinct, and the wedge of pale tissue shortens and assumes a somewhat ovoid form. Some pale fibres stretch across the septum between each ovoid space. With a few changes as to size and separation this arrangement continues to the posterior end of the worm, where it gradually ceases. So far as I can make out, the pale bands (just described in transverse section) are not composed of nervous tissue, for which they appear to have been mistaken by Schmarda.

The proboscis of the animal is Planarian in structure, having a glandular investment, with subjacent circular and longitudinal muscular fibres—the former being most conspicuous immediately below the mucous surface, and an intermediate and apparently erectile tissue. The digestive tract throughout is also Planarian. It is branched in front and laterally, and towards the posterior end becomes divided by a perpendicular septum into a right and a left division.

The structure of the generative system as described by M. Claparède<sup>1</sup> shows a wide divergence from the Nemertean.

<sup>1</sup> 'Mém. de la Soc. de Phys. et d'Hist. Nat. de Genève,' tome xvi, 2ème partié, pp. 293—312, 1862.

This animal, therefore, leans to the Planarian rather than the Nemertean type; and on the whole it would appear that, while the affinities of these groups are sometimes in accordance, there can be little doubt as to the higher position of the latter in almost every respect.

*Balanoglossus.*

Two species of *Balanoglossus* dredged in the last cruise of the "Porcupine" (1870), in the one instance by Mr. Jeffreys outside the Strait of Gihraltar, to the south of Tangier, in 128 fathoms,<sup>1</sup> and in the other by Dr. Carpenter off the Algerine coast, at a point intermediate between Capes Falcon and Tenes, in 51 fathoms,<sup>2</sup> gave me an opportunity of investigating an apparently intermediate type of much interest. Unfortunately, none of the specimens were in good condition, either from rapid decay before being placed in spirit, or some other cause. None of the fragments exceeded  $1\frac{3}{8}$  inch in length, and the diameter at the collar or widest portion was about  $\frac{3}{8}$ ths of an inch.

The general appearance of those dredged by Dr. Carpenter resembles the penis, the short conical anterior end or "proboscis," with the overlapping collar behind, closely imitating the *gians penis*, with its prepuce retracted. On the dorsum the "proboscis" is marked by a furrow at its base, and, continuous with this on the body, two well-marked ridges course along the median line. On the ventral aspect is a deep median furrow, a groove also being present on the head in the same line. The body is rounded anteriorly, flattened posteriorly.

The "proboscis" exhibits various appearances, from the bluntly conical form in contraction to a more elongated and pointed contour in partial extension; and it is evidently a very mobile muscular organ. On reaching the collar, its base becomes contracted all round, so as to be connected with the trunk only by a narrow pedicle, which is attached just over the anterior opening or mouth, the whole having the appearance of an operculum or plug. The anterior end or "proboscis" has lost its dermal layers in all the preparations, showing externally a tough, translucent and slightly granular membrane, probably the representative of the hasement-membrane of the cuticular tissues. A considerable belt of circular muscular fibres forms the next investment. In transverse section a large number of vertical lamellæ are observed to be arranged within the latter coat, in a divergent manner with regard to the central space. These can readily be split from each other in a longitudinal direction, yet so intimately do the fibres mix that in longitudinal sections their main direction is longitudinal, while they follow a transverse direction in transverse section. From the shape of the region the lamellæ become narrowed in front and widened posteriorly. The nature of the specimens did not warrant a decision as to the presence or absence of a terminal pore, but, from an examination of specimens in the living condition, other authors, such as Delle Chiaje,<sup>3</sup> Keferstein,<sup>4</sup> Kowalewsky,<sup>5</sup> and Willemoes-Suhm,<sup>6</sup> have observed one. The posterior end of the "proboscis" in contraction fits into a kind of cup

<sup>1</sup> No. 36, surf. temp., 75°; bottom, 55° Fahr.

<sup>2</sup> No. 50, " 75°; " 54° 7'.

<sup>3</sup> 'Memorie sulla storia e not. degli,' &c., vol. iv, p. 117.

<sup>4</sup> 'Untersuchungen ueber nied. Seethiere,' p. 91.

<sup>5</sup> 'Mém. de l'Académie imp. des sc. de St. Pétersbourg,' vii' sér., tom. x, No. 3, 1867.

<sup>6</sup> 'Zeitsch. f. w. Zool,' Bd. xxi, 3, p. 388.

formed by the fleshy collar of the body, which projects after the manner of that in *Terebella*, but without the break or fissure.

In his excellent account of the anatomy of *Balanoglossus clavigerus* and *B. minutus*, Kowalewsky describes the chief muscular fibres of the "proboscis" as longitudinal, and the circular as insignificant. This does not quite agree with the state of the parts in the foregoing examples.

*Structure of the Body-wall.*

Few traces of the cutaneous elements remain in any of the specimens, but the structure of fragments in the furrows demonstrates that it is allied in the closest manner to that of the Nemertean. The cutis consists of a multitude of cells and globules in a gelatinous intercellular substance, the skin on section being streaked and loaded with circular and elongated granular masses, as in the former group. Indeed, the ease with which almost the whole cutaneous elements had separated from the subjacent tissues corroborated the relationship. A tough and continuous basement-membrane, having a finely streaked appearance, intervenes between the former and the next coat, which is a thick layer of longitudinal fibres, most developed, perhaps, on the ventral surface. The interfascicular substance is slightly marked, but there are many intersecting fibres which radiate inwards from the outer margin of this investment, through the next layer, to the wall of the digestive chamber. In longitudinal sections the longitudinal coat has, therefore, a transversely streaked aspect. It also presents three well-marked dorsal gaps anteriorly, viz. a median and two lateral, while ventrally a single hiatus exists in the centre. The circular muscular coat, which comes next in order, is moderately developed. The space between the latter and the wall of the digestive canal is partly occupied by the divergent fibres previously mentioned, the glandular or "liver"-tissue, and a few cells and globules.

The examination of living specimens enabled Kowalewsky to see the cilia with which the whole integuments are covered, and he further describes a fine "cuticula," but, so far as an examination of preserved specimens warrants me in affirming, this structure is not more differentiated than in the Nemertean, and therefore not demonstrable histologically as a special layer. In his anatomy of the body-wall he places the circular muscular coat to the exterior of the longitudinal—beneath our basement-membrane, and thus his specimens deviate in type from the foregoing.<sup>1</sup>

Within the circle formed by the collar a conical process having a filiform terminal appendage projects from the truncated anterior extremity of the body, and fits into the hollow at the base of the "proboscis." This structure is supported upon a somewhat enlarged firm base, round which the tough basement-membrane of the "proboscis" is fixed. Below the line of attachment of the latter the process is again narrowed, and presents just over the opening of the

<sup>1</sup> There would seem to be considerable variety in the structure of the body-wall of these forms. Another species dredged in 125 fathoms off Cape Rosier, in the Gulf of St. Lawrence, by Mr. J. F. Whiteaves, shows (in the spirit-preparation) underneath the glandular lining of the digestive chamber all round a dense and almost cartilaginous layer marked on its inner surface by regular transverse striae, but there is no specialization of chitinous tissue as in the Mediterranean examples.

mouth a smooth eminence of cartilaginous density, tinted of a reddish-brown hue. This terminates posteriorly in two brown chitinous rods, which diverge along the margin of a firm valvular process (forming on each side part of the lips of the oral aperture) and support the axis to which the "proboscis" is attached. A pointed and somewhat dense papilla lies at the fork of the chitinous processes. On the dorsal aspect of the valves and in the central line of the animal a series of transverse bars or ridges commences on each side. They are arranged in a double row, separated by a well-defined median furrow, which corresponds with the groove between the dorsal ridges externally. When first observed these firm bars had somewhat the appearance of a vertebral column—split as in a dried fish, and this special chitinous skeleton might therefore furnish the modern theorist with as good grounds as usual for the demonstration of the true stepping-stone to the vertebrate series. They are upwards of seventy in number, commencing by a well-marked chitinous bar just behind the fork of the axial processes, and, from the gradual diminution of the rows, terminating in a somewhat pointed extremity. Generally the whole structure may be separated into two divisions, viz. septal and branchial proper. Each septum is furnished with a brownish chitinous rod, which is conspicuous throughout its entire length in front, but is chiefly observed towards the median line posteriorly. These septa mark off the branchial spaces, since by splitting and uniting with others at the outer extremity, a branchial furrow is completed. From a point a little exterior to the median line each septal rod passes outwards to bifurcate as already mentioned, its course being easily seen anteriorly on account of the brownish hue of the process. This colour, however, is really confined to the central part of the flattened organ, which has throughout a thin translucent edge above and beneath, and is densest near the fork of the branchial lamella. From each side near its base is given off a translucent lamina, which, with another from the adjoining septum, forms the support of the branchial sabre. The junction of these laminae with the septal process is interesting, for in transverse section the base presents the form of an anchor. The septal rod, elevated on a fold of the basement- and mucous membrane, constitutes the strong central support (shank) of the T-shaped structure, while the branchial laminae, passing from the transverse bar as long recurved processes, correspond to the flukes. At the junction of the septal rod with the transverse portion is a slight swelling of the former, having the brown chitinous part in the centre, the rest of the process, as well as the branchial laminae, being quite translucent. As the sections proceed outwards, however, a slightly brownish hue from the presence of dense chitinous matter is seen at the base of the branchial laminae where they join the septal rod. The latter is marked almost from the commencement by a vertical median line, showing its double composition. The branchial laminae at this part touch at the lower edges, but gape at the upper, so as to make a triangular channel, which is completed by the thick membrane of the region. Further outwards the branchial arches stand freely in their grooves, their supporting chitinous laminae being enlarged at the upper end and bent inwards in transverse section, and the tunnel completed by the membrane formerly described. The supporting chitinous rods gradually taper from the median line to the outer edge, as also do those of the septal regions; thus the diminution in the former case has to be compensated by an increase of the soft parts of the tunnel. After the branchial lamella forms an independent sabre in the groove, the septal process is found (in transverse section) elevated on a still higher fold of the mucous membrane as a club-shaped structure, the central brown chitinous part—somewhat triangular in shape—appearing in the rounded summit. The next change is the increase of the brown hue in the chitinous supports



of the branchial lamellæ. The double nature of the septal process also becomes more evident, even from the fold of membrane upwards. The summit, however, is still uniformly coated by the investing membrane of the branchial region; hy-and-hy the papilla on which it is placed shortens, and the pale chitinous tips of the rods split to form the arch at the boundary. The laminae of the branchial processes diminish into slender pale chitinous rods, which lie towards the inner (lateral) margin of the canal, and each soon terminates in a closed extremity. Over the whole of the processes just described a thick mucous layer, probably ciliated during life, is spread. In ultimate structure it is glandular in appearance, being finely streaked in vertical section and minutely granular. A peculiar fibrillated condition is observed in that forming the wall of the branchial lamella, and also at the base of the chitinous supports of the septa. This mucous layer rests upon a basement-membrane, from which numerous divergent fibres pass to the exterior muscular coat of the body-wall, here and there enclosing spaces for the fatty "liver"-structure found in this region.

The foregoing account, of course, is only meant to convey a description of the framework of the branchial apparatus, which in other respects has received careful treatment from the excellent Russian naturalist Kowalewsky. The arrangement of the system in this form shows a close approach to that of *Balanoglossus clavigerus*.

#### *Accessory Glands to the Digestive System.*

Anteriorly a considerable space occurs between the dorsal surface of the branchial apparatus and the body-wall, which is occupied for the most part by transversely arranged sacs of the yellowish fatty "liver"-tissue. These bodies are surrounded by a distinct membrane, enclosing a vast number of compound fatty globules and granules, similar in minute structure to the same tissue in the Nemerteans. In transverse section the contents seem to fall out of the centre, but a thick layer of globules still adheres to the wall of the sac. These saccate glands occur under the branchial lamellæ, and generally in the space between the inner muscular layer and the wall of the digestive tract anteriorly. As soon as the branchiæ cease, however, they become much more prominent. The digestive and respiratory functions are thus performed in one chamber anteriorly, and the structure and arrangement throw considerable light on the condition of the same part in the Nemerteans, where a characteristic distinction exists between the two regions of the digestive system. Kowalewsky shows a folding of the branchial region in his species, so that a special chamber is separated from the general alimentary cavity. This digestive would therefore not intrude on the respiratory function.

#### *Digestive Cavity Proper.*

This chamber commences at the oral aperture, and continues in the form of a wide tube to the posterior end of the animal, which, however, is incomplete in all our examples. It is supported and held in position by the radiating fibres that pass inwards from the external muscular coat of the body-wall. Anteriorly the glandular mucous membrane, which forms its inner coat, presents

a frilled appearance, from the rugæ, which, as in the Nemerteans, often assume an arborescent appearance, owing to the extrusion (under pressure and preparation) of their cellular and granular elements. The wall of the canal is somewhat thinner in front, while the glandular lining is largely developed. Behind the branchial region, however, the following structure is clearly seen:—Externally the radiating fibres from the outer coat of the body-wall pass into a well-marked layer of circular muscular fibres, upon which the continuous basement-membrane and its glandular lining rest. The latter is thinner than in front. The structure on the whole closely approaches the Nemertean digestive tract.

Kowalewsky mentions that the surface of the digestive chamber is richly ciliated. His specimens occurred on sandy ground, as might be expected from the nature of their food.

#### *Circulatory system.*

Two vessels only could be satisfactorily made out by an examination of the specimens. A large longitudinal dorsal vessel lies over the fibrous band connecting the branchial septal rods across the median furrow. At this point it has externally only the circular muscular coat, the basement-membrane and cutaneous tissues, since there is a hiatus in the longitudinal muscular layer. The vessel is continued to the posterior end of the specimen over the wall of the digestive tract. Exactly in the median line on the ventral surface a similar vessel occurs, with the same relations to the cutaneous and alimentary textures. Both trunks have distinct walls. Besides the elaborate arrangement of vessels in connection with the branchial lamellæ, Kowalewsky shows a lateral vessel on each side, and various minute twigs from the larger trunks.

A single imperfect example of the other form of *Balanoglossus* was dredged by Mr. Jeffreys as above mentioned. In general features and size it resembles the foregoing, but certain anatomical differences merit special notice.

The "Proboscis" consists of a bluntly conical mass, which has lost its cutaneous elements. Externally, instead of the basement-membrane and circular fibres of the former type, there is a coat of longitudinal fibres, or, rather, of fibres whose direction is chiefly longitudinal, for they are felted firmly together. Within is a belt of circular fibres, from which the vertical lamellæ of the central region spring. The lamellæ consist of fleshy columns, which are fixed to the outer wall all round, but have a free margin internally. In transverse section, thus, the region somewhat resembles the kind of fruit called *hesperidium*, such as that of the orange, only the carpels are enormously increased. The columns are composed of densely felted fibres—longitudinal, oblique, and radiating, besides circular fibres towards the inner free margin. The whole must therefore form a powerful squeezing or propelling organ, after the manner of the heart of the higher animals. This region is attached to the body by an elongated, chitinous, process which has a broad basis at the mouth, and sends four divergent chitinous spurs into the tissues for support, the posterior pair coursing along the borders of the dorsal valves or lips, as in the

previous form. The broad, fleshy collar has two powerful conical bands of fibres (continuous with the dorsal belts) attached to the chitinous process on the dorsum, while ventrally a special bundle of fibres passes from the collar to the anterior margin of the trunk.

The dermal layers of the body agree in both species, as also does the external (longitudinal) muscular coat; but though certain circular muscular fibres lie under the latter, they are so indistinct as scarcely to merit the name of a special layer.

A considerable difference is apparent on opening the body-cavity, as at first sight the branchial arrangement characteristic of the former examples seems to be absent. On careful inspection, however, many minute, transparent, chitinous processes are found in the somewhat thickened membrane behind the dorsal valves. These processes have the form of a pointed molar tooth with very long fangs, and a fissure passing up the centre of the tooth to the crown. Some of the fangs or processes are bifid at the tip, each division diverging with a curve from the main stem. In all probability they form a short double row, after the type of the former species; but the specimen is not in a condition to bear searching investigation.

The digestive canal and accessory glands have a similar character to those in the foregoing species; the former being distended with muddy sand containing many Foraminifera and other microscopic organisms, the latter chiefly grouped along the dorsal area.

This species would not seem to approach any yet described.

In reviewing the several features presented by these curious forms, and contrasting them with what is known of Nemertean anatomy and physiology, the following reflections occur:—

In both the cutaneous tissues have the closest similitude as regards ciliation and minute structure. In *Balanoglossus*, however, the basement-membrane underneath the latter is more differentiated, and assumes a slightly fibrous appearance.

In the arrangement and histology of the muscles of the body-wall they much resemble each other.

The digestive system is similar. Both have a ciliated chamber divided into two great regions, represented by the first or branchial, and the succeeding division in *Balanoglossus*, and by the oesophageal and alimentary cavity proper in the Nemertean. The peculiar *rete mirabile* over the oesophageal region of the Nemertean, and the elaborate branchial circulation of *Balanoglossus* are apparently homologous. The minute structure of the proper wall of the chamber is closely allied. Moreover, while the "liver"-tissue is separated into elongated sacs in *Balanoglossus*, and simply diffused over the alimentary region in the Nemertean, its histological features are nearly identical. The mouth and anus are also similarly arranged.

With regard to the "proboscis" of *Balanoglossus* and that of the Nemertean I fear there is no homology; indeed, I would be inclined to regard the anterior region in *Balanoglossus* rather as the homologue of the Nemertean snout. The pore at the tip in the former would therefore correspond with the aperture for the proboscis in the latter, the mouth in both being placed a considerable distance backwards.

A great divergence happens in regard to the nervous system. It is not yet sufficiently understood to enable us to form a correct idea of its relations in *Balanoglossus*, while it is conspicuous in the Nemertean.

There is considerable similitude in the circulatory system. Both have a main dorsal and two

lateral trunks, the blood in each group flowing from behind forward in the dorsal. The much greater differentiation of the branchial region in *Balanoglossus* necessitates a corresponding complexity of the vessels, yet there is a connecting link in the elaborate plexus in the cesophageal region of the Nemertean.

In regard to generation and development there is also a parallelism. The reproductive elements are developed in sacs in both, and the sexes are often distinct. Certain of the young in each case undergo a kind of metamorphosis, as shown on the one hand by the description already given, and on the other by the interesting observations recently made by E. Metschnikoff on *Tornaria*,<sup>1</sup> apparently the early condition of *Balanoglossus*. The occurrence of eye-specks in the anterior region ("proboscis") in the latter would seem to indicate that the above view of its homologies is correct.

Having thus examined the relations and homologies of the Nemerteans with their inferiors and apparent equals in the scale, we may next inquire into their affinities with the higher annelids. Here, however, there is room for very diverse opinions, since, so far as known, there are no intermediate forms through which they may be linked on to any higher group.

Their relationship would rather appear to be with the Leeches than with the *Gephyrea* or *Scolecida* of Prof. Allman's classification, although a considerable gulf intervenes. Thus, in regard to the cutaneous system the cilia are not present in the leeches, though the exudation of the cutis proper is abundant enough. The muscles of the body-wall are less definitely arranged in the latter (e.g. *Nepheleis*), the internal longitudinal bundles for instance being placed in the body-cavity, and separated by regularly arranged vertical fasciculi at the lateral regions. The external coat is composed of circular fibres, within which lie a decussating series. The digestive system opens by a mouth in front of the ganglia, after passing through a nervous collar, and the muscular cesophageal region is distinguished from the more glandular stomachal portion, as in the Nemerteans. There are no cilia in the alimentary chamber, but it is occasionally furnished with caecal processes. The alimentary canal adheres as much to the body-wall in the Leeches as in the Nemerteans, which in this respect differ from the higher Annelids. The dorsal and the two great lateral vessels of the leech are probably homologous with the three vessels of the Enopla, but the ventral is additional.

In regard to the nervous system, the superior lobes of the Nemertean brain seem to correspond with the supra-cesophageal ganglia of the leech, and the inferior (from which the great lateral trunks arise) with the sub-cesophageal. If in the Enopla the two ganglia were separated, and the lateral nerve-trunks thrown together in the median line of the body, the alimentary canal would become dorsal in position, and would perforce pass through the nervous system to open ventrally, while the lateral vessels would remain in their usual situation. Thus a partial resemblance to the state in the leech would ensue. A much greater amount of branching of course would occur after the concentration of the nervous system.

The two cephalic sacs and coiled ducts in the Enopla may be the homologues of the segmental organs in the leech.

<sup>1</sup>Zeitsch. f. w. Zool., Bd. xx, p. 131, taf. 13, 1870.

There is a considerable difference in regard to the reproductive organs, for the Leeches are hermaphrodite, whereas the Nemerteans are chiefly unisexual. The capsule of mucus for the ova in *Lineus* is homologous with the cocoon of the leech; the latter being apparently due to the same abundant secretion poured forth by the general cutaneous surface, and is not necessarily connected in any way with the numerous segmental organs. Some of the higher Annelids, again, agree with the Nemerteans in discharging the generative products through lateral pores, e. g. *Harmothoë* and *Phyllodoce*. As in the Enopla, no metamorphosis occurs in the embryo of the leech. All the latter are oviparous, whereas some of the former are ovo-viviparous.

There is no feature to connect them with the *Brachiopoda*, which Mr. Morse<sup>1</sup> thinks should be classed with the true Annelida; indeed, we are not prepared at present to admit the relationship until we are more acquainted with the grounds on which the American author bases his conclusions.

I would be inclined to place the Turbellaria next the true Annelida, without the usual interpolation of the Rotatoria.

#### GENERAL DISTRIBUTION OF THE NEMERTEANS.

The Nemerteans have a very wide geographical range, extending from the arctic seas to those of the equator, and it is probable they occur on every suitable sea-beach, as well as in the surrounding depths. The forms adapted for swimming generally frequent the latter, and perhaps only approach the shallow water at the extreme limit of their range, and in a somewhat modified form, especially as regards size. Moreover, examples of the two great types (Enopla and Anopla) are common both to the arctic seas and the antipodes. The range of the freshwater species is involved in obscurity; they have been found in various parts of the world, but not yet in this country.

With regard to the distribution of the British species, some forms are cosmopolitan, such as *Amphiporus lactiflorus*, *Tetrastemma melanocephala, candida*, and *dorsalis*, *Nemertes Neesii*, *Lineus marinus*, *L. gesserenis*, *Cerebratulus angulatus*, and *Carinella annulata*, extending from the Zetlandic seas along both eastern and western shores to the Channel Islands, and, in addition, radiating widely all round. Thus I have received *A. lactiflorus* from Greenland, and apparently the same form is described by M. de Quatrefages from the Mediterranean. *Tetrastemma melanocephala*, *T. candida*, and *T. dorsalis* range from the latter to the extreme north of Europe. *Lineus gesserenis*, again, appears to be even more widely distributed, for besides being prevalent in the European seas, it (or a form almost identical in every respect) extends to the shores of the United States. *Cerebratulus angulatus* attains greater dimensions in the seas of Greenland and the Boreal province generally than it does in the Channel Islands. In other forms, however, e. g. *Lineus marinus*, I have observed no apparent difference in bulk between those from Shetland and those from Guernsey; though at the same time it must be stated that nowhere have the Nemerteans occurred of greater size and beauty than amongst the sheltered tangle-forests of the

<sup>1</sup> 'Ann. Nat. Hist.,' 4 ser., vol. vi, p. 267.

Zetlandic seas. *Carinella annulata* stretches from the north of Shetland to the Mediterranean, and a very similar species is found at the Cape of Good Hope.

Others, again, have a more southerly range, and have not yet been found in the northern portions of the British Islands; but on this point I would not speak dogmatically, for very much yet remains to be done in regard to the distribution of marine animals. *A. spectabilis*, *Borlasia Elizabethæ*, and *Micrura curantiaca* may be instanced as specially southern forms.

Some of the Nemerteans live at a depth of many fathoms and at a considerable distance from land, as well as between tide-marks, for example, *Nemertes Neesii*, *Lineus marinus*, and *bitineatus*, *Micrura purpurea* and *Carinella annulata*. *Amphiporus pulcher* and *Cerebratulus angulatus* are rarely found elsewhere than in deep water, the limits being from 5 to 120 fathoms. Amongst the Nemerteans procured in the dredgings of the "Porcupine" in 1869 and 1870, no new form, so far as can be ascertained from the spirit-preparations, occurs. It is interesting, however, to notice that the Anopla much exceed the Enopla in number, the most abundant form being *Micrura fusca*, with its flattened and oar-like posterior extremity. *Tetrastemma candida*, again, was found at a depth of 420 fathoms, its usual site being the laminarian and litoral regions. Representatives of the Anopla come from the great depth of 795 fathoms off the coast of Portugal. The Planarians accompany them in these sites, and there is no reason why both should not be found at yet greater depths. *A. laetiflorens*, all the *Tetrastemma*, *Prosorhochmus*, *Nemertes carcinophila*, many of the *Linei* and *Micrura*, and *Cephalothrix*, have their habitat between tide-marks, though sometimes at the extreme border of the litoral zone; indeed, as a rule, *Tetrastemma dorsalis* is a laminarian form.

M. de Quatrefages states that he has seen imprints in the rocks of Solenhofen and Strasbourg, which he thinks belong to Nemerteans, in the latter case especially to the "genus *Borlasia*;" and palæontologists have expressed similar opinions. The fossils in the lithographic stone of Solenhofen recently noticed by Prof. Ehlers<sup>1</sup> under the name *Legnodesmus* bear a close resemblance to such as might be caused by the Nemerteans; but a perusal of his excellent descriptions and drawings leaves an impression so indefinite that further and more extensive investigations are evidently necessary before a safe decision can be arrived at. The most interesting part of this paper is the account of his finding stylets in the *Legnodesmus* figured in taf. xxxvii, figs. 1 and 2. My acquaintance with the living animals leads me to entertain doubts as to their connection with the so-called fossil Nemerteans (*Nemeritites*) of the Cambrian rocks; at least, those coils I have seen suggest the following ideas:—Since they are simply casts without organic remains, the worms which made them could only have done so in shallow water, so as to have raised the snout to the surface, and crawled off in the usual manner (by floating). Any other mode of departure would have blurred the tracks in a deposit so soft as to receive such impressions. Moreover, I have often observed similar contorted tracks in the soft muddy sand in tidal pools—tracks made by litoral univalves in their daily wanderings.

<sup>1</sup> 'Ueber fossile Würmer aus dem lithographischen Schiefer in Bayern.' Cassel, 1869.

DESCRIPTION  
OF THE  
GENERA AND SPECIES  
OF THE  
BRITISH NEMERTEANS.





## GENERA AND SPECIES OF THE NEMERTEANS.

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*Sub-Order*.—ENOPLA.

Proboscis furnished with stylets.

*Family* I.—AMPHIPORIDÆ.\*

*Sub-Family*.—AMPHIPORINÆ.

Proboscis' proportionally large.

*Genus* I.—AMPHIPORUS. Ehrenberg, 1831.

BEFORE the time of Ehrenberg the species of this group had chiefly been included under the genera *Fasciola* and *Planaria*. In his 'Symbolæ Physicæ,' published in 1831, this author established three genera, viz., *Polystemma*, *Ommatoplea*, and *Amphiporus*, for the reception of animals probably belonging to the present type; and, while there is room for doubt with regard to the exact nature of the first two genera, as illustrated respectively by the examples *Polystemma adriaticum* and *Ommatoplea laniata*, it is quite clear to every observer that his *Amphiporus albicans* from the Red Sea is a characteristic representative of the *Enopla*, closely allied to *A. laetiflorens*. I have therefore deemed it right to use for the typical forms that generic name about which there can be no misunderstanding, and which name, moreover, is contemporaneous with the others. Usage, perhaps, inclined me to favour the adoption of the generic title *Ommatoplea*, but in the present state of our knowledge this nomenclature would not have been strictly appropriate, and by the discovery of the typical form from which Ehrenberg drew up his description it might be our misfortune to find that it is one of the *Anopla*, since there is nothing decisive in his account or figure. The name here adopted is not free from faults, for the *Anopla* as well as the *Enopla* have a pore at either end; but the term *Ommatoplea* stands in the same position, numerous eyes occurring in the one group as often as in the other. In his description of the genus, Ehrenberg, although noting and figuring the glandular papillæ of the proboscis, omitted to observe the stylets, and did not truly comprehend the situation and relations of the mouth, as he mistook the proboscidian aperture for the latter. The name *Polia* instituted by Delle Chiaje, and

\* Ἀμφί and πόρος, an aperture.

adopted for this genus by M. de Quatrefages, was applied by its founder to examples of the Anopla.

In distinguishing the species of *Amphiporus* the chief characters are drawn from the arrangement of the eyes, the nature of the cephalic furrows, and the structure of the stylet-region of the proboscis.

*Generic character*.—Eyes more or less numerous and large, but never arranged in a square. Body rather short, and often flattened.

1. AMPHIPORUS LACTIFLOREUS, JOHNSTON. Plate I, figs. 1 and 2.

*Specific character*.—Eyes grouped in two series on each side. Body whitish, roseate or grayish.

SYNONYMS.

1776. *Lumbricus oxyurus*, Pallas. Miscell. Zool., p. 146, tab. 11, f. 7 and 8.  
 1828. *Planaria lactiflorea*, Johnston. Zool. Journal, vol. iii, p. 489.  
 1837. *Nemertes lactiflorea*, Johnston. Mag. Zool. and Bot., vol. i, p. 535, pl. 17, f. 2 and 3.  
 1841. " " W. Thompson. Ann. Nat. Hist., vol. vii, p. 482.  
 1843. *Borlasia? alba*, W. Thompson. Rep. Brit. Assoc., 1843, p. 271.  
 1844. *Polysetemma roseum* (partim), CErsted. Entwurf Plattwir., p. 92.  
 " " " Ibid. De Regionibus marin., p. 80.  
 1845. *Nemertes glaucus* (?), KÖlliker. Verhandl. d. schweiz. nat. Gesellsch. zu Chur im Juli, 1844, p. 89.  
 " *Borlasia alba*, W. Thompson. Ann. Nat. Hist., vol. xv, p. 320, with woodcut.  
 " *Planaria rosea*, Ibid. Op. cit., p. 321.  
 1846. *Borlasia? alba*, Johnston. Ann. Nat. Hist., vol. xvi, p. 434 (Index).  
 " *Prostoma lactiflorea*, Ibid. Op. cit. (Index), p. 435.  
 " *Prostoma? rosea*, Ibid. Index, p. 436.  
 " *Polia mandilla*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., tom. vi, p. 203, tab. 8, f. 1 and 1a, and tab. 9, f. 2.  
 " *mutabilis*, Ibid. Op. cit., p. 205, tab. 10, f. 2.  
 " *violacea*, Ibid. Op. cit., p. 210.  
 " *berca*, Ibid. Op. cit., p. 211.  
 " *glaucæ*, Ibid. Op. cit., p. 206, tab. 10, f. 3.  
 1849. " *mandilla*, Ibid. Voyage en Sicilie, vol. ii, p. 115, pl. 15, f. 1, a, b.  
 " *mutabilis*, Ibid. Op. cit., p. 117, pl. 15, f. 4 and 5.  
 " *violacea*, Ibid. Op. cit., p. 122, pl. 16, f. 16, and pl. 17, f. 1.  
 " *berca*, Ibid. Op. cit., p. 123, pl. 15, f. 18.  
 " *glaucæ*, Ibid. Op. cit., p. 118, pl. 15, f. 7—9, var.  
 1850. *Nemertes glaucus*, Von Siebold. Archiv für Naturges., ii, p. 382.  
 " *mandilla*, Diesing. Syst. Helm., vol. i, p. 275.  
 " *Omatopiea mutabilis*, Ibid. Op. cit., p. 252.  
 " *violacea*, Ibid. Op. cit., p. 253.  
 " *berca*, Ibid. Op. cit., p. 252.  
 " *glaucæ*, Ibid. Op. cit., p. 253.  
 " *alba*, Ibid. Op. cit., p. 252.  
 1853. *Gordius albicans*, Dalyell. Pow. Creat., vol. ii, p. 73, pl. 10, f. 5a and 6.

1862. *Ommatoplea mutabilis*, Diesing. Revision der Turbell., p. 257.  
*violacea*, Ibid. Op. cit., p. 257.  
 „ „ *berea*, Ibid. Op. cit., p. 257.  
 „ „ *glauca*, Ibid. Op. cit., p. 257, bis.  
 „ „ *alba*, Ibid. Op. cit., p. 257.  
*Nemertes mandilla*, Ibid. Op. cit., p. 303.  
 „ *Borlasia mandilla*, Kieferstein. Zeitsch. für wiss. Zool., Bd. 12, p. 58, Taf. 5, f. 1—7.  
 1863. *Ditactorrhachma mandilla*, Diesing. Nachträge zur Revis. der Turb., p. 11.  
 1865. *Ommatoplea rosea*, Johnston. Catalogue Brit. Mus., p. 23, pl. IIa, f. 2, 2\*, 2\*\*\*, 3, and 3\*.  
 „ „ *alba*, Ibid. Op. cit., p. 23.  
 1865-6. *Polia mandilla*, De Quatrefages. Hist. Nat. des Annelés, pl. 4, f. 3.  
 1866. *Ommatoplea rosea*, Lankester. Ann. Nat. Hist., 3d Ser., vol. xviii, p. 388.  
 „ „ *alba*, Ibid. Op. cit., p. 388.  
 1867. „ „ McIntosh. Rept. Brit. Assoc., 1867; Trans. Sect., p. 92.  
 1868. „ „ Ibid. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.  
 1869. „ „ and var. *rosea*, McIntosh. Trans. Roy. Soc. Edinb., vol. 25, pt. ii, p. 323 et seq.

*Habitat*.—Under stones between tide-marks and in the laminarian region; abundant. Generally distributed—from the Arctic Seas probably to the Mediterranean.

*Body* rounded on the dorsal surface, flattened on the ventral, not much tapered towards the tail, which is rather blunt. In newly spawned specimens the body is much flattened, but in those bearing ova it is rounded. Length one to three inches, and occasionally even reaching four inches; breadth three lines.

*Colour*.—Various shades of white or pinkish white, with a translucent streak along the centre of the dorsum—caused by the proboscidian chamber. Specimens with the generative organs well developed assume a grayish aspect. There are two conspicuous pink or reddish-pink spots indicating the ganglia in front. The under surface has the same colour as the dorsum, and during the quiescent state of the reproductive organs is distinctly marked by the pinnæ of the digestive chamber. A specimen found at St. Peter Port, Guernsey, had the body of a pale greenish hue, like that usually seen in *Tetrastemma melanocephala*; while in the Bight of Vatsland (to the north of Bressay Sound) in Shetland a variety with the pigment everywhere increased abounds on a sandy bottom.

*Head* spatulate, flattened, and slightly pointed; furnished with numerous eyes placed in two or three groups on each side, the anterior generally forming a marginal row; the posterior arranged in front of or sometimes over the ganglia, and three often forming a triangle. In the pale brownish variety from Shetland an eye-speck on each side in front of the ganglia is larger and more conspicuous than the others.

*Cephalic furrows*.—Midway between the tip of the snout and the anterior border of the ganglia a furrow runs inwards and slightly forward on the dorsum, ceasing before it reaches the middle line. On the ventral surface is a similar though shorter furrow, the two meeting on the side at a richly ciliated dimple, which leads into the cephalic pit. A short distance behind the ganglia two other superficial furrows exist, each slanting backwards and inwards to meet its fellow of the opposite side in the middle line. These furrows are also continued inferiorly, but with a slightly altered direction, so that they meet under the ganglia. The two sets of furrows are indicated in the flattened head by lateral notches.

This is a very common animal, generally lurking under stones between tide-marks, whether these rest on sand, gravel, or sandy mud, and sometimes the latter is odoriferous; thus at Hern it frequently lives amidst crushed and bleakened fragments of *Zostera marina* and sea-weeds under stones. In such situations it generally resembles in contraction a cream-coloured larva, but when placed in sea-water it readily extends itself and crawls with a slow gliding motion, and likewise progresses on the surface of the water with the ventral region uppermost. It lives well in confinement, and numerous broods can be reared from captive specimens. The white ova are deposited in a free condition from January to April, and the young are from the first furnished with two eyes. I have not been able to see this species feed in confinement, but the rapid fattening in the free condition after spawning shows that it takes nourishment greedily.

The skin presents an acid reaction to test-paper, and the mucus secreted thereby is of a most tenacious description, the animal, indeed, rapidly forming an investment by this means when placed in a vessel containing a little sand.

Considerable confusion has prevailed with regard to this very abundant and widely distributed species. Johnston, Ersted, and others have considered the *Planaria rosea* of O. F. Müller referable to this form, but, as will be noticed elsewhere, a careful consideration of all the facts has led me to a different conclusion. When descriptions and figures are so vague and uncharacteristic, it is impossible to clear away all doubts, but such uncertainty cannot be laid to our charge. The earliest reliable account of the species is, perhaps, that given by Pallas in his 'Miscellanea Zoologica,' but the specific name (*oxyurus*) there given is objectionable, and I have consequently adopted another. Dr. Johnston, amongst modern authors, first clearly described this common worm, and since his period less difficulty has been encountered in regard to its discrimination. This author changed the name originally applied by him to the species from various causes, none of which, however, interfere with our following the usual laws of zoological nomenclature. For some time I was inclined to include the *Amphiporus albicans* of Ehrenberg under the synonyms, as it has many characters in common, but it approaches *A. pulcher* in others, and the arrangement of the eye-specks in his figure is so different that I have struck it off. For the same reason the *Planaria elongata* of Montagu (MS. p. 231) was not included. The *Polia mandilla* of De Quatrefages, from St. Vaast, probably belongs to this form, and there is nothing in the slight differences noted in *Polia mutabilis*, *P. violacea* and *P. berea* to distinguish them from the same worm. The *P. glauca* of this author is also, in all likelihood, a dark variety of the species.

2. AMPHIPORUS PULCHER (O. F. Müller), Johnston. Plate I, fig. 3, and Pl. XIV, fig. 11.

*Specific character*.—Eyes well-defined and numerous, irregularly grouped on each side. A central reserve-stylet in the proboscis. Cephalic furrows slightly branched.

SYNONYMS.

1774. *Fasciola rosea*, O. F. Müller. Verm. terrest. et flav. hist., i, 2, p. 58.

1776. *Planaria rosea*, Ibid. Zool. Danic. Prodr., p. 221, No. 2879.

1788. „ Ibid. Zool. Danic., ii, p. 81, tab. 64, f. 1 and 2.

1788. *Planaria rosea*, Linnæus. Syst. Nat. (Gmelin's), tom. i, pars vi, p. 3088.  
 1827. " " Bosc. Hist. Nat. des Vers., i, p. 256.  
 1837. *Nemertes pulchra*, Johnston. Mag. Zool. and Bot., vol. i., p. 536, pl. 17, f. 6.  
*Polystemma roseum*, Örsted. Kroyer's Nat. Tids., iv, p. 579.  
 " *pulchrum*, Ibid. Ibid., p. 580.  
 1844. " " Örsted. Entw. Plattw., p. 93.  
 1846. *Prostoma pulchra*, Johnston. Ann. Nat. Hist., vol. 16, p. 436.  
 1850. *Omatoplea rosea* (partim), Diesing. Syst. Helm., vol. i, p. 251 et postea.  
 " *pulchra*, Ibid. Ibid., p. 252.  
 1853. *Vermiculus rubens*, Dalyell. Pow. Creat., vol. ii, p. 39, pl. 10, f. 13—18.  
 1862. *Ommatoplea pulchra*, Diesing. Revis. der Turbell., p. 257.  
 1865. " Johnston. Catalogue Brit. Mus., p. 24, pl. ii a, f. 6 and 6\*.  
 1866. " " Lankester. Ann. Nat. Hist., 3rd ser., vol. 17, p. 388.  
 1868. " " McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.  
 " " Ibid. Rept. Brit. Assoc., 1868, p. 340.  
 1869. " " Ibid. Trans. Roy. Soc. Edinb., vol. 25, pt. ii, p. 337 et seq.

*Habitat*.—Generally diffused round the British coasts in water eight to thirty fathoms deep, and specimens were dredged by Mr. Jeffreys off Unst, Shetland, even at a depth of 120 fathoms. It frequently occurs amongst shells and other débris brought from the coralline region by the fishermen.

*Body* one to three inches and a half long, and three to five lines broad; flattened, thinned at the edges, slightly narrowed behind the snout; of nearly equal diameter throughout the middle region when stretched, but the anterior part is often narrowed, while the posterior forms a broad flattened oar. In extreme contraction, the body resembles an *Elysia* or *Limapontia*, or even becomes baccate.

*Colour*.—During the period of reproductive quiescence the animal has a general dull pinkish hue, pale at the snout, along the margins, and at the tail. The pinkish tint proceeds forward in the centre of the snout in front of the ganglia. The under surface is pale pinkish. In the ripe females the lateral regions are enlivened by the rich reddish hue of the ova, which shine through the transparent integuments, so that, from their somewhat symmetrical disposition, the animal has a segmented appearance, from the termination of the oesophageal region nearly to the tip of the tail. In specimens which have lived a considerable time in captivity the dorsum becomes freckled with brownish-red grains, especially towards the snout.

*Head* broadly spatulate, pointed at the tip, flattened; the snout clearly defined from the rest of the body by a well-marked furrow, which notches each side, and passes inwards almost to the middle line. The tip is furnished with a distinct central papilla, from which an opaque line generally proceeds backwards to the central glandular mass. Some distance behind the transverse furrow another oblique groove coming from the ventral surface slants backwards and inwards—meeting its fellow of the opposite side in the middle line of the dorsum, so as to form an acute angle. There are numerous large, well-defined eyes, which form somewhat irregular groups on each side, to the number of about twenty-three in all, three or four lying behind the transverse furrow. These are much more distinct in some specimens than in others. On the under surface the furrows are continued straight inwards towards a dimple (Plate XIV, fig. 11), then curve forward and inwards to the middle line. Numerous longitudinal grooves slant from the front

towards these furrows so as to produce a similar appearance to that in *Amphiporus spectabilis*, Quatref., but less marked in the lateral regions. The ganglia lie quite behind the transverse furrow, as indicated by the shading in the figure.

This species is often found in crevices of the coils of *Serpula* attached to shells and stones from deep water, and it is one of the most interesting of the group. It glides over the bottom of the vessel with considerable speed, almost without a wrinkle of its body; and when irritated a healthy example turns on its edge, and, by swift lateral strokes of the oar-like posterior extremity, swims rapidly through the water like a *Nepheleis* or a horseleech, so that not infrequently the uninitiated mistake it for a species of the latter. In contraction the head is drawn within the anterior portion of the body, the neck forming a kind of collar through which the organ slips inwards.

It rapidly secretes a tough sheath of transparent and iridescent mucus, under which it remains for days. The skin presents an alkaline reaction to test-paper.

The ova are developed in the beginning of May and are nearly ripe towards the end of June, but though many ova have been discharged in the vessels, I have hitherto been unable to watch their development.

While, for a time, of opinion that the *Planaria rosea* of O. F. Müller ('Zool. Danica') might refer either to this or the previous form, I now think that in all probability this species has the preference in the description and figure. He says, "Body elongate, sub-equal, convex above, of a rosy colour, marked with black points and lines (not distinct in some); flat beneath, of a pale red interrupted with transverse stria, posterior end blunt, anterior produced into an angular head; the latter is marked on each side by a semicircle of black points." The figure (which has its anterior end downwards) bears a considerable resemblance to this form, especially in the head and position of the eyes. His remark, however, that it is common everywhere leaves a certain degree of doubt, and I have therefore chosen Dr. Johnston's title. The latter author was the first to give a proper account of the species, from specimens procured amongst corallines and old shells in deep water off the coast of Berwickshire. He noted the appearance of the ova in the female, describing them as a series of bright scarlet spots along the sides. Sir J. Dalyell mentions a stripe, generally yellowish, which runs down the back, and a broader stripe along the ventral surface, but these probably refer to the colour of the digestive canal. Fair figures of the structure of the proboscis and the external appearance of this species are present in Gaimard's 'Voyages en Scandinavie, en Laponie,' as mentioned in the zoography.

I have not thought it necessary to include all the synonyms given by Örsted and Diesing, since it is doubtful to what species they refer.

### 3. AMPHIPORUS SPECTABILIS, De Quatrefages. Plate III, figs. 2, 7, and 8.

*Specific character.*—Head spatulate, peculiarly narrowed posteriorly. Eyes in two long rows on each side. Cephalic furrows conspicuously branched. Longitudinally striped with brown on the dorsum.

## SYNONYMS.

1846. *Cerebratulus spectabilis*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., p. 219, tab. 10, f. 7.  
 1849. " Ibid. Voyage en Sicilie, vol. ii, p. 131, pl. 17, f. 12 and 13.  
 1850. *Nemertes spectabilis*, Diesing. Syst. Helm., vol. i, p. 272.  
 1852. *Cerebratulus spectabilis*, Max Schultze. Zeitsch. f. wiss. Zool., Bd. iv, p. 183.  
 1861. " " Grube. Ein Ausflug nach Triest, &c., pp. 80 and 129.  
 1862. *Nemertes spectabilis*, Diesing. Revision der Turbell., p. 299.  
 " *Borlasia splendida*, Keferstein. Zeitsch. f. wiss. Zool., Bd. xii, p. 59, taf. v, f. 10—18.  
 1863. *Ptychodes splendida*, Diesing. Nachträge zur Revis. der Turb., p. 12.  
 1864. *Cerebratulus spectabilis*, Grube. Die Insel Lussin u. ihre Meeresf., p. 94.  
 1869. *Cerebratulus (Ommatoplea) spectabilis*, McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, pp. 342 and 355.

*Habitat*.—Dredged off St. Peter Port, Guernsey, at a depth of 18—20 fathoms, in a fissure of *Eschara foliacea*. Sicily, the Adriatic and St. Vaast-la-Hougue; generally in the crevices of shells.

*Body* rather more than three inches in length, and about a fifth of an inch in breadth, flattened; dilating rather abruptly behind the snout, and again diminishing towards the tail. The margins are thin.

*Colour* brownish, with six longitudinal brown stripes on the dorsum, and five pale intermediate lines. The two bands on each side of the central line are somewhat dark in colour, wide in front, narrow and somewhat closely applied posteriorly. The two adjoining brown belts become considerably wider towards the tail. Besides the foregoing there is also a marginal brown stripe, which is somewhat wider posteriorly. The tip and edges of the snout are pale, the four central brown bands of the dorsum being continued thereon, the two lateral becoming indistinct over the pigmentary region, the two central almost reaching the tip of the snout. All the four stripes are much narrowed and more closely approximated after passing the cephalic furrows, and the two lateral are in addition bent inwards towards the middle line at the latter. The under surface has a uniform pinkish colour, slightly marked within each border by a reddish coloration from the vessel.

*Head* narrower than the rest of the body, somewhat conical, defined posteriorly by a very distinct notch on each side. The region assumes various shapes according to the motions of the animal, sometimes presenting a blunt tip with a notch in the centre and almost cylindrical, at others a dilated tip and a constricted posterior portion. In the recently captured animal the eye-specks are not very evident on the dorsum, but after it has been blanched by captivity, they are observed to form two rows on each side, the central having about ten eye-specks, and the lateral a larger number. The former are best seen on the dorsal, the latter on the ventral surface, or from the side, and they proceed further forward than the central, indeed, almost to the tip of the snout. In the inner rows the eyes are nearly equal in size, while in the outer there are some larger ones towards the front.

*Cephalic furrows*.—From the notch, which on each side marks the posterior boundary of the snout, a well-marked furrow proceeds inwards and backwards, and is joined by eight or nine deep grooves which occupy the slightly dilated region immediately in front of the oblique furrow. These accessory grooves have in general a longitudinal direction, but they are curved in various

ways, and are of different lengths. On the under surface of the snout the lateral furrow follows a different course, being directed forward and inward on each side.

This animal lives well in confinement; the sole specimen procured at Guernsey in the end of July survived till the middle of November. At this time it discharged a vast number of ova and perished in their midst, so that the effort of spawning had been too much for its health, or the water had become vitiated by the fluids exuded during the process. When irritated it swam rapidly through the water like *A. pulcher*, but generally lay quiescent on the bottom of the vessel surrounded by a delicate mucous investment, the body being shortened and thickened, but the head narrow and papilliform.

It has strictly the structure of the *Amphiporidae*, the longitudinal bands of the reticulated layer of the pinkish proboscis being very apparent. The blood is reddish-pink.

The species was first described in a recognizable manner by M. de Quatrefages, and though his drawing of the complete animal and its head are not quite accurate, their identity is satisfactorily made out. He does not say anything about the blood of this form, but he mentions that in *Cerebratulus crassus* it is reddish, and this with other points at one time inclined me to unite the species. The arrangement of the eyes is, at any rate, very similar, and if more pigment is added to the dorsum of the present form, the distinction only rests on the author's account of the stylets, on which comparatively little reliance can be placed. It was erroneously described as a new species by the lamented Prof. Keferstein under the name *Borlasia splendida*, and as having the mouth behind the ganglia; but he correctly interpreted the structure of the stylet-region of the proboscis. Prof. Grube accepted the anatomy given by M. de Quatrefages, and did not dissect the animal himself.

The *Potia pusilla* of Delle Chiaje (Descrip. e Notom., &c., tom. iii, p. 126, tav. 103, figs. 13—15) is a closely allied species.

#### AMPHIPORUS HASTATUS, n. s. Plate VIII, fig. 2.

*Specific character.*—Snout not wider than the succeeding portion of the body, with a grooved median ridge; unguate when viewed laterally, hastate when seen from the dorsum. Eyes somewhat indistinct. Brownish yellow, with white grains on the snout.

*Habitat.*—In seven fathoms Bressay Sound, Shetland, amongst tangle-roots attached to horse-mussels.

*Body* about an inch and three fourths long, and a seventh of an inch broad, rather rounded, gently dilating from the snout backwards, a slight diminution only occurring at the tail, which is thick and broad. The edges of the body are not thinned off, as in *A. pulcher* and others.

*Colour* pinkish; very much resembling that variety of *A. lactifloreus*, the hue being deepest in front, behind the reddish spots caused by the ganglia. The snout is paler than the subsequent portion of the body, and shows a series of whitish grains on the upper surface. The proboscis and proboscidian fluid are visible in the median line of the body. The mouth (woodcut, fig. 9) has some grayish-brown pigment-grains along its margins, and there is a curved band of the same hue a little behind the tip of the snout on each side.

The under surface of the body is generally paler than the upper.



*Head* with a snout narrower than the succeeding portion; bluntly pointed, and similar in shape to the head of a short spear or harpoon. In the median line is a grooved ridge, which, although cut by the cephalic furrow, is continued some distance along the dorsum of the body. On each side of the ridge is a longitudinal hollow on the snout. The eyespecks are placed a little behind the tip of the latter, and from their deep situation are somewhat indistinct. When viewed laterally the peculiar tapering of the snout resembles the hoof of a horse. The mouth is marked on the under surface, either as a slit like a key-hole, or as a linear depression (fig. 9)—rendered conspicuous by its pigment, according to the degree of contraction: in few species, indeed, is it so well seen.

*Cephalic furrows*.—At the posterior border of the snout a well-marked groove proceeds inwards and slightly forward on each side to the median ridge, where a  $\Lambda$ -shaped process is formed by a sudden turn of the furrow inward and forward. The groove is continued on the ventral surface in a similar manner, and also has a slightly developed median angle at the mouth.

This curious form combines the hardihood of *A. iactifloreus* with the irritability of *A. pulcher*. It is exceedingly contractile, becoming quite baccate when stimulated; the head being withdrawn through a collar of the body, as in the latter species. The grooves of the snout during the various movements become much exaggerated, and give the animal a very characteristic appearance. In minute anatomy it belongs strictly to the *Amphiporidae*, the large prothoscis, moreover, being furnished with four marginal stylet-sacs.

FIG. 9.



Under surface of the anterior region of *Amphiporus hastatus*. Somewhat enlarged.

AMPHIPORUS BIOCULATUS, n. s. Plate VIII, fig. 3.

*Specific character*.—Dull orange; snout acutely pointed, with a distinct cephalic furrow forming an angle directed forward at its posterior boundary. Eyes two, placed at the extreme tip of the snout.

*Habitat*.—Amongst tangle-roots attached to horse-mussels, in eight fathoms, Bressay Sound, Shetland.

*Body* about an inch in length, and rather more than a line in breadth, rounded, increasing in diameter from the pointed snout almost to the posterior third. The tail is rather blunt.

*Colour* dull orange, or pale brownish, inclining to reddish in front, especially in the region of the snout. Under surface somewhat pale.

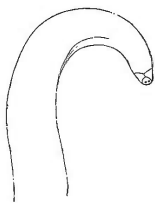
*Head* with a small, pointed snout, which is bounded posteriorly by an angular furrow (woodcut, fig. 10). The mouth is indicated on the ventral surface by a streak running forward from the arch of the latter (woodcut, fig. 11). Two eyes, consisting of simple masses of black pigment, are observed at the tip of the upturned snout (woodcut, fig. 10).

*Cephalic furrows*.—Viewed from the dorsum the furrow passes from each side of the snout inwards and forward, so as to form an angle. On the ventral surface, again, it makes an arch with the convexity directed forward, the slit for the mouth springing from the centre. The

course of the dorsal and ventral furrows is such that when the snout is seen in profile, a somewhat acute angle is formed at their junction on the side.

This is another interesting species supplied by the rich tangle-roots on the mussel-ground of

FIG. 10.



Outline of the anterior dorsal region of *Amphigorus bicoculatus*. Enlarged.

FIG. 11.



Ventral surface of the anterior region of *A. bicoculatus*.

Bressay Sound. It lives well in confinement, and it can be observed that, instead of the usual gliding progression of its allies, this form moves its snout in a boring manner.

The specimens were loaded with fully-developed spermatozoa in the beginning of August.

Genus II.—TETRASTEMMA,<sup>1</sup> Ehrenberg, 1831.

Like many others of the race, the species of this genus were included amongst the *Pasciola* by O. F. Müller, the first who, in the 'Zoologica Danica,' clearly described a species (*Pasciola candida*). Ehrenberg, in establishing his genus *Tetраstemma*, in 1831, seized upon a very constant character; but we must dissociate it from many of the genera which formed along with it the anomalous Family Gytracina. Though he describes the proboscis as being exerted from a transverse fold of the snout in his typical species, and hence apparently connecting it with Kefferstein's *Prosorhochmus*, an attentive examination of the other parts of his description and his figures has convinced me that he alludes to a form identical with one not uncommon in Britain, viz., *Tetраstemma flavida*.

Generic character.—Eyes four; arranged so as to indicate a square or oblong.

<sup>1</sup> Τετρας, four, στήμα, a crown.

## 1. TETRASTEMMA MELANOCEPHALA, Johnston. Plate II, fig. 1.

*Specific character*.—A large mass of black pigment between the eyes. Marginal stylet-sacs placed considerably in front of the central apparatus.

## SYNONYMS.

1808. *Planaria unipunctata*, Montagu. MS., p. 286, tab. 55, f. 5.  
 1837. *Nemertes melanocephala*, Johnston. Mag. Zool. and Bot., vol. i, p. 535, pl. 17, f. 5.  
 1842-3. " " " " Ersted. Kroyer's Naturhist. Tidsskr., iv, p. 577.  
 1844. " " " " Ibid. Entwurf. Plattw., p. 88.  
 1846. *Prostoma melanocephala*, Johnston. Ann. Nat. Hist., vol. 16, p. 436.  
 " *Nemertes melanocephala*, W. Thompson. Ann. Nat. Hist., vol. xviii, p. 387.  
 " *Polia coronata*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., tom. vi, p. 213.  
 " " *pulchella*, Ibid. Op. cit., p. 214.  
 1849. " *coronata*, De Quatrefages. Voyage en Sicilie, vol. ii, p. 125, pl. 13, f. 6-9.  
 " " *pulchella*, Ibid. Op. cit., p. 126, pl. 16, f. 7 and 8.  
 1850. *Cerstedtia pulchella*, Diesing. Syst. Helm., vol. i, p. 248.  
 " *Nemertes melanocephala*, Ibid. Op. cit., p. 270.  
 " " *coronata*, Ibid. Op. cit., p. 271.  
 1859. *Lowerrhochma coronatum*, Schmarida. Neue wirb. Thiere, t. i, p. 39.  
 1862. *Tetраstemma melanocephalum*, Diesing. Revis. der Turbell., p. 291.  
 " *Lowerrhochma coronatum*, Ibid. Op. cit., p. 295.  
 1865. *Omatoplea melanocephala*, Johnston. Catalogue Brit. Mus., p. 23, pl. 11a, f. 5 and 5\*.  
 1866. " " " " Lankester. Ann. Nat. Hist., 3rd ser., vol. 17, p. 388.  
 1867. *Cephalotrix unipunctata*, Parfitt. Catal. Annel. Devonsh., p. 5.  
 " *Omatoplea melanocephala*, Ibid. Ibid., p. 7.  
 1868. *Ommatoplea* McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.  
 1869. " " " " Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 333 et seq.

*Habitat*.—Under stones between tide-marks, in crevices of rocks near low-water mark, and ranging to twenty fathoms off Guernsey. Coast of France, and Sicily.

*Body* two to two and a half inches in length, somewhat flattened in progression, rounded in contraction, gently dilating behind the head, then continuing of almost equal calibre until near the tail.

*Colour* dull yellow, greenish yellow, or dull green; occasionally with minute brownish pigment-grains along the sides. A large and somewhat quadrate black patch on the snout, in some cases with one faintly marked band of white pigment in front, and another—more distinct—posteriorly. In a specimen from deep water off Guernsey the dark spot on the head was nearly invisible, and the whitish pigment indistinct. The fluid in the proboscidian sheath causes a pale streak along the centre of the dorsum.

*Head* flattened, much wider than the succeeding portion of the body, furnished with a notch in front. The first two eyes are placed some distance behind the tip of the snout, and incorporated with the anterior border of the black patch, so that they are not at first observed. The posterior eyes lie quite behind the pigment-patch, the white band, when present, intervening.

The pairs are equidistant. Rarely the single specks are represented by two or three smaller pigment-patches.

*Cephalic furrows.*—An oblique furrow runs from the margin on each side inwards and backwards towards the posterior eye, and behind the latter two other grooves meet at an angle, as in *A. lactifloreus*, in the middle line of the dorsum. On the under surface of the snout a furrow passes from the cephalic pit inwards on each side; and there is a continuation of the posterior furrows, as in the last-mentioned form.

It is less hardy than *A. lactifloreus* in confinement, but can readily be kept several months. It remains chiefly at the water-line in a silky sheath of the tough transparent mucus. Almost every specimen in the free state in the Channel Islands was furnished with the latter, though the case was less transparent on account of the adherent débris. The skin gives an acid reaction to test-paper.

I have not yet seen a specimen of this species with ova or spermatozoa, so that it must breed very late or very early. The young soon acquire the black patch on the snout, and other characteristics. It was absent from the rocks at St. Andrews in April and May.

This species was first discriminated by Col. Montagu under the name *Planaria unipunctata*, though Dr. Johnston's title has the priority by publication. The former described the species, which he procured on the south coast of Devonshire, as follows:—"Body filiform, with a black subquadrangular spot that nearly covers the head, behind which are two minute black eyes, distant from each other." The *Planaria ascaridea* of the same author had the "body long, linear, white, with a square black spot close to the anterior end," and in all probability is to be referred to the same species. Length one inch. Moreover, though he describes the square black spot of *Planaria filum* as situated between the pairs of eyes, this too can scarcely be any other animal than that now under discussion. CErsted remarks that there is a transverse brown bar between the eyes of his *Tetrahymena rufescens*, but there is no other character to connect it with this form. It is probable Professor Kölliker refers to the same species under the name *Nemertes Knochi* (*Krohnii*?), as he describes a transverse brownish-red band of pigment on the head. There is no doubt of the identity of the present species with the *Polia coronata* of M. de Quatrefages, from Bréhat, though his figure of the head is faulty, and the colour peculiar, since he states that the spot between the eyes has a violet hue. The *Polia pulchella* of the same author, from Sicily, seems to be a greenish variety, in which the pigment-patch on the head is separated from the eyes in front and behind by a larger interval than usual.

## 2. TETRASTEMMA ROBERTIANÆ, n. s. Plate III, fig 1.

*Specific character.*—Anterior pair of eyes larger than the posterior, which are sometimes quite hidden in the pigment-belt; body longitudinally striped with two brown and a median white line.

*Habitat.*—Dredged in four fathoms in Lochmaddy amongst tangles, and from the roots of the same seaweeds in Bressay Sound at a depth of six to eight fathoms.

*Body* about 1½th inch long, flattened, rather narrowed in front, then gently dilating towards the tail, which is slightly tapered, and furnished with a somewhat thin margin.

*Colour* a uniform dull pinkish or pinkish-brown, marked on the dorsum by three stripes—a central white and two lateral brown belts. The latter commence at a ring of the same colour which surrounds the posterior boundary of the snout, and proceed backwards to the tail, where they join; and the central white line follows a similar course. They are not close to each other, but a stripe of the usual ground-colour of the dorsum intervenes. The abdominal surface has a pale pinkish-brown hue throughout, with the exception of the ventral portion of the brown ring in front.

*Head* wider (in its greatest transverse diameter) than the succeeding portion of the body, spatulate, furnished with four black eyes, the anterior pair of which is the larger, while the posterior specks are closer and just in front of the transverse pigment-belt. The mouth is a well-marked longitudinal slit, in the usual position on the ventral surface.

*Cephalic furrows*.—These pass inwards and backwards from the prominent angles of the snout on the dorsum towards the posterior pair of eyes. The lateral notch is seen on the ventral surface, but the direction of the furrows thereafter (if such exist) is indistinct.

In a pale example from Shetland the brown ring anteriorly appears only on the dorsum, and the central white line is somewhat faint. In the coloured drawing (Plate III, fig. 1) only two eyes are visible, the posterior pair being covered by the great development of the pigment-belt. The ordinary condition is represented in the woodcut fig. 12.

Ersted describes a *Tettrastemma bioculata*, but the snout in his species is peculiarly acuminate, and he indicates no stripes or other colouring of note.

FIG. 12.



Dorsal view of the anterior region of *Tettrastemma Robertiana*. Enlarged.

### 3. TETRASTEMMA CANDIDA, O. F. Müller, 1774. Plate II, figs. 2 and 3.

*Specific character*.—Head flattened, wider than the rest of the body; eyes distinct. Stylets large. Colour pale yellow, greenish, or reddish.

#### SYNONYMS.

1774. *Fasciola candida*, O. F. Müller. Verm. terrest. et fluv. hist., 4, ii, p. 71.  
 1776. *Planaria candida*, Ibid. Zool. Dan. Prodr., p. 223, No. 2704.  
 1780. " O. Fabricius. Fauna Grœnlandica, p. 327.  
 1788. " " Linnaeus (Gmelin). Syst. Nat., tom. i, pars vi, p. 8094.  
 1798. " O. Fabricius. Skrivt. af Naturhist. Selskab., iv, p. 62, tab. 11, f. 11.  
 1828. " Bosc. Hist. Nat. des Vers., i, p. 262.  
 1829. *Planaria quadrioculata*, Johnston. Zool. Jour., vol. iv, p. 56.  
 1837. *Nemertes quadrioculata*, Ibid. Mag. Zool. and Bot., vol. i, p. 535, pl. 17, f. 4.  
 " *Tettrastemma varicolor* (partim), Ersted. Kroyer's Naturhist. Tids., iv, p. 575.  
 1844. *candidum*, Ibid. Entw. Plattw., p. 88.  
 " *varicolor* (partim), Ibid. Op. cit., p. 85, f. 41 and 44.  
 " " " Ibid. De Region. marin., p. 79.

1846. *Prostoma quadrioculata*, Johnston. Ann. Nat. Hist., vol. xvi, p. 436.  
 „ *Polia quadrioculata*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., tom. vi, p. 216, pl. 11, f. 1.  
 1847. „ „ Frey u. Leuckart. Beiträge z. Kennt. wirth. Thiere, p. 150.  
 1849. „ „ De Quatrefages. Voyage en Sicilie, vol. ii, p. 128, pl. 16, f. 10 and 11.  
 1850. *Tetраstemma varicolor*, Diesing. Syst. Helm., vol. i, p. 257.  
 „ „ *granlandicum*, Ibid. Op. cit., p. 259.  
 „ „ *Krohmii*, Siehold. Archiv für Naturges., ii, p. 382.  
 1851. „ „ *varicolor*, Maitland. Descrip. syst. anim. Belg. septent., p. 190.  
 1853. *Vermiculus coluber*? var., Dalyell. Pow. Creat., vol. ii, p. 91, pl. 10, f. 24.  
 „ *Planaria alge*, Ibid. Op. cit., p. 117, pl. 16, f. 24 and 25.  
 1858. *Polia quadrioculata*, Williams. Philos. Trans., 1858, p. 181.  
 1859. *Tetраstemma alge*, Leuckart. Archiv für Naturges., ii, p. 188.  
 1860. *Polia obscura* (partim), Van Beneden. Mém. Acad. Belg., tom. xxxii, p. 23, pl. 4, f. 2, 4, &c.  
 „ „ *capitata*, Ibid. Op. cit., p. 28, pl. 4, f. 12, &c.  
 „ „ *farinosa*, Ibid. Op. cit., p. 29, pl. 4, f. 17.  
 1861. *Tetраstemma varicolor*? Claparède. Recher. Anat. sur les Annél. Turh., &c., p. 81, pl. 5, f. 6.  
 1862. „ „ (partim), Diesing. Revis. der Turbell., p. 289.  
 „ „ *obscurum* (partim), Ibid. Op. cit., p. 291.  
 „ „ *capitatum*, Ibid. Op. cit., p. 292.  
 „ „ *granlandicum*, Ibid. Op. cit., p. 298.  
 „ „ *farinosum*, Ibid. Op. cit., p. 298.  
 „ „ *Loxorhochma obscurum*, Ibid. Op. cit., p. 295.  
 1863. *Tetраstemma varicolor*, Diesing. Nachträge zur Revis. der Turbell., p. 10.  
 „ „ *alge*, Ibid. Op. cit., p. 11.  
 1864. *Polia quadrioculata*, Gruhe. Die Insel Lussin u. ihre Meerest., p. 96.  
 1865. *Tetраstemma varicolor* (partim), Johnston. Catalogue Brit. Mus., pp. 20 and 289.  
 „ „ *alge*, Johnston. Op. cit., p. 20.  
 1865-6. *Polia quadriocellata*, De Quatrefages. Hist. Nat. des Annelés, pl. 4, f. 2.  
 1869. *Tetраstemma alge*, McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 389 et seq.

*Habitat*.—Not uncommon under stones near low-water mark, especially amongst the algae and corallines which cover their surfaces, and, indeed, one of the best modes of procuring the species is to immerse portions of such stones in sea-water, when the animals seek the water-line and are easily observed. It extends from the Shetland to the Channel Islands.

*Body* one to one and a half inch long, and nearly a line in breadth; somewhat flattened, narrowed behind the head, and again tapered towards the tail.

*Colour*.—Various shades of grass- or siskin-green, but females bearing ova have a dull grayish aspect. Some varieties, also, are pale yellow. The head is usually paler than the rest of the animal. Two dull red spots indicate the ganglia. A Zetlandic variety occurs in Bressay Sound of a reddish-brown colour, and in some a few white grains are situated between the anterior pair of eyes.

*Head* much flattened, spatulate, wider than the succeeding portion of the body, with a pale streak in the median line anteriorly, where there is also a slight notch. Eyes four, forming a square; by the lengthening of the snout, however, they are placed at the corners of an oblong.

*Cephalic furrows*.—The two oblique anterior furrows course inwards near the posterior pair of eyes, and cause a notch at the margin of the snout in front of the latter. The posterior pair were

only examined in small examples, and they were very indistinct, but they probably have the same direction as in other species.

A variety was dredged off St. Peter Port, Guernsey, in 10 fathoms, with the eyes of large size, very pale, and with whitish grains from the tip of the snout backwards between the pairs. The stylet-region had the posterior border of the muscular investment nearly transverse, but probably this was abnormal, as in all other respects it agreed with that of *T. candida*.

This is a very restless species, constantly gliding about with considerable speed; indeed, it is one of the most active of the group. It is tolerably hardy, and will survive more than twenty-four hours on a moist stone in a room. In Bressay Sound the variety above mentioned abounds amongst *Obelia geniculata* about half-tide mark, as well as amongst *Corallina* bored by *Leucodore* at the extreme verge of high-water.

Whether the variety shown in Plate III, fig. 5, and having a pale orange hue, will prove to be specifically different on further investigation, I am at present unable to say, as the drawing was the sole remembrance brought by my sister in one of her excursions. It was procured from the deep water off St. Andrews Bay.

The ova are developed in April and May, as well as in autumn.

I am inclined to refer the *Fasciola candida* of O. F. Müller to this common and variable form. It was discovered by O. Fabricius under stones on the shores of Greenland, and his specimens were unusually large, viz. from two to three inches, the only doubtful feature in the description. Örsted's *Tetраstemma varicolor*, again, seems to include both this species and *T. dorsalis*. The occurrence of a single stylet-sac in the example of M. de Quatrefages is purely accidental. The *Vermiculus coluber* of Sir J. Dalzell is probably a pinkish variety of this form, and not *T. melanocephala*. M. van Beneden included this along with others under his *Polia obscura*, and the *Polia farinosa* of the same author presents no feature different from the young of this species. M. Claparède's *T. varicolor* comes under the same head, a view supported by his figure of the stylet-region. This is the only Nemertean mentioned in Maitland's 'Fauna Belgii septentrionalis.'

#### 4. TETRASTEMMA VERMICULA, *De Quatrefages*. Plate III, fig. 3.

*Specific character*.—A longitudinal dark patch between the eyes of the respective sides.

#### SYNONYMS.

1846. *Polia vermiculus*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., tom. vi, p. 214.  
 1849. " Ibid. Voyage en Sicilie, vol. ii, p. 126, pl. 14, f. 12 and 13.  
 1850. *Nemertes vermiculus*, Diesing. Syst. Helm., vol. i, p. 270.  
 1862. *Tetраstemma vermiculus*, Ibid. Revis. der Turbell., p. 290.  
 1869. " " McIntosh, Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 339 et seq.

*Habitat*.—Not uncommon under stones between tide-marks, and occasionally dredged in the laminarian region, from the North of Scotland to the Channel Islands. Coast of France (Bréhat).

*Body*.—Three fourths to one inch in length, and about a line in breadth, moderately elongated, dilating very gradually behind the head, continuing for some distance of considerable diameter, and again diminishing towards the tail.

*Colour*.—Dull whitish, salmon, or pinkish, with two elongated dark spots on the head. In a specimen from St. Peter Port, Guernsey, the digestive tract was pale siskin-green. There was also a faint white streak on the middle of the dorsum, commencing between the posterior pair of eyes, and proceeding a short distance backwards.

*Head* wider than the succeeding portion of the body, flattened, having its greatest diameter in the middle, and marked by the cephalic furrows. Eyes four, the pairs separated by a considerable interval, which on each side is nearly filled up by a longitudinal patch of dark pigment. The latter is widest anteriorly, and often does not quite reach the posterior eye, which is thus prominent, while the anterior is indistinct. There is sometimes an opaque whitish patch between the anterior pair of eyes, and this is continued faintly along the central streak.

*Cephalic furrows*.—A little in front of the posterior pair of eyes is the groove connected with the cephalic pit, which (furrow) passes inwards and slightly backwards on each side and soon terminates. Somewhat behind the posterior pair of eyes another furrow slants inwards and backwards, and meets its fellow of the opposite side in the middle line.

*T. vermicula* in its lively and restless habits much resembles *T. candida*. Many perish by crawling out of the water and being dried on the side of the vessel.

The ova are deposited in a free condition about the beginning of May.

I have placed this pretty species under the name of M. de Quatrefages, but with amended characters. He erroneously states that the head is not distinguished from the rest of the body, and that the marginal stylet-sacs are situated on the "dorsal and ventral" aspects of the proboscis. His figure, also, of the entire animal is too elongated, and his remark that the pigment-patch between the eyes of each side is violet can only refer to the aspect under transmitted light. Stimpson has a *Tetrastemma* (?) *vermiculus* in his 'Prodrômus' (ii, p. 19), but its identity with the present form is doubtful.

##### 5. TETRASTEMMA FLAVIDA, Ehrenberg. Plate IV, fig. 1.

*Specific character*.—Head not wider than the rest of the body. Anterior and posterior pairs of eyes widely separated.

##### SYNONYMS.

1831. *Tetrastemma flavidum*, Ehrenberg. Symb. Phys., Phyt. Turb., No. 25, tab. 5, f. 3, a—d, and  $\sigma^m$ — $\sigma^k$ .
- 1844-5. " *longecephitatum*, Örsted. Kroyer's Naturhist. Tids., i, p. 418.  
*flavidum*, Ibid. Op. cit., iv, p. 576, in note.  
 " " " Ibid. Entwurf Plattw., p. 87.
1846. *Polys sanguinolentus*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., tom. vi, p. 208, tab. 11, f. 3 and 7; tab. 12, f. 1.
1849. " Ibid. Voyage en Sicilie, vol. ii, p. 120, pl. 15, f. 11 and 12.



1850. *Tetраstemma flavidum*, Diesing. Syst. Helm., vol. i, p. 257.  
 „ *Nemertes hematodes*, Ibid. Op. cit., p. 270.  
 1860. *Polia obscura* (partim), Van Beneden. Mém. Acad. Belg., tom. xxxii; Recher. sur les Turb. (sep. copy), p. 23, pl. 4, f. 10.  
 1862. *Tetраstemma flavidum*, Diesing. Revis. der Turb., p. 289.  
 „ „ *sanguirubrum*, Ibid. Op. cit., p. 290.  
 „ „ *longicaepitatum*, Ibid. Op. cit., p. 293.  
 1869. „ *varicolor*, McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 339 et seq.

*Habitat*.—Under stones between tide-marks and in fissures of rocks; less common than *T. candida*. From Scotland to the Red Sea.

*Body* one to one inch and a half in length, attenuated, flattened, nearly of equal diameter throughout, except where slightly tapered towards head and tail.

*Colour* pinkish or pale peach, from the hue of the digestive tract. The snout is translucent, with a slight opacity between and rather in front of the posterior pair of eyes, and a pale patch from the ganglia behind them. The lateral margins are pale.

*Head* rather indistinctly defined, bluntly rounded at the tip, from the centre of which the usual pale streak proceeds. The eyes are equidistant in each pair, and the latter are separated from each other by a much longer interval than exists in *T. candida* and the others. The anterior eyes have the larger masses of pigment.

*Cephalic furrows*.—The openings of the cephalic sacs are placed nearly opposite the first pair of eyes, so that the anterior furrows are carried far forward. They slant inwards and backwards just behind the eyes, while inferiorly they are nearly transverse. The posterior furrows lie a little behind the last pair of eyes, and, proceeding inwards and backwards, meet in the centre of the dorsum. They have a direction forward and inwards on the inferior surface, but less obliquely than on the dorsum; thus, while the dorsal meet towards the posterior part of the ganglia, the ventral coalesce near the anterior border of the latter. The two sets of furrows are indicated by lateral notches.

This species is more sluggish than *T. candida*, and much more delicate. It resembles *Nemertes carcinophila* in the slow, gliding manner in which it moves about the vessel, a very gentle undulatory motion of the head and body taking place.

The ova are developed in May.

Prof. Ehrenberg first gave a description and drawing of this species. The equidistant eyes, with the pairs widely separated, and the cephalic furrows passing inwards nearly opposite the first pair, are fairly represented. The *TetraSTEMMA assimile* of Gersted, no doubt, has the anterior and posterior pairs of eyes widely removed, but this is the only character which can be identified with the present species. The *Polia sanguirubra* of De Quatrefages, again, appears to be a variety with tinted nuclei to the proboscidian discs (a phenomenon probably due to refraction of the rays of light), and the Sicilian *Polia baculus* of the same author differs only in the somewhat more attenuated condition of the snout. His *Polia armata* is also closely allied in external characters, but the presence of four stylet-sacs, if not accidental, is a distinguishing feature. Two of these marginal stylet-sacs, according to this author, occur a considerable way in front of the central stylet, or at the anterior part of the elongated stylet-region, and two behind, opposite the basal apparatus of the central organ. M. van Beneden seems to have included

specimens of this species under his *Poia obscura*. In the absence of more definite characters I have not thought it proper to place the *Tetраstemma sanguirubra* of Stimpson amongst the synonyms.

6. TETRASTEMMA DORSALIS, *Abildgaard*. Plate I, fig. 4, and Plate III, fig. 4.

*Specific character*.—Body short, thick and round, little tapered towards either extremity. Speckled with yellow and brown, or with a single dorsal stripe.

SYNONYMS.

1806. *Planaria dorsalis*, Abildgaard. Zool. Danic., vol. iv, p. 25, tab. 142, f. 1—3.  
 1844. *Tetраstemma fuscum*, CErsted. Kroyer's Naturhist. Tids., iv, p. 575.  
 " " " Ibid. Entw. Plattw., p. 86, woodcut 14.  
 " " " Ibid. De Region. Marin., p. 79.  
 1846. *Erstedtia maculata*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., tom. vi, p. 222, tab. 8, f. 2.  
 " " *tubicola*, Ibid. Op. cit., p. 223.  
 1849. " *maculata*, Ibid. Voyage en Sicilie, vol. ii, p. 134, pl. 17, f. 15—17.  
 " *tubicola*, Ibid. Op. cit., p. 135, pl. 17, f. 18 and 19.  
 1850. " *maculata*, Diesing. Syst. Helm., vol. i, p. 247.  
 " " *tubicola*, Ibid. Op. cit., p. 247.  
 " *Tetраstemma fuscum* (partim), Ibid. Op. cit., p. 257.  
 " " *varicolor* (partim), Ibid. Op. cit., p. 257.  
 1853. *Vermiculus variegatus*, Dalyell. Pow. Creat., vol. ii, p. 91, pl. 10, f. 25 and 26.  
 1859. *Tetраstemma variegatum*, Leuckart. Archiv für Naturges., ii, p. 188.  
 1862. *Erstedtia maculata*, Diesing. Revis. der Turbell., p. 263.  
 " " *tubicola*, Ibid. Op. cit., p. 263.  
 " *Tetраstemma fuscum*, Ibid. Op. cit., p. 289.  
 1863. *variegatum*, Ibid. Nachträge zur Revis. der Turbell., p. 10.  
 " " *marmoratum*, Claparède, Beobach. über Anat. u. Entwicklung., &c., p. 24, taf. 5, f. 14.  
 1865. " *variegatum*, Johnston. Catalogue Brit. Mus., pp. 20 and 289.  
 1866. " " Lankester. Ann. Nat. Hist., 3rd Ser., vol. 17, p. 368.  
 1868. " " McIntosh. Rept. Brit. Assoc., 1868, p. 340.  
 1869. " " Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 339 et seq.

*Habitat*.—Abundant in the laminarian region, in three to ten fathoms, where it haunts *Ceramium rubrum* and other algae. It is also occasionally found under stones at extreme low water. Extends from Shetland to the Channel Islands.

*Body* half to three quarters of an inch in length, and rather more than half a line in breadth. It is so round as to be nearly circular in transverse section, with the exception of a little flattening on the ventral surface; very slightly tapered at either extremity.

*Colour*.—On the coasts of Scotland two varieties are especially common. The most abundant form is of various shades of brown or reddish-brown, speckled with groups of yellowish-white granules, often of considerable size, which are placed along the centre of the dorsum from one

end of the body to the other, but they do not form a continuous stripe. In some there is also a distinct brown lateral line. The other variety is reddish-brown, with a pale yellow dorsal stripe from snout to tail. The sepia-brown grains of the dorsum are placed on a reddish-brown ground. As soon as the pigment of the body becomes dark enough, a fine purplish lustre is produced by the play of light on the cilia, and the animal assumes a rich velvety aspect. In these dark examples, with a reddish-yellow central stripe, the under surface of the snout generally presents two pale symmetrical ovoid spaces a little behind the line indicating the mouth. In some cases the yellowish grains are scattered over both dorsal and ventral surfaces, and are quite characteristic of the species. In a large example dredged in Bressay Sound the dorsum was curiously variegated with patches of cinnamon-brown on a general ground-colour of pale brown speckled with yellowish grains, the pale brown of the ventral surface having a few specks of the same hue as the dorsum. The ventral surface is somewhat pale in all cases, and occasionally assumes a dull brownish-orange posteriorly. When floating with the ventral surface uppermost, a brownish margin is generally visible. Young examples are occasionally reddish-orange.

*Head* somewhat truncate and even notched in front, slightly narrowed posteriorly towards the cephalic furrows, and very little flattened. Eyes four, nearly in a square, the first pair being further from the tip of the snout than the last are from the cephalic furrows. They are deeply situated, and somewhat lateral in position—from the roundness of the snout when seen from above, and in profile appear considerably below the dorsal line. A variety from the harbour of Symbister, in Whalsay (Shetland), has the head somewhat pointed and better defined than usual, and the tail is also more tapered.

*Cephalic furrows*.—The anterior furrows are not visible on the dorsum. The posterior slant inwards and slightly backwards some distance behind the posterior eyes, meeting in the middle line. On the ventral surface they are directed slightly forward.

*T. dorsalis* is a marine rather than a littoral form, and sometimes occurs in vast numbers clinging to the débris of various seaweeds dredged in the laminarian region. It is hardy in confinement, either gliding with scarcely an undulation of its body, or rolling its snout from side to side in a peculiar manner as it progresses along the glass. It is also fond of enclosing itself in a tough transparent sheath, which is fixed to the wall of the vessel at the water-line. The sheath is highly elastic, and, while remaining perfectly transparent under a high power, is yet minutely streaked with translucent granules or specks, which are not due to fine creases or folds. The animal often reverses itself in the tube, and is sometimes doubled therein. It is curious to watch the pertinacity with which it progresses in a definite direction to stretch itself along the water-line.

The ova are deposited in the beginning of September, but some latitude is necessary in this respect, since specimens from deep water produced ova in June.

This species was brought into notice by P. C. Abildgaard in the fourth volume of O. F. Müller's celebrated 'Zoologica Danica;' and though he did not observe the eyes, his account is otherwise good. He terms it an eyeless brown 'Planaria,' with a pale ventral surface and a white dorsal line, and which constantly twists itself and loves to swim on its back. M. de Quatrefages, again, made a distinction between two varieties of this species, one of which (*Arctedia tubicola*), he said, formed a tube, while the other (*O. maculata*) did not. Moreover, he elevated them into a new genus—characterized by the sublateral position of the nerve-trunks, and their cylindrical bodies. Their structure, however, is in all respects strictly conformable to

the type of the Enopla. The large size of *O. maculata* (3 to 3½ in.) from the shores of Sicily is peculiar. Sir J. Dalyell says it is rare, and that its colour is universally variegated red and white, with a white line down the back, but his drawing shows only interrupted specks along the dorsum. This excellent author held the opinion, which I cannot endorse, that the *Planaria dorsalis* of Abildgaard referred to a fragment of *Lineus bilineatus*. The *Tetrastemma marmoratum* of M. Claparède, from the coast of Normandy, is the present species. The cylindrical form of the body had previously been known.

Genus III.—PROSORHOCHMUS,<sup>1</sup> *Keferstein*, 1863.

The typical species of this genus was first mentioned by Col. Montagu (MS., Library of the Linnean Society), who, however, was inclined to refer it to the *Planaria candida* of O. F. Müller. It is unlikely that so common a species escaped the notice of observers from the foregoing period up to 1863, the date at which Professor Keferstein published his descriptive characters of the genus in his 'Untersuchungen,' but it is probable that it was confounded with other forms. The four eyes which are characteristic of the previous genus are retained, only they do not form a rectangle. I would not place much weight (generically) on the ovo-viviparous character, as this is a condition which further investigation will probably extend to many genera.

*Generic character*.—Eyes four, not forming a rectangle; snout dimpled and furnished with a transverse superior lobe. Ovo-viviparous.

PROSORHOCHMUS CLAPAREDI, *Keferstein*. Plate II, fig. 4.

*Specific character*.—Snout blunt; eyes placed far back, the space between the anterior pair widest; yellowish. Other characters as in the genus.

SYNONYMS.

1808. *Planaria flava*, Montagu. MS., p. 237, tab. 35, f. 2.  
 1846. *Polia fumosa*, De Quatrefages. *Annal. des sc. nat.*, 3<sup>me</sup> sér., Zool., vi, pp. 206-7.  
 1849. " " *Ibid.* Voyage en Sicilie, vol. ii, p. 118, pl. 14, f. 9—11.  
 1862. *Prosorhochmus Claparedi*, Keferstein. *Zeitseb. f. wiss. Zool.*, Bd. xii, p. 61, taf. 6, f. 1—5.  
 1863. " " Diesing. *Nachträge zur Revis. der Turbell.*, p. 10.  
 " " " Claparède, *Beobach. über Anat. u. Entwickl.*, p. 23, taf. 5, f. 10—12.  
 1869. " " " McIntosh. *Trans. Roy. Soc. Edinb.*, vol. xxv, pt. ii, p. 344 et seq.

*Habitat*.—Under stones, and in fissures of rocks between tide-marks, on the southern shores of England, and in the Channel Islands.

*Body* an inch to an inch and a half in length, and three quarters of a line in breadth, flattened, somewhat narrowed behind the head, then gradually dilating, continuing for some distance of nearly equal diameter, and again diminishing towards the tail. In those examples in which the ovisacs are filled with developing young the body is round. The anus is very distinct.

πρόσω, the front, and ῥωχμός, a fissure.

*Colour* pale yellow, or, in some, pale orange, with two translucent spots behind the eyes, marking the situation of the ganglia. Long confinement increases the number of the dull orange grains on the dorsum. The young have numerous orange pigment-specks in their skins at birth.

*Head* wider than the succeeding portion of the body, though not distinctly defined posteriorly, broadly spatulate as well as somewhat truncate in front, and with a well-marked central notch from which a pale streak proceeds some distance behind the ganglia. Just behind the notch is a transverse furrow, furnished with very long cilia, which have a radiate appearance under the microscope. Eyes situated considerably behind the tip of the snout, the anterior pair being the larger, and while those of opposite sides are widely apart, those on the same side are closely approximated. The anterior pair under pressure often present a crescentic margin in front, and I have seen a clear globule in connection with them, which may represent a lens. In profile the two halves of the snout in front form a pair of large and prominent lips, with the mouth underneath and behind—in the shape of a well-marked elliptical or ovoid slit, while a third lobe, less prominent, occurs on the dorsum. The trilobed condition of the snout is well seen in small specimens placed between glasses separated by a chip.

*Cephalic furrows*.—A very slight notch is observed opposite the first pair of eyes, which indicates the opening of the cephalic pit, and an indistinct furrow runs from this point inwards.

*P. Claparedii* is not so active and restless in its movements as some of its allies, but it is the most hardy four-eyed example of the Enoptera I have yet seen, even more so than *T. dorsalis*. The specimens bore a journey to the Channel Islands to Scotland without the loss of one, or rather with a considerable increase, since the adults gave birth to numerous young individuals. It is interesting to see the comparatively large embryo moving in the interior of the adult, without interfering with its comfort in any way. They are observed in the bodies of their parents in July, and some remained there till October, having meantime considerably increased in size. Under pressure the embryos sometimes escape *per anum*. Both young and old are fond of leaving the water and remaining on the side of the vessel in the open air, and dozens of the former are frequently found floating on the thin whitish film which gathers on the surface of the sea-water after long keeping. They appear to be somewhat social animals in the free condition, as groups of adults (from ten to fifteen in number) are occasionally found in fissures of the rocks at St. Peter Port, Guernsey.

If the indefatigable Col. Montagu had published his notes and figure of this species it would have borne his name. He describes it as "long, filiform, yellow, with the front rounded and slightly bifid. Four eyes placed quadrangular." Five were found entwined together on the coast of Devon. He thought it might be the *Pleuroaria candida* of Müller, but the arrangement of the eyes and other points in his figure, together with the description, show its real nature. Græsted remarks that the anterior pair of eyes in his *Tetrastemma subpellucidum* are widest apart, but we are otherwise left in doubt as to the actual species he describes. The *Polia fumosa* of M. de Quatrefages has certain close resemblances to this form, such as the arrangement of the eyes and the truncated snout, and it is difficult to see to what species the author refers if not to this. The colouring of the figure (op. cit., fig. ix, a, b) is much too dark, and the outline not at all characteristic. The enlarged anterior end, however, in fig. x, though not accurate, can scarcely apply to any other species. He found it in fissures of the rocks at St. Vaast and Bréhat. It was not till more than half a century after the English naturalist's observations

that Prof. Keferstein published his account of the animal from specimens collected at St. Vaast-la-Hougue. His statement, however, that its mouth is behind the ganglia is erroneous, and it may be remarked that the position of the mouth is more easily seen in this species than usual. The occurrence of three marginal stylet-sacs in some examples is evidently accidental or abnormal.

The notched condition of the anterior border of the snout, so characteristic of this species, is very conspicuous in a large and flattened member of the Enopla, from New Zealand, in the British Museum. The specimens (in spirit) are about three inches long.

*Sub-Family*—NEMERTINÆ.

Proboscis proportionally small.

*Genus* IV.—NEMERTES, Cuvier, 1817 (Char. emend.).

Cuvier founded this genus for the description of *Lineus marinus*, which previously had received other names, and therefore the new title ought to have lapsed. But being set abroad by a zoologist so distinguished, it naturally came to be much employed in describing numerous and often diverse genera, as well as used by subsequent authors as the title of the entire order. Though the genus was first established, therefore, for the reception of one of the Anopla, yet the name has very frequently been bestowed on forms belonging to the Enopla, and, besides, claims attention for its priority, both as a generic title and as applied to one of the typical forms (*Nemertes gracilis*) of this genus.

*Generic character*.—Body more or less elongated, while the proboscis is very much diminished, the anterior region of the organ especially being shortened, so as to cause the central stylet to approach the ganglia.

1. NEMERTES GRACILIS, Johnston. Plate II, fig. 5.

*Specific character*.—Eyes numerous; snout broader than the rest of the body; central stylet of proboscis with an extremely long basal apparatus. Greenish or olive.

SYNONYMS.

1837. *Nemertes gracilis*, Johnston. Mag. Zool. and Bot., vol. i, p. 534, pl. 17, f. 1.  
 1841. „ „ W. Thompson. Ann. Nat. Hist., vol. vii, p. 482.  
 1844. *Polystemma gracile*, CErsted. Entw. Platw., p. 93.  
 1846. *Prostoma gracilis*, Johnston. Ann. Nat. Hist., vol. xvi, p. 435.  
 „ *Nemertes balnea*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., tom. vi, p. 197; tab. 9, f. 3—6; tab. 11, f. 2, and 4; and tab. 12, f. 2.  
 1849. „ „ Ibid. Voyage en Sicilie, vol. ii, p. 109, pl. 10, f. 6 and 7, and pl. 19, f. 3—6.

1850. *Omatoplea balmea*, Diesing. Syst. Helm., vol. i, p. 249.  
 " " *gracilis*, Ibid. Op. cit., p. 250.  
 1862. " *balmea*, Ibid. Revision der Turbell., p. 255.  
 " " *gracilis*, Ibid. Op. cit., p. 255.  
 1865. " " Johnston. Catalogue Brit. Mus., p. 22, pl. ii a, f. 1 and 1\*.  
 1869. " " McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 334 et seq.

*Habitat*.—Frequent under stones between tide-marks, and especially abounding under tangle-roots at low water. No example, however, was met with during an excursion to the Channel Islands.

*Body*.—Eight to twenty inches in length, and about a line in breadth, flattened in progression, and thrown into ever-varying wrinkles, dilatations and contractions. The diameter is nearly uniform for a considerable distance behind the head, and then the body gradually tapers towards the tail. It is occasionally attenuated to a mere thread.

*Colour*.—Dull greyish-green on the dorsum, deepest in front, and somewhat duskier in the centre from the hue of the alimentary tract. Some incline to bluish-green anteriorly, others are dull olive throughout. There are two reddish specks (due to the ganglia) behind the head. In some specimens the dorsum for a short distance posterior to the latter is marked with minute pale specks or with black pigment-grains, the latter occasionally continuing to the tip of the tail. The under surface is greyish-white, dappled in the ripe females with dull whitish spots from the ova. The reddish colorations from the ganglia are best observed on this surface, and there is also a pale streak in the oesophageal region.

*Head*.—Somewhat spatulate, flattened, rather blunt at the tip, and slightly dilated laterally, so as to be wider than the rest of the body. Eyes arranged in two or three groups on each side, the anterior cluster containing the larger number, and being situated just within the pale border of the snout. The number of eyes in this series ranges from five to nine, but, as usual, it is variable. The next group is placed distinctly posterior, nearer the middle line of the head, and consists of three, four, or five eyes, which in some are transversely arranged. The third cluster lies at the anterior border of the ganglion, or, occasionally, proceeds backwards along the outer border of the latter. The first-mentioned groups are visible from the ventral surface.

*Cephalic furrows*.—There are no evident furrows on the dorsum of the head, and inferiorly there is only the central slit of the mouth.

This species lives a considerable time in confinement. Sometimes, when it has stretched its snout beyond the water-line, while its tail reaches the bottom of the vessel, it assumes a very regular spiral arrangement. If the snout be loosened from its attachment, the body is at once gracefully shortened, like the stalk of a Vorticella or a coiled spring. It can also attenuate itself to an extreme degree. It secretes a very tenacious, transparent mucus, especially when irritated, and envelopes itself therewith, apparently for protection. The fine threads of this secretion are so tough that they support the animal when lifted above the surface of the water. The skin is acid to test-paper.

*Nemertes gracilis* spawns in May.

This animal was discovered by Dr. Johnston on the coast near Berwick, a region that became so rich in novelties under his patient and searching scrutiny. It was re-described many years later by M. de Quatrefages under the name *Nemertes balmea*, from Bréhat. The French

author did not observe any cephalic furrows, or "genital aperture" (mouth), and therefore he concluded that the latter was a temporary orifice. Its mouth occupies the usual position.

2. NEMERTES NEESII, *Ersted.* Plate III, fig. 6; and var., Plate VII, fig. 6.

*Specific character.*—Eyes numerous. Stylets short and grooved. Streaked with purplish-brown on the dorsum.

SYNONYMS.

1828. *Planaria flaccida*, Johnston. Zool. Journ., vol. iii, p. 488.  
 1844. *Amphiporus Neesii*, Ersted. Kroyer's Naturhist. Tids., iv, p. 581.  
 " " " Ibid. Entw. Plattw., p. 95.  
 1846. *Borlasia? flaccida*, Johnston. Ann. Nat. Hist., vol. xvi, p. 435.  
 " " *camillea*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., tom. vi, p. 194, tab. 9, f. 1, and tab. 14, f. 3.  
 1849. " " Ibid. Voyage en Sicilie, vol. ii, p. 106, pl. 10, f. 4 and 5.  
 " *Amphiporus Neesii*, Leuckart. Archiv für Naturges., i, p. 149.  
 1850. " " Diesing. Syst. Helm., vol. i, p. 245.  
 " *Nemertes camillea*, Ibid. Op. cit., p. 274.  
 1853. *Gordius fuscus*, Dalyell. Pow. Creat., vol. ii, p. 83, pl. 9, f. 15 to 17, and pl. 12.  
 1859. *Amphiporus Neesii*, Leuckart. Archiv für Naturges., ii, p. 187.  
 1862. *Borlasia Neesii*, Diesing. Revis. der Turbell., p. 249.  
 " *Emplectonema camillea*, Ibid. Op. cit., p. 306.  
 1865. *Serpentaria fusca*, Johnston. Catalogue Brit. Mus., pp. 28 and 298.  
 1865-6. *Borlasia camillea*, De Quatrefages. Hist. Nat. des Annelés, pl. 4, f. 14.  
 1866. *Serpentaria fusca*, Lankester. Ann. Nat. Hist., 3rd ser., vol. xvii, p. 389.  
 1868. *Ommatoplea purpurea*, McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.  
 " " " Ibid. Report Brit. Assoc., 1868, p. 340.  
 1869. " " " Ibid. Trans. Roy. Soc. Edinb., vol. xxv, p. 336 et seq.

*Habitat.*—Under stones between tide-marks, in crevices of rocks and tangle-roots near low water, and in fissures of the Gouliot caves, Sark. It also occurs on the tangle-ground in Shetland, and in deep water off the east coast of Scotland. Ranges from Iceland to the Channel Islands.

*Body.*—Four to eighteen inches in length, and, in large specimens, about a quarter of an inch in breadth, elongated, much flattened, appearing almost of equal diameter throughout, though in reality slightly tapering towards the posterior end. It is generally thrown into numerous equidistant transverse wrinkles, which are only obliterated in extreme extension.

*Colour.*—Variouly speckled madder-brown, with a faint purplish iridescence from the play of light on the cilia. Towards the anterior part of the body the specks are more marked, and the general colour somewhat paler, especially on the head. Behind the latter the dorsum assumes a streaky appearance, brown being the predominant hue, with longitudinal flesh-coloured stripes, all of an interrupted character. The lateral regions abound with brown



specks. Towards the tail the colour again becomes paler, and the dorsal specks more numerous. The entire under surface is pale pinkish-white, or skin-coloured. In the darker specimens the streaks are less numerous, though more boldly marked. Some examples are of a very pale brownish hue, the dorsum having only pale brown pigment-grains and no streaks. Other varieties, again, are very curiously mottled, like polished rosewood or walnut, or of a faint yellow, speckled with brown. Young specimens from deep water are occasionally almost white, or faint skin-colour, and some have a uniform dull orange hue, from the digestive chamber. The proboscis in the latter examples is pale pink. Young specimens, and those from dark recesses, are generally pale.

*Head*.—Spathulate, wider than the rest of the body, with a pale margin, and a central streak from the notch or dimple in front backwards. Eyes numerous, arranged in two dense clusters on each side—a little behind the tip of the snout. Unless in pale specimens, they are distinguished with difficulty on account of the dark coloration of the dorsum. They are larger than the eyespecks of *N. gracilis*.

*Cephalic furrows*.—The snout is bounded posteriorly by two dorsal transverse grooves, which also mark a slight constriction. On the under surface two furrows slant outwards and backwards from the mouth, a short distance behind the tip of the snout, and from these the openings of the cephalic pits proceed. They are visible as two curved lines, which do not reach the lateral margin of the body, and thus are wholly ventral.

*N. Neesii* is rather plentifully distributed on our coasts, four or five being occasionally procured under one stone, or in a fissure of the shelving rocks. The facility with which it coils and twists its body in all directions is most interesting. Sometimes the posterior part of the animal lies in a tangled knot, while the anterior extends outwards as a long screw, the alternate dark and light shades of the dorsal and ventral surfaces forming a very agreeable contrast; and from the frequency with which it assumes this attractive position one might be excused in attributing to the animal some sense of the splendour with which nature has endowed it. It floats with ease on the surface of the water, the body being thrown into various undulations, as when progressing on the surface of the ground, though, of course, more slowly and less distinctly. It is killed by immersion in fresh water, the body before death being surrounded by a tough coating of mucus, like many of its allies and the *Didemna*. The skin is alkaline to test-paper.

In one specimen of a pale brick-red hue, from Guernsey, the muscular investment of the basal apparatus of the central stylet was abnormal (a state that could scarcely have resulted from degeneration, for it was examined on the third day after capture), being elongated posteriorly and split into processes like rootlets, from the peculiarities of the fibres.

It spawns in March and April.

The *Lineus maculosus* of Montagu (MS., p. 274) can scarcely refer to any other British form than the above. It is described as "rufous-brown, mottled, beneath white, resembling *L. marinus*. Length more than a foot, and not larger than *Gordius aquaticus*." Dr. Johnston, however, first published an account of the species, from a specimen coiled in a valve of *Saxicava rugosa*, from deep water in Berwick Bay. The *Amphiporus Neesii* of CErsted, as R. Leuckart mentions, is clearly synonymous with the *Gordius fuscus* of Dalyell (the present species), and as CErsted's specific title is free from the objections connected with Johnston's, it has been chosen. Sir J. Dalyell noticed its tendency to coil in knots. His examples spawned in April, the ova

merely lying in a "thin albuminous matter" (probably mucus), and covering the bottom of a vessel two inches in diameter. He hazarded the opinion that the mouth was apparently in the anterior part. There is nothing to indicate specific distinction from the present form in the description and figures of the *Borlasia camillea* of De Quatrefages. I cannot, however, make the same statement with regard to the *Implectonema camillea* of Stimpson and the *Nemertes camillea* of Williams. Two specimens in the British Museum, from Greenland, have very short, thick bodies, and the proboscis in each is proportionally large; but these appearances may be due in some respects to the mode of preparation.

This species has sometimes been confounded with "Serpentaria fragilis" (*Cerebratulus angulatus*).

### 3. NEMERTES CARCINOPHILA, Kölliker. Plate I, fig. 5.

*Specific character*.—Eyes two; proboscis furnished with a central stylet only. Body of a pale pink colour.

#### SYNONYMS.

1845. *Nemertes carcinophilus*, Kölliker. Verhandl. d. Schweiz. naturf. Gesellsch. in Chur., p. 89.

1850. " " " Von Siebold. Archiv für Naturges., p. 382.

1860. *Polia involuta*, Van Beneden. Recher. sur les Turbell. (sep. copy, from Mém. Acad. Belg., tom. xxxii), p. 18, pl. 3.

1862. *Cephalothrix involuta*, Diesing. Revis. der Turbell., p. 254.

" *Nemertes carcinophila*, Ibid. Op. cit., p. 298.

1869. *Polia involuta* (*Nemertes carcinophila*, Kölliker), McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 309 et seq.

*Habitat*.—Abounds in tubes attached to the abdominal hairs of female specimens of *Carcinus manas* bearing ova. Messina and the Coast of Belgium.

*Body*.—One to two inches long, scarcely so thick as a thread during extension, flattened, nearly equal in diameter throughout, or very slightly tapered at head and tail.

*Colour*.—Pale skin or slightly pinkish; pale rose-pink in contraction or when coiled *en masse*. There is a pale patch behind the snout, indicating the region of the proboscis.

*Head*.—Slightly tapered towards the anterior end, not defined from the rest of the body, and ending in a blunt snout. Eyes two, situated considerably behind the tip of the latter.

It is a somewhat sluggish animal, lying doubled in its sheath, or when removed gliding about the vessel in a slow, feeble manner. It is also less hardy in confinement than the majority of the group.

*N. carcinophila* spawns in April, and it is easy to watch the development of the young.

Prof. Kölliker first found the worm in its usual position on a small crab at Messina, and his account of it is quite characteristic. This paper, however, escaped the notice of M. van Beneden, who re-described it as a new species from "*Cancer manas*" many years subsequently. It is not strictly a parasite of the shore-crab, but, like diverse annelids in other sites, it seems to find the hairs of the abdominal feet of females bearing ova a convenient position for its sheaths, and

probably for protection and a proper supply of food. In the same way the *Tetrastemma* before mentioned frequents the branchial chambers of the Ascidians, the *Planaria angulata* of Agassiz (not Müller) the under surface of *Limulus*, and the *Planaria* the cavities of the Medusæ; or, as *Harmothoe imbricata*, *Polynoë areolata*, and others, live in harmony with *Chelopterus norvegicus* in its tube, and *Polynoë scolopendrina* with *Marphysa sanguinea* and *Terebella nebulosa* in their tunnels.

Prof. van Beneden, however, correctly indicates its affinity with the *Prorhynchus stagnalis* of Max Schultze, a freshwater species, and gives an interesting if not strictly accurate account of its development.

*Sub-Order*—ANOPLA.

Proboscis without stylets.

*Family* II.—LINEIDÆ.

*Genus* V.—LINEUS,<sup>1</sup> Sowerby, 1806.

The typical species of this genus was one of the first Nemerteans known to science, viz. the *Gordius marinus* of Montagu. The generic name employed by the latter, however, as he himself was well aware, could not stand; and while he was waiting till the discovery of other species would enable him to give a more comprehensive description of the genus, Sowerby published 'The British Miscellany,' in which the generic name above mentioned was bestowed on the same characteristic species.

*Generic character*.—Body more or less elongated, rounded or somewhat flattened, and tapered posteriorly. Head distinct, spatulate, and generally truncate in front. Eyes numerous, arranged along the sides of the snout anteriorly; rarely absent. Mouth in the form of a conspicuous longitudinal slit on the ventral surface. Other characters as in the family.

1. LINEUS MARINUS, *Montagu*. Plate IX; and Plate XVIII, figs. 1—3.

*Specific character*.—Eyes numerous, deeply set in a marginal row on each side of the snout. Of a blackish or very dark olive colour, more or less distinctly streaked longitudinally. Body rather rounded.

SYNONYMS.

1758. *Sea-Long Worm*, Borlase. Nat. Hist. Cornwall, p. 255, tab. 26, f. 13.

1804. *Gordius marinus*, Montagu. Linn. Trans., vol. vii, p. 72.

1806. *Lineus longissimus*, T. W. Simmons. Sowerby's Brit. Misc., p. 15, pl. 8.

*Linea*, a line.

1807. *Lineus longissimus*, Turton's British Fauna, p. 180.  
 1808. „ *marinus*, Montagu. MS., p. 271.  
 1811. „ *longissimus*, Jameson. Wernerian Memoirs, vol. i, p. 557.  
 1812. *Gordius marinus*. Pennant's British Zoology, vol. iv, p. 74.  
 1815. *Borlasia anglicæ*, Oken. Lehrbuch, &c., p. 365, tab. xi, f. 4.  
 „ *Gordius marinus*, Davies. Trans. Linn. Soc., vol. xi, p. 292.  
 1816. „ Ibid. Lond. Med. and Phys. Jour., xxxvi, pp. 207-9.  
 1817. „ Ibid. Extr. in Isis, 1817, pp. 1054-56.  
 „ *Nemertes Borlasii*, Cuvier. Rêg. An., tome iv, p. 37.  
 1828. *Borlasia anglicæ*, De Blainville. Dict. des sc. nat., 57, p. 575; ibid., Atlas, Parentomozoaires, f. 1 a—1 d.  
 1834. *Nemertes Borlasii*. Griffith's Cuv., vol. xii, p. 468.  
 1836. *Borlasia longissimus*, Templeton. Loud. Mag. Nat. Hist., vol. ix, p. 236.  
 1838. *Nemertes Borlasii*, W. Thompson. Charlesworth's Mag. Nat. Hist., vol. ii, p. 21.  
 1843. *Borlasia striata*, Rathke. Beitr. z. Fauna Norweg. (Nor. Act. Nat. Curios., xx), p. 231.  
 1842-3. *anglicæ*, CErsted. Kroyer's Naturhist. Tids., iv, p. 572, in nota.  
 1844. *Nemertes Borlasii*, Ibid. Entw. Plattw., p. 92.  
 „ „ *striata* (Rathke), Ibid. Op. cit., p. 92.  
 1845. „ *gracilis*, H. Goodsir. Ann. Nat. Hist., vol. xv, p. 378, pl. 20, f. 3.  
 1845.? „ *Borlasii*, De Quatref. Règne An. illust. (Zoophytes, 12<sup>e</sup> livraison, pl. 83).  
 1846. *Lineus longissimus*, Johnston. Ann. Nat. Hist., vol. xvi, p. 435.  
 „ „ *gracilis*, Ibid. Op. cit., p. 435.  
 „ *Borlasia anglicæ*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., tom. vi, p. 192, tab. 8, f. 4 and 5; tab. 10, f. 8; tab. 12, f. 3 and 4; and tab. 13, f. 1—3 and 5—9.  
 1849. „ „ Ibid. Voyage en Sicilie, vol. ii, p. 104, pl. 9, f. 7; pl. 11; and pl. 12, f. 2, &c.  
 1850. *Meckelia Borlasii*, Diesing. System. Helm., vol. i, p. 265.  
 „ „ *gracilis*, Ibid. Op. cit., p. 268.  
 „ *Nemertes striata*, Ibid. Op. cit., p. 274.  
 1851. *Lineus longissimus*, Williams. Rept. Brit. Assoc., 1851, p. 244, f. 64 (?)  
 1853. *Gordius maximus*, Dalyell. Pow. Creat., vol. ii, p. 63, pl. 8, and pl. 9, f. 1.  
 1855. "An ascaroid or planarian worm." North Brit. Review, No. 43, p. 38.  
 1856. *Borlasia nigra*, Byerley. Fauna of Liverpool, p. 98.  
 1857. *Nemertes Borlasii*, De Quatrefages. Ramb. of a Naturalist, Eng. edit., vol. i, p. 116.  
 1859. „ „ Kingsley. Glaucus, p. 124, pl. 3, f. 1.  
 „ *Borlasia anglicæ*, Leuckart. Archiv für Naturges., ii, p. 187.  
 1860. *Nemertes Quatrefagesii*, Van Beneden. Recher. sur les Turb., &c., p. 15, pl. 2, f. 5—9, var.  
 1862. *Meckelia Borlasii*, Diesing. Revis. der Turbell., p. 235.  
 „ „ *gracilis*, Ibid. Op. cit., p. 303.  
 „ *Quatrefagesii*, Ibid. Op. cit., p. 304.  
 1863. „ *Borlasii*, Diesing. Nachträge z. Revis. der Turbell., p. 8.  
 1865. *Borlasia striata*, Johnston. Catalogue Brit. Mus., pp. 22 and 291.  
 „ „ *longissimus*, Ibid. Op. cit., pp. 25 and 293.  
 „ „ *gracilis*, Ibid. Op. cit., pp. 26 and 295.  
 „ „ *lineatus*, Ibid. Op. cit., pp. 26 and 295.  
 „ „ *mareoides*, Ibid. Op. cit., p. 26.  
 „ „ *fasciatus*, Ibid. Op. cit., pp. 26 and 295.  
 1866. „ *longissimus*, Lankester. Ann. Nat. Hist., 3d ser., vol. xvii, p. 389.

1866. *Borlasia gracilis*, Ibid. Op. cit., p. 389.  
 „ *lineatus*, Ibid. Op. cit., p. 389.  
 1867. *longissimus*, Parfitt. Catal. Annel. Devon, p. 8.  
 „ *lineatus*, Ibid. Op. cit., p. 8.  
 1868. *longissimus*, McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.  
 „ „ Ibid. Proceed. Linn. Soc., vol. 4, p. 251.  
 „ „ Ibid. Rept. Brit. Assoc., 1868, p. 340.  
 1869. „ „ Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 374 et seq.

*Habitat*.—Not uncommon under stones between tide-marks, either in or out of tidal pools, in fissures of rocks, amidst tangle-roots in the luminarian zone, and occasionally in deep water.

*Body*.—Fifteen to thirty feet to as many yards in length, and from one to four lines in breadth, rather rounded, slightly narrowed behind the head, continuing of nearly equal calibre throughout the greater part, and then gradually narrowing towards the tail.

*Colour*.—Blackish-brown, relieved throughout by the fine purplish iridescence of the cilia. The tip of the snout is pale or whitish, and there are three pale bands from this region backwards. The central passes along the body a considerable distance, but gradually becomes indistinct, and the two lateral, which follow a similar course on the dorsum, vanish sooner. In addition to the foregoing, a very distinct pale stripe commences on each side at the posterior part of the cephalic fissure, and courses along the infero-lateral region of the body to the tip of the tail. Another well-marked stripe commences on the ventral surface at the centre of the snout, and continues along the middle nearly to the termination of the body. There is not much difference in colour between the dorsal and ventral surfaces. In young examples the brown is much paler, assuming an olive-brown or olive hue, and the stripes are more numerous and conspicuous; indeed, there is considerable variety in this respect. Generally, a reddish coloration is observed on both surfaces in the ganglionic region. The stripes exist on many good spirit-preparations, those on the head being especially distinct, and the slight eversion of the mouth causes a pale margin (or lip) all round. In dark specimens the lateral lines of the body are the most conspicuous. The rich dark colour of many shows that they are not unused to light in their native haunts.

*Head*.—Wider than the succeeding portion of the body, narrowed towards the anterior and posterior borders. The tip of the snout is generally bilobed, with a distinct papilla in the centre and two small ones on each lateral eminence. On each side is a deep lateral fissure with large lips, the superior being often rolled or curved inwards. The fissures have the usual reddish hue posteriorly. There is a dense group of eyes on each side of the anterior margin of the snout, arranged in a longitudinal manner, or rather their outline forms a long wedge—narrow anteriorly and wide posteriorly. In very dark examples these eyes are not easily seen, indeed they have escaped the notice of many observers; but if the animals are kept in confinement a long time, the bleaching of the snout renders them conspicuous, as may be noticed by contrasting the large coloured figure in Plate IX with Plate XVIII, fig. 1, which (latter) represents the head of the same specimen upwards of a year after its capture. In young animals the eyes are easily seen from the dorsum.

This is unquestionably the giant of the race, and even now I am not quite satisfied about the limit of its growth, for after a severe storm in the spring of 1864 a specimen was thrown on shore at St. Andrews which half filled a dissecting jar eight inches wide and five inches deep. Thirty

yards were measured without rupture, and yet the mass was not half uncoiled. It chiefly delights to lurk under stones not far from low-water mark, or in tidal pools, and is occasionally found looped like a living string of caoutchouc amongst the seaweeds fringing the sides of the latter. It is useless in such a case to attempt to capture the worm by pulling at the free end, for, although it resists considerable tension, rupture is apt to follow: it should be allowed to contract itself, and then lifted or rolled in a mass into the vessel. At first sight it seems strange that nature should have fashioned an animal so soft and apparently so helpless as this, devoid of arms either of offence or defence throughout its extreme length, and which, moreover, can be so easily ruptured. Yet the facility with which reproduction can take place in wounded examples on the one hand, and the shelter afforded by its site on the other, give it sufficient protection in the struggle for existence as an adult form, while the enormous powers of increase in the ordinary way by ova render the continuance of the species doubly secure.

There is something remarkable in the movements of a large specimen of this huge worm, as its quivering body emerges from a dark creek in one of the little caverns that abound amongst the tidal rocks. No useless bustle warns its companions of its approach, but it glides silently forward with its exploratory snout, and scatters the smaller inhabitants by the very stealth and suddenness of its appearance. Some may even be excused in reckoning it the evil genius of the pool—dark, slimy and mysterious, moving hither and thither, as it were, by an invisible agency, and whose ways, like the inextricable knots and coils of its serpentine body, are difficult to find out. It is not to be more harshly judged, however, than the young *Cotté*, *Shannies*, and *Cyclopteri*, that shelter themselves from its approach amidst the blades of the trailing tangles, the *Hippolytes* and *Mysidæ* that reconnoitre it from under the fringes of *Corallina*, *Ulva* and *Cramium*, the *Idoteidæ* and *Capprellidæ* that climb monkey-like on their branches, or than the sluggish *Doris* adherent to the variously tinted *Halichondria*. All are equally predatory, and subservient to the special ends for which they live; and if the elongated worm preys by stealth and not by swift and open attack, this is due to its physical constitution, and not to any acquired vice or degradation. If it swallows its prey alive, it is, at any rate, devoid of instruments of laceration or torture, such as the jaws of its higher allies or the thread-cells of the Hydrozoa.

*L. marinus* lives well in confinement, and, without receiving any food, will survive for years, though the body greatly diminishes in size, both as regards length and thickness. Indeed, as in other examples, the insensible consumption of the formed tissues supports the animal under circumstances so abnormal, for we cannot place any weight upon food derived from microscopic organisms in so limited a supply of salt water, and one so rarely or never changed. Sickly specimens die from behind forward piece by piece, a fresh portion being thrown off at intervals until the head is reached. It is fond of taking refuge in tubes; thus a small one captured at Herm thrust out the rightful owner (a *Protula*), coiled itself therein, and is now preserved *in situ*. Several have also been found with the body looped through a broken *Trochus* or *Littorina*, which formed a kind of anchor in the runlets of sea-water in which their protecting stoncs lay. Not only do some fragmentary specimens, when put in spirit, turn themselves inside out, as Sir J. Dalyell saw in the living animal in salt water, but more than once I have been puzzled when making transverse sections by finding one part of the body doubled quite within the other, and this for a considerable distance. The entire skin gives a marked acid reaction to test-paper.

The breeding season would seem to be in June, but spermatozoa have been found fully

developed in May and September. Sir J. Dalyell had a specimen which discharged innumerable white ova in May.

This Nemertean was first noticed by the Rev. W. Borlase, under the name of the Sea-Long Worm, but it received its scientific title from Col. Montagu. If subsequent writers on the Nemerteans had had the privilege of consulting the manuscript of this author, great confusion would have been avoided, and this not more conspicuously than in the present instance. He had observed the variable colours—from dusky to rufous-brown, and striped more or less plainly—of adults and young specimens. His description, on the whole, is excellent, though, in common with many other naturalists, he omitted to notice the eyes; and in his early account in the 'Linnean Transactions' it is probable he thought the proboscis the excreta. He makes the curious remark, that "It is not fragile unless contracted by spirits, for we have generally measured the length by winding upon a cylinder of wood of known circumference, suffering five or six feet of the animal to be pendent, in order to ascertain as nearly as possible the utmost length. In this state they have been suffered to die, and rarely break by contraction." Prof. Jameson observes that it was "noticed many years ago by my friend Mr. Neill, afterwards transmitted by the late Mr. Simonds to Mr. Sowerby, who has figured and described it in his 'British Miscellany.'" He calls it the Black Worm of the Newhaven fishermen. The Rev. Hugh Davies did not see the eyes, and rather vaguely conjectured that it advanced by coiling its "amazing length into a compact spiral, each volution of which assisted in the act of progression," a supposition only less wide of the truth than that of M. de Quatrefages, who mentions that it glides through the water by means of excessively fine cilia. Sir J. Dalyell, again, considered that small examples floated less by their specific levity than by the repulsion of the lubricating matter investing the body, a method somewhat involved in obscurity. I am not satisfied that the *Ophiocephalus murenoides* of Delle Chiaje is this species; indeed, the flattened form and pointed snout shown in a figure in his 'Descrizione' point this out rather as allied to *Cerebratulus angulatus*, Müller, than to the present species. The so-called specimens of *Lineus murenoides*, also, of British naturalists, are all referable to *L. marinus*. I have included M. van Beneden's *Nemertes Quatrefagesii* under the same head, for it seems to be only a pale and young variety, with the stripes distinctly marked. The arrangement of the eyes, as noted by this author in regard to his supposed new form, is equally characteristic of *L. marinus*.

2. *LINEUS GESSERENSIS*, O. F. Müller. Plate IV, fig. 2; and Plate V, fig. 1.

*Specific character*.—Eyes numerous, marginal. Snout distinctly wider than the rest of the body. Greenish, olive or reddish-brown.

#### SYNONYMS.

1766. *Alia LUMBRICI marini* species, tota atra, Pallas. Miscell. Zool., p. 216, tab. 11, f. 9.  
 1771. Der Strömische Röd-Aat, O. F. Müller. Wurm-Arten des sussen u. salzigen W., p. 118, tab. iii, figs. 1—3.  
 1774. *Ascaris rubra*, O. F. Müller. Verm. terrest. et fluv. Hist., vol. i, ii, p. 36.  
 1776. "Ibid. Zool. Danic. Prodr., p. 213, No. 2587.  
 1780. *Planaria fusca*, O. Fabricius. Fauna Groenlandica, p. 324.

1788. *Planaria gesserensis*, O. F. Müller. Zool. Danic., ii, p. 32, tab. 64, f. 5—8.  
Gmelin. Linn. Syst. Nat., tom. i, pars vi, p. 3098.
1798. " *fuscescens*, O. Fabricius. Skriv. af Naturhist. Selsk., iv, ii, pp. 58—62, tab. 11,  
f. 8—10 (?)
1816. " *gesserensis*, Lamarck. Hist. Nat. des an. sans vert., vol. iii, p. 179.
1827. " " Bosc. Hist. Nat. des vers, i, p. 262.
1829. " *bioculata*, Johnston. Zool. Jour., vol. iv, p. 56.
1837. *Nemertes (Borlasia) olivacea*, Johnston. Mag. Zool. and Bot., vol. i, p. 536, pl. 18, f. 1.
- " " *purpurea*, Ibid. Op. cit., p. 537, pl. 18, f. 3.
1843. *Borlasia rufa*, Rathke. Beiträge z. Fauna Norweg., p. 234 (?).
- " *Meckelia olivacea*, Ibid. Op. cit., p. 234.
- 1842-3. *Planaria gesserensis*, Örsted. Kroyer's Naturhist. Tids., iv, p. 572, in nota.
- " *Nemertes olivacea*, Ibid. Op. cit., p. 578.
- " *purpurea*, Ibid. Op. cit., p. 579, in nota.
1844. *Tricelis gesserensis*, Örsted. Entw. Plattw., p. 27.
- " *Nemertes olivacea*, Ibid. Op. cit., p. 89.
- " " *fuscescens*, Ibid. Op. cit., p. 92.
- " " *purpurea*, Ibid. Op. cit., p. 91.
1846. *Borlasia olivacea*, Johnston. Ann. Nat. Hist., vol. xvi, p. 434.  
" " W. Thompson. Op. cit., vol. xviii, p. 388.
- " " *purpurea*, Ibid. Op. cit., p. 388.
1847. " *rufa*, Frey u. Leuckart. Beiträge z. Kennt. wirtb. Thiere, p. 72, tab. 1, f. 15 and 16; var.
1849. *Nemertes fusca*, Leuckart. Archiv für Naturges., i, p. 152.
1850. *Notospermus gesserensis*, Diesing. Syst. Helm., vol. i, p. 260.
- " *Meckelia olivacea*, Ibid. Op. cit., p. 264.
- " " *fusca*, Ibid. Op. cit., p. 266.
- " *Nemertes rufa*, Ibid. Op. cit., p. 271.
- " " *olivacea*, Ibid. Op. cit., p. 273.
- " " *purpurea*, Ibid. Op. cit., p. 275.
1852. " *olivacea*, Max Schultze. Zeitsch. f. wiss. Zool., iv, p. 178.
1853. *Gordius minor viridis*, Dalyell. Pow. Creat., vol. ii, p. 72, pl. 9, f. 2—7.  
" *gesserensis*, Ibid. Op. cit., p. 73, pl. 10, f. 5.
- " *Vermiculus lineatus*, Ibid. Op. cit., p. 90, pl. 10, f. 19 and 20 (young with two eyes).
1857. *Cerebratulus oleaginus*, Stimpson. Proceed. Acad. Nat. Sc. Philad., p. 160.
- " *Nemertes olivacea*, Max Schultze. Icones Zootom. (V. Carus), tab. 8, f. 14.
1859. *Meckelia olivacea*, Leuckart. Archiv für Naturges., ii, p. 187.  
*Gordius gesserensis*, Ibid. Op. cit., p. 187.
- " *Nemertes olivacea*, Ibid. Op. cit., p. 187.
1860. " *flaccida*, Van Beneden. Recher. sur les Turb., &c., p. 14, pl. i, f. 14—17 (?)
1862. *Meckelia oleagina*, Diesing. Revis. der Turbell., p. 280.  
" *fusca*, Ibid. Op. cit., p. 285.
- " *Nemertes rufa*, Ibid. Op. cit., p. 298.
- " " *gesserensis*, Ibid. Op. cit., p. 299.
- " " *purpurea*, Ibid. Op. cit., p. 299.
- " " *olivacea*, Ibid. Op. cit., p. 300.
- " " Kieferstein. Zeitsch. für wiss. Zool., Bd. xii, p. 66.
- " *Meckelia olivacea*, Diesing. Nachtzüge zur Revis. der Turbell., p. 8.
- " *Gordius gesserensis*, Ibid. Op. cit., p. 14.
- " *Nemertes olivacea*, Ibid. Op. cit., p. 14.



1865. *Borlasia olivacea*, Johnston. Catalogue Brit. Mus., pp. 21 and 289, pl. ii *b*, f. 1 and 1\*.  
 „ „ *gesserensis*, Ibid. Op. cit., pp. 21 and 290.  
 „ „ *Lineus viridis*, Ibid. Op. cit., pp. 27 and 296.  
 1866. *Borlasia olivacea*, Lankester. Ann. Nat. Hist., 3rd ser., vol. xviii, p. 388.  
 1867. „ „ McIntosh. Jour. Micros. Sc. ; Trans., p. 39.  
 1868. „ „ Ibid. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.  
 1869. „ „ Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 371 et seq.

*Habitat*.—Abundant on all our shores under stones between tide-marks, and in the laminarian region, from the Shetland to the Channel Islands.

*Body*.—Four to nine inches in length, breadth a line and a half or more, flattened, tapered towards the head, and more distinctly towards the tail; marked by numerous pale transverse wrinkles, somewhat regularly disposed, and most conspicuous in pale specimens.

*Colour*.—Two very distinct hues are characteristic of this species, viz. reddish-brown and dull olive, while pale reddish and green varieties are also occasionally met with. The pigment is generally darkest in front, before and behind the reddish mark in the ganglionic region, the rest of the body being uniformly tinted except towards the tail, which is paler. The snout is surrounded by a broad pale margin, as far back as the termination of the fissures. The ciliation gives the body under certain conditions either a purplish or an opalescent hue. The sides are often marked with numerous pale spots, from the generative apertures. The ventral surface is paler than the dorsal, especially towards the snout, which is also reddish posteriorly. The mouth is surrounded by a pale margin. Party-coloured varieties are sometimes found, the anterior region, for instance, being dark green mottled with white, while the posterior half is quite pale. Such bleaching is different from that caused by parasitic attacks.

*Head*.—Somewhat elongated, flattened, spatulate, rather truncate in front, with a small central and two lateral papillæ, and having on each side—from the tip of the snout backwards—a deep fissure with pale edges and a pinkish bottom, the latter hue being most distinct posteriorly. It tapers slightly anteriorly, and is decidedly wider than the succeeding portion of the body, on account of the lips of the lateral fissures. The eyes are situated at the anterior central pigimentary portion of the snout, and number from three to six or more on each side, the largest being generally in front. They are not always symmetrical; three, for example, occurring on one side, and occasionally eight on the other, besides some indistinct grains. The mouth opens as a longitudinal slit a short distance behind the ganglia.

*L. gesserensis* progresses in an easy, graceful manner, with slight undulatory motions of the head, its body being marked with successive contractile waves, which proceed from before backwards. The specimens frequently herd together in the water, which they are prone to leave, and remain attached to the side of the glass a considerable time. They are very easily kept in confinement for years; but, as with many of their allies, great diminution of bulk occurs, from deprivation of the natural supply of food. When recently captured specimens are placed in a jar containing injured Annelida, numerous fecal masses, consisting of the bristles of *Nereis pelagica*, and other annelids and digested matter, are found lying on the bottom of the vessel, showing how greedily they have fed; a fact, indeed, very easily ascertained by actual observation. It is also frequently noticed that specimens confined in vessels along with the deep green *Eudalia viridis* assume a similar hue, probably from feeding on the rejected debris of those animals, if not upon the latter themselves. In their native haunts the stones under which they lie

are often placed on dark, muddy and highly odoriferous sand or gravel, and the water cannot be otherwise than brackish at the estuary of a river.

The skin of this species gives an acid reaction.

The ova are deposited in gelatinous sheaths from January to May, and abound under stones in pools and moist places between tide-marks.

The want of precision in the descriptions of authors has burdened the literature of the present group of animals with diverse synonyms, especially as regards this widely distributed species. Though O. F. Müller's specific name *rubra* has the priority, and *fusca* comes next in order, yet, as each of these terms implies something at variance with the true description of the species, as contrasted with others, or retains some elements of doubt, I have chosen the succeeding title, viz. *gesserensis* (of the same author), as more appropriate. His description of the form under the latter name, and the accompanying figure, leave no room for uncertainty, even the pale specks for the exit of the reproductive elements being noticed on the sides. Müller's *Ascaris rubra* was probably a small specimen of the same worm.\* For some time I was inclined to include *Planaria viridis* under the present species, but the thick or almost baccate appearance of some of the figures in the 'Zoologica Danica' gives rise to so much doubt that I have not deemed it prudent to unite them. The *Planaria carnea* of Jens Rathke ('Skrivter af Naturhist. Selskabet,' &c., 5<sup>th</sup> Bd., p. 83, tab. iii, f. 10, a, b) appears to be referable to this common form. It is doubtful whether the *Lineus oculatus* of Montagu (MS.) applies to *L. gesserensis* or to *L. sanguineus*. Dr. Johnston first described the species as having two eyes, but, as Örsted states, the author had only seen a young specimen. He afterwards gave it four eyes, but the number of the latter is of little moment, since the animals are so liable to vary in this respect. Dr. Johnston also observed the presence of the gregariniform parasites for the first time, though he did not correctly interpret their nature. The *Nemertes obscura* of B. Desor, from the coast of the United States, is allied in the closest manner to this species, and the *Nemertes flaccida* of M. van Beneden is either a pale variety of the same or *L. sanguineus*.

### 3. LINEUS SANGUINEUS, Jens Rathke. Plate V, fig. 2.

*Specific character.*—Eyes more regularly arranged than in the foregoing; snout narrower. Body more elongated, and of a reddish or reddish-brown hue. Regenerates easily.

#### SYNONYMS.

1799. *Planaria sanguinea*, Jens Rathke. Skrivter af Naturhist. Selsk., vol. v, i, p. 83.  
 1828. „ *unicolor*, Johnston. Zool. Jour., vol. iii, p. 488 (?).  
 1829. „ *octoculata*, Ibid. Op. cit., vol. iv, p. 56.  
 1837. *Nemertes (Borlasia) octoculata*, Ibid. Mag. Zool. and Bot., vol. i, p. 537, pl. 18, f. 2.  
 Örsted. Kroyer's Naturhist. Tids., iv, p. 579, in nota.  
 „ *Planaria sanguinea*, Ibid. Op. cit., pp. 572 and 579, in nota.  
 1844. *Nemertes octoculata*, Ibid. Entw. Plattw., p. 91.  
 „ „ *sanguinea*, Ibid. Op. cit., p. 92.  
 1846. *Borlasia octoculata*, Johnston. Ann. Nat. Hist., vol. xvi, p. 434.

1846. *Borlasia octoculata*, W. Thompson. Ann. Nat. Hist., vol. xviii, p. 388 (?)
1850. *Nemertes octoculata*, Diesing. Syst. Helm., vol. i, p. 276.
- ” ” *sanguinea*, Ibid. Op. cit., p. 276.
1856. *octoculata*, Byerley. Fauna of Liverpool, p. 98.
1860. *communis*, Van Beneden. Recher. sur les Turb., p. 7, pl. i, f. 1—18.
1862. *octoculata*, Keferstein. Zeitsch. f. wiss. Zool., Bd. xii, p. 63, taf. 7, f. 1 and 2.
- ” ” *communis*, Diesing. Revis. der Turbell., p. 302.
- ” ” *octoculata*, Ibid. Op. cit., p. 305.
- ” ” *sanguinea*, Diesing. Op. cit., p. 305.
- ” ” *octoculata*, Ibid. Nachträge z. Revis. der Turbell., p. 14.
1865. *Borlasia octoculata*, Johnston. Catalogue Brit. Mus., pp. 21, 287, and 290, pl. ii 5, f. 2 and 2\*.
1866. ” ” Lankester. Ann. Nat. Hist., 3rd ser., vol. xvii, p. 388.
1867. ” ” McIntosh. Jour. Micros. Sc.; Trans., p. 89.
1868. ” ” Ibid. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
- ” ” Ibid. Proceed. Linn. Soc., Zool., vol. x, p. 251, tab. 7.
1869. ” ” Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 374 et seq.

*Habitat*.—Under stones between tide-marks; less abundant than *Lineus gesserensis*, but having a similar range in the British Islands.

*Body*.—Four to eight inches long, and about a line and a half in breadth, flattened, of nearly equal diameter for some distance behind the head, and then gradually diminishing towards the tail. It is always proportionally much longer and more slender than *Lineus gesserensis*. The dorsum is crossed, sometimes at rather distant intervals, by transverse lines, which cause a dimple at each side, and it is probably at these furrows that rupture so frequently occurs.

*Colour*.—Various shades of red and brown. Some specimens anteriorly are of a very bright red, which becomes fainter posteriorly, the caudal region being pale brown. In the dark brown examples the ganglionic region (not the ganglia) is bright red, the succeeding portion of the dorsum dull brownish-red, and then dark brown, the latter gradually becoming paler towards the tip of the tail. The under surface is somewhat paler.

*Head*.—This differs from that of the former species by being scarcely wider than the succeeding portion of the body. Its posterior boundary can just be distinguished dorsally by the slight indentations at the termination of the cephalic fissures. The whole region is narrow, flattened, slightly tapered towards the tip, which is pale, and furnished with a central and two lateral papillae, or, as the case may be, with a notch and two lateral papillae. The eyes are placed further back than in *L. gesserensis*, are more distinctly defined, and form a regular row on each side, to the number of three or four. The lateral fissures have narrow lips, and extend from the tip of the snout backwards. The mouth opens in a pale space some distance behind the ganglia.

The worm is much longer and more slender than *L. gesserensis*, from which it is at first sight distinguished by the fine reddish coloration anteriorly. It is also a less active and restless species, and is prone to seek shelter under shells and stones, or in fissures and tubes, where it remains in a quiescent condition for weeks. It frequently lies coiled as a firm ball amongst the debris in the vessel, or loosely on the bottom, so that when the vessel is held obliquely the specimens roll from side to side. On account of these retiring habits it is somewhat difficult to get a good view of the animal. This may, however, be accomplished by transferring the hidden or coiled worm to another vessel of salt water, when the change of element generally causes it to

move out of its shelter or unroll. It readily reproduces heads or other portions in fragments of its body, so that the irritation and discomfort of a long journey in a jar is found occasionally to increase rather than diminish the number of specimens. The skin is acid to litmus-paper.

*L. sanguineus* feeds on *Harmothoë imbricata* and other annelids in a decaying or at least dead condition.

The ova are developed in October.

After some hesitation I have referred the *Planaria sanguinea* of Jens Rathke to this species. The *Planaria unicolor* of Dr. Johnston may also be the same animal; indeed, so far as can be made out, it does not approach any other form. His preparation of *Borlasia purpurea* in the British Museum belongs to the same species. This author does not seem to have been aware that several varieties of *Lineus gesserensis* have a reddish-brown colour, when he described this hue as distinctive of the present species, yet he probably had the true *L. sanguineus* before him. M. van Beneden remarks that his *Nemertes communis* is distinguished from *L. gesserensis* by the length of the body and the double row of eyes. The latter character occurs in both species; and while his form, probably, differs from *L. gesserensis*, he does not satisfy us as to its separation from *L. sanguineus*. I have made Prof. Keferstein's *Nemertes octoculata* synonymous after some doubt, since there is little in his description to distinguish it from a pale variety of *L. gesserensis*.

#### 4. LINEUS LACTEUS, Montagu, MS. Plate V, fig. 8.

*Specific character*.—Snout similar to the foregoing, but the mouth is placed much further behind the ganglia. Body reddish anteriorly, pale posteriorly.

#### SYNONYMS.

1808. *Lineus lacteus*, Montagu. MS., p. 275.  
 1867. *Borlasia lactea*, McIntosh. Quart. Jour. Micros. Sc.; Trans., p. 39.  
 " " " Parfitt. Catal. Annel. Devon. (Ext. Trans. Devonsh. Assoc. for the Advancement of Sc., &c.), p. 6.  
 1868. " " McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.  
 1869. " " Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 372 et seq.

*Habitat*.—South coast of England, under stones between tide-marks.

*Body*.—One to two feet in length, rather less than a line in breadth, flattened, almost insensibly tapered from head to tail, and marked by pale transverse lines. In contraction it is rounded, and very frequently the animal advances with its body thrown into various stiff wrinkles and dilated portions.

*Colour*.—Uniform dull whitish or cream-yellow, with the regions before and behind the ganglia (three quarters of an inch or more) of a fine rose-pink, which gradually fades posteriorly. The coloured region behind the ganglia corresponds to the long circulatory space in front of the mouth. Snout and tail translucent.

*Head*.—Elongated, very slightly broader than the succeeding portion of the body, and in many positions narrower, tapered anteriorly, with the tip rather rounded, and furnished with three papillæ. It is distinguished posteriorly by a slight incurvation at the termination of the cephalic

fiures, which are rather shallow. Eyes forming a nearly parallel row on each side, distinctly separated, and to the number of six or eight in each row. They are not symmetrically arranged, and a considerable translucent space exists between their commencement and the tip of the snout. The mouth is situated much further back than in *Lineus sanguineus*, to which it is otherwise closely related.

Seven or eight specimens were sent me, in October, 1866, by Mr. Parfitt, of the Devon and Exeter Institution, in a tin box, and a few are still alive (Dec., 1871), so that they exhibit the usual hardihood in confinement. In progression the head is often ribbed in a longitudinal manner. When irritated, the extended worm contracts, generally in a spiral or closely coiled manner, and sometimes in a form so regularly twisted as to resemble a rope with its strands. It advances by gentle undulations of the body, and frequently the head is rolled from side to side. The worm also readily forms itself into a knotted mass, as well as stretches to an extreme degree of tenuity. The skin presents an acid reaction.

This is one of the many discoveries made by the acute and persevering Montagu on the southern coast. There are few external characters in the description of the animal that has escaped him. It is doubtful whether Prof. Grube's *Nemertes lactea* from Villafranca ('Archiv für Naturges.,' 1851, p. 151, taf. 7, f. 3 and 4) coincides with our species. His enlarged drawing of the head has certainly many more eyes, and the orange specks on the dorsum are quite different. Moreover, it is scarcely to be supposed that this author would not mention so important a point as the distance of the mouth behind the ganglia. He states that the "mouth is rounded," and about two millimètres from the snout. Dr. Johnston's preparation of *Lineus albus*, Dalyell, in the British Museum, resembles the present species very closely.

##### 5. LINEUS BILINEATUS, *Delle Chiaje*. Plate VI, fig. 1.

*Specific character*.—Head rather rounded anteriorly; eyeless. Body pale brown or dull pinkish, with a white stripe on each side of a dorsal median line.

##### SYNONYMS.

1841. *Poia bilineata*, Delle Chiaje. Descr. e Notom. degli anim. invert., tom. iii, p. 126, tab. 103, f. 11 and 12.  
 1844. *Nemertes bilineata*, Örsted. Entw. Plattw., p. 91.  
 1850. *Meckelia bilineata*, Diesing. Syst. Helm., vol. i, p. 264.  
 " *cerebratulus*, Ibid. Op. cit., p. 269.  
 1858. *Gordius tania*, Dalyell. Pow. Creat., vol. ii, p. 70, pl. 10, f. 1—4.  
 1860. *Cerebratula Örstedii*, Van Beneden. Recher. sur les Turbell., p. 16, pl. 2, f. 1—4.  
 1862. *Cerebratulus bilineatus*, Ibid. Op. cit., p. 273.  
 " *Meckelia Örstedii*, Diesing. Revis. der Turb., p. 286.  
 " *cerebratulus*, Ibid. Op. cit., p. 286.  
 1865. " *tania*, Johnston. Catalogue Brit. Mus., pp. 28 and 298.  
 1866. " Lankester. Ann. Nat. Hist., 3rd ser., vol. xvii, p. 389.  
 1868. *Cerebratulus tania*, McIntosh. Rept. Brit. Assoc., 1855, p. 340.  
 1869. " *bilineatus*, Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 37½ et seq.

*Habitat*.—Generally occurs in somewhat deep water on coralline ground, or oyster-beds, but also under stones and in cracks of oyster-shells between tide-marks. The largest specimen I have seen was procured from the stomach of a haddock caught off St. Andrews Bay.

*Body*.—A few inches to a foot and a half in length, and of variable breadth; not much flattened, except on the ventral surface, widest in front and gently tapering towards the posterior extremity.

*Colour*.—Various shades of pale madder-brown, chocolate or reddish-brown, darkest in front, and gradually fading posteriorly. From the centre of the snout, just within the pale border, a white or yellowish stripe commences by a wide origin, which occupies nearly the whole breadth of the region, and proceeds to the tip of the tail along the middle line of the dorsum. It is widest anteriorly, and is rendered double by a dark central streak. Sometimes a young specimen presents an opaque white pigment-patch on each side of the usual central bands of the snout, so that by transmitted light the organ seems furnished with two large eyes. In a variety the anterior third was very pale, the rest of the body being of a bright rose or carmine colour. The under surface of the body is paler than the upper, especially towards the middle line and the region of the mouth. Specimens found in exposed places between tide-marks are darker than those from more sequestered regions.

*Head*.—Flattened and somewhat spatulate, rather blunt anteriorly and somewhat narrowed posteriorly at the termination of the cephalic fissures, from which a slight depression slants inwards and backwards towards the central stripes. The lateral fissures are deep, and tinted of a vivid red colour towards the pit posteriorly. The narrowing of the snout anteriorly and posteriorly gives it a somewhat elliptical or ovoid appearance. There is no trace of eyes or eye-specks. The mouth opens a short distance behind the ganglia.

*L. bilineatus* is rather a sluggish species in confinement, but is easily preserved alive for years. It progresses with a rolling motion of the head, but will remain for weeks in a dormant condition under a shell or in a mass of hardened mucus. The skin is strongly acid to test-paper.

I have not found specimens containing developed generative organs, but Sir J. Dalyell relates of his captives that a vast quantity of white ova, amidst a thin glairy matter, appeared in the vessel in June.

I have little doubt the *Polia bilineata* of Delle Chiaje refers to this species; and since he describes the *Cerebratulus (Ophiocephalus) bilineatus* of Renier as quite a different form, probably the same as the *Nemertes peronea* of De Quatrefages, with two dorsal black lines, I have omitted Renier's name altogether from the synonyms, for I have not been successful in seeing a copy of his early work. It is unlikely that so acute an observer as Delle Chiaje would confound the two species, especially as the published description of the first form was in his own language. Sir J. Dalyell thought the *Planaria dorsalis* of Abildgaard (*Tetrastemma dorsalis*) was probably a mutilated fragment of this worm. M. van Beneden, again, not long ago described it as a new species from deep water off the Belgian coast. I have not been able to verify this author's remark, that there are three divisions in the alimentary canal, nor have I ever seen it or any other Nemertean "threatening its prey with its proboscis." In his 'Nachträge zur Revision der Turbellarien' Dising erroneously places Dalyell's *Gordius tania* (the present form) under *Ommatoplea peronea*.

Genus VII.—BORLASIA,<sup>1</sup> Oken, 1817.

The genus *Borlasia* was formed by Oken in his 'Lehrbuch der Naturgeschichte' for the previously named *Lineus marinus* of Montagu, and therefore very properly was disused in that instance. Instead of applying the title to represent forms belonging to the Enopla, as Prof. Keferstein and others have done, I have chosen rather to bestow it on the present new type of the Anopla, a type, indeed, not far removed from that to which the name was originally given.

*Generic character.*—Body round and massive, not tapered posteriorly. Snout acutely pointed. Proboscis extremely slender, furnished with elastic external, longitudinal, circular, and glandular coats. There are no accessory bands at the poles in transverse section. Circulatory fluid and muscles tinted reddish.

## BORLASIA ELIZABETHÆ, n. s. Plate VII, figs. 1 and 2.

*Specific character.*—Eyeless; snout much tapered anteriorly. Posterior part generally contracted into a thick rugose mass. Head pale, faintly streaked with greenish brown; body mottled with deep madder-brown.

*Habitat.*—In a pool near low-water mark to the north of Rat Island, Herm.

*Body.*—About a foot in length and a fifth of an inch in breadth, rounded in extension, flattened in contraction, tapering towards the snout, and also slightly towards the tail, which ends bluntly; indeed, the posterior end generally forms a dilated mass with a dimple in the centre, and coarsely marked by transverse wrinkles. The body is seldom free from numerous longitudinal furrows, which are especially distinct anteriorly.

*Colour.*—The head throughout two thirds of its length anteriorly is pure white, with olive-green specks; for rather more than the posterior third, however, the deep purplish-brown and white touches of the dorsum occur. The speckled dorsum is marked at somewhat regular intervals by belts of pinkish white, which entirely surround the body. Some of the pale rings are broader than others, but there does not seem to be any regularity in this respect. They continue to the tip of the tail, but gradually grow faint posteriorly. The colours are brightest anteriorly, the greater part of the body being of a speckled olive-brown hue. A very slight reddening is noticed over the ganglionic region. The pale olive specks of the snout pass into the anterior part of the cephalic fissures, while the posterior end of each is deep red. The snout continues pale to a similar extent ventrally, while the olive-green specks are few and indistinct. The ventral surface of the body generally is somewhat paler. Captivity does not seem to affect these hues very soon.

*Head.*—Not distinguished posteriorly from the rest of the body, except in certain positions, when the slight elevation of the posterior fold of the cephalic fissure indicates a separation. It tapers rather abruptly to a somewhat narrow tip, furnished with a central papilla. From the angle of the tip on each side a deep lateral fissure runs to the posterior border of the snout, where

In honour of the Rev. W. Borlase, the natural historian of Cornwall.

the dilated termination is conspicuous on account of its reddish coloration. A groove generally present on the side of the body is continuous with the end of the latter, but such a furrow, of course, is only one of the variable longitudinal rugæ of the body. The lips of the cephalic fissures are usually kept in apposition, except at the posterior dilated portion. The mouth commences just behind the ganglia, and forms a considerable longitudinal slit.

On turning over a large stone in the litoral pool above mentioned a piece of the tenacious grayish-white clayey mud so characteristic of the locality, and which was furnished with a smooth groove, adhered to a corner on the under surface; and on searching the now muddy pool from which the stone had been raised, the rest of the firm clayey groove and a purplish or dark madder-brown body about two inches long were found. The latter very much resembled the rough siphons of a bivalve mollusk, being flattened, transversely rugose, somewhat abruptly truncated at each extremity, hard and resilient under the touch. On placing this curious structure in pure sea-water, the head of the animal was by-and-by pushed out from the dilated mass, not by the gradual elongation of the whole, but as if an invisible power were drawing caouchouc through a fixed aperture. It was transported to Scotland without difficulty, and lived there until dissected, pushing its anterior end slowly about the bottom of the vessel, and seldom completely extending itself. Indeed, the remarkable dilatation of the posterior end, which was often enveloped in mucus, was characteristic. Sometimes, however, the stretched tail was attached to mucus at the bottom, while a dilated mass of the body remained about an inch in front of it, the rest of the animal being attenuated, and perhaps laid along the water-line. Its habits on the whole were sluggish, and corresponded with its native situation.

On taking the animal out of the water after several months' confinement it contracted itself firmly, an elliptical rent appeared on the ventral surface, and in a few seconds it ruptured into four pieces. The anterior fragment with the head lived several months longer, and during this time the posterior end had become considerably enlarged and peler, and there is no doubt the original size and shape would have been gradually attained under favourable circumstances, while its lost fragments were mounted as microscopic preparations.

The skin gives an acid reaction to test-paper.

An allied species was dredged by Mr. Jeffreys in the "Porcupine" Expedition, 1870, off Cape Finisterre, at a depth of 80 fathoms.

*Genus VII.*—*CEREBRATULUS*,<sup>1</sup> *Renier*, 1804.

The species upon which this genus in the present work rests was probably known to O. F. Müller as *Planaria angulata*. Renier in 1804, in his 'Prospetto della classe dei vermi,' established the genus *Cerebratulus* for a worm which appears to have been allied to the present form, and certainly one of the Anopla, if we may judge from Diesing's reprint of the characters given by this author. I have chosen rather to run some risk in using Renier's name than to aid in perpetuating the profuse nomenclature which arose chiefly from insufficient acquaintance with the literature and anatomy of the subject.

*Generic character.*—Body generally flattened, and thinned at the margins. Snout pointed

*Cerebrum*, the brain; probably from the fancied resemblance of the respective tissues.



in front. Eyes obscure. Proboscis with a cross of fibres at each pole in transverse section.

CEREBRATULUS ANGULATUS, O. F. Müller, 1774.

*Specific character*.—Snout pointed. Body much flattened, brownish.

SYNONYMS.

1774. *Fasciola angulata*, O. F. Müller. Verm. Terrest. et Fluv., vol. i, part ii, p. 58.  
 1776. *Planaria angulata*, Ibid. Zool. Danic. Prodr., p. 221, No. 2680.  
 1780. O. Fabricius. Faun. Grœnland, p. 323, No. 303.  
 1788. Gmelin. Lin. Syst. Nat., p. 3088, No. 9.  
 1798. O. Fabricius. Skriv. af Naturhist. Selskabet, 4<sup>te</sup> Bind, 2<sup>de</sup> hefte, p. 52, &c., tab. ii, f. 1—7.  
 1844. *Cerebratulus ? angulatus*, Ersted. Entw. Plattw., p. 94.  
 1845. *Serpentaria fragilis*, H. Goodsir. Ann. Nat. Hist., vol. xv, p. 377, pl. 20, f. 1 and 2.  
 1850. *Meckelia serpentaria*, Diesing. Systema Helm., vol. i, p. 266.  
 1853. *Gordius fragilis*, Dalvell. Pow. Creat., vol. ii, p. 55, pls. 6, 7, and 7 (bis).  
 1857. *Lineus Beattii*, J. E. Gray. Proceed. Zool. Soc., pt. xiv, p. 210, pl. 48.  
 1858. „ *longissimus*, W. Beattie. Op. cit., pt. xxvi, p. 307.  
 1859. *Meckelia serpentaria*, Leuckart. Archiv für Naturges., ii, p. 187.  
 „ *Lineus longissimus*, Beattie. Ann. Nat. Hist., 3rd ser., iii, p. 160.  
 1862. *Meckelia serpentaria*, Diesing. Revis. der Turbell., p. 281.  
 „ „ *Beattii*, Ibid. Op. cit., p. 285.  
 1863. „ *olivacea* (Rathke), Diesing. Nachträge z. Revis. der Turbell., p. 8.  
 1865. *Serpentaria fragilis*, Johnston. Catalogue Brit. Mus., p. 28.

*Habitat*.—Generally in deep water throughout the British coasts. Greenland.

*Body*.—Fifteen inches to three feet long, and about an inch in breadth; flattened, bluntly and rather suddenly tapered in front, more gradually posteriorly, and thinned at the margins all round, so that a transverse section of the contracted body is elliptical.

*Colour*.—Universally gray, darker on the dorsal, paler on the ventral surface, and with a pale margin. Sir J. Dalvell's figure has a brown stripe commencing at the anterior third, and continuing to the tip of the tail, and the divisions of the alimentary organ are indicated inferiorly, but of course we must be cautious in making deductions therefrom. This author also observes that in one of his specimens a portion of the edge was reddish, a colour in all probability due to the nerve-trunk and its surroundings. Mr. Goodsir states that his example was of a slate-blue colour, with a yellowish edge.

*Head*.—Tapered to a blunt snout in front, with a cephalic fissure on each side, and apparently without eye-specks. Mouth forming a large slit on the ventral surface in the usual position.

I have referred this species to the *Planaria angulata* of O. F. Müller, from a careful consideration of all the circumstances connected with its history, including the examination of several examples from the north sea, and named by northern naturalists. Müller's account of its size, the pointed nature of its snout, its colour and other points, can scarcely apply to any other species; and in the preparations the flattened body, thinned edges, and the structure of the

proboscis are quite characteristic. The late Mr. Harry Goodsir mentions that, "when swimming, the animal is very active, and advances with considerable rapidity by means of an undulatory serpentine motion. When handled it throws itself into various contortions, and instantly casts off numerous annuli from the posterior part of its body, each of which, immediately upon its separation from the original, begins to move in a similar manner." Sir J. Dalyell afterwards made like observations, and noted that the animal was full of a yellow substance, a remark which probably applied to the wall of the digestive cavity, the same colour being present in *Micrura fusca*. He also found numerous white ova discharged from a fragment in May. The *Linceus Beattiae* of Dr. Gray, and the *L. longissimus* of Mr. Beattie, appear to belong to this species, if we may judge from the preparation of the former and the proboscis of the latter in the British Museum. Mr. Alex. Agassiz mentions that he found the *Planaria angulata* of O. F. Müller on the under surface of the tail of *Limulus*, but of course this refers to quite a different form, probably to a *Planaria*.

This species is very closely allied to *Micrura fusca*; and if the structure of the proboscis had not deviated so distinctly I should have been inclined to unite them.

Genus VIII.—MICRURA,<sup>1</sup> Ehrenberg, 1831.

As has occurred in several instances, the typical form was known to the veteran naturalist O. F. Müller, as well as to Col. Montagu. Ehrenberg, however, separated the genus from others for the first time in his 'Symbolæ Physicæ,' and gave a good figure of *M. fasciolata*, though he was unaware that the same form had previously been observed by others.

*Generic character*.—Body not much elongated. Head distinctly marked, snout truncated. Other characters as in *Linceus*, with the addition of a caudal process or style capable of attachment.

I. MICRURA FUSCA, n. s. Plate VI, fig. 3.

*Specific character*.—Eyes four to eight on each side, small. Body much flattened and thinned at the edges; speckled with brownish grains on the head and anterior region.

SYNONYM.

1869. *Micrura*, McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 376, &c.

*Habitat*.—Not uncommon amongst the débris from the coralline ground in fishing boats, amidst oysters and tangles in the laminarian region in Shetland, under stones between tide-marks at Herm, and at a depth of 795 fathoms off the coast of Portugal.

*Body*.—Two to four inches in length, slightly tapered towards either extremity, flattened both

<sup>1</sup> Μικρὸς, small or slender, and οὐρά tail. Strickland applied the same title to a genus of Certhiidae in 1841 ('Ann. Nat. Hist.').

dorsally and ventrally, and furnished with a pale caudal filament. It is frequently marked by transverse lines or slight furrows.

*Colour*.—Pale skin, ash or brownish; dorsum speckled with pale brown touches, especially distinct over the head, which has also a well-marked reddish hue in the ganglionic region. A little within the pale margin of the body a pinkish streak occurs on each side from the coloration of the nerve-trunks. Posteriorly the lateral divisions of the dull yellowish digestive tract shine through the skin. Ventral surface of a pale skin-colour, also enlivened by the coloration of the nerves, and in some cases with a few pale brownish specks anteriorly. The caudal style occasionally shows a few white grains in the central line towards the base.

*Head*.—Spathulate, but much pointed towards the tip, dilating from the latter backwards to the termination of the cephalic fissures, the whole region being peculiarly hastate. Eyes small, black, grouped on each side of the pointed snout, and varying in number from four to eight on each side. The lateral fissures are deep, and have the reddish hue very brightly marked posteriorly.

This is one of the flattest among the shorter species of the group, both before and after preservation in spirit. During life it swims through the water on its edge, with an eel-like wriggle, similar to that of *A. pulcher*, but somewhat less vigorously. When progressing the margins of the body are often very prettily frilled, the reddish longitudinal lines just within the pale border increasing the effect. It is rather irritable, throwing out its yellowish proboscis when touched, or breaking into several fragments. The former clings closely to the finger by means of its tenacious secretion.

It fixes the tip of its caudal process as in *M. fasciolata*, and elongates it so as to resemble a very fine thread, which, however, is slightly moniliform. It agrees in minute structure with the foregoing, and, when detached from the worm, much resembles a long *Opalina*, or other ciliated organism, in facile and independent movements.

The skin presents an acid reaction to test-paper.

I at first thought that this form was only a small variety of the great *Gordius fragilis* of Dalyell (the previous species), and future investigators may establish a closer relation between them than I have been able to make out. I did not feel justified, however, in uniting them, on account of the remarkable difference in the structure of the proboscis, which in *M. fusca* has the anatomy characteristic of *Lineus*, while the double isolated longitudinal bands at one of the poles in transverse sections of the organ in *C. angulatus* exhibit quite a new feature.

No author, so far as I am aware, has mentioned the caudal process in the last species, but this is a point which may have been easily overlooked.

Whether the young animal shown in Plate VI, fig. 4, is an early condition of this or an allied species I am unable to decide. It was one of the novelties found by its artist during one of her trips to St. Andrews in the spring of 1866.

## 2. MICRURA FASCIOLATA, *Elxenberg*. Plate VI, fig. 2.

*Specific character*.—Eyes marginal, placed towards the anterior part of the snout. Body various shades of brown, generally barred with white belts.

## SYNONYMS.

1788. *Planaria filaris*, O. F. Müller. Zool. Danic, ii, p. 38, tab. 68, f. 18—20.  
 " " " Gmelin. Linnæus Syst. Nat., tom. i, pars vi, p. 8093.  
 1808. " *lineata*, Montagu, MS. tab. 56, f. 5.  
 1831. *Micrura fasciolata*, Ehrenberg. Symb. Phys., Phyt. Turb., No. 15, tab. 4, f. 4, a—i.  
 1827. *Planaria filaria*, Bosc. Hist. Nat. des Vers., i, p. 261.  
 1844. *Nemertes pusilla*, Cérsted. Entw. Plattw., p. 90.  
 " " *fasciolata*, Ibid. Op. cit., p. 91.  
 " " *pusilla*, Ibid. Kroyer's Nat. Tids., iv, i, p. 578 (partim).  
 " " " Ibid. De Region. Marin., p. 80.  
 1847. *Pygidium gyrans* (young form), Müller. Archiv für Anat., p. 159, taf. 7, f. 1—4.  
 1850. *Micrura fasciolata*, Diesing. Syst. Helm., vol. i, p. 261.  
 " *Nemertes pusilla*, Ibid. Op. cit., p. 271 (partim).  
 1851. *Pygidium gyrans*, Busch. Beobachtungen über Anat., &c., p. 107, taf. 16, f. 1—8.  
 " *Alaridus caudatus*, Ibid. Op. cit., p. 111, taf. 11, f. 8.  
 1853. *Gordius fragilis spinifer*, Dalyell. Pow. Creat., vol. ii, p. 79, pl. 11, f. 5 (var.).  
 " *fasciatus spinifer*, Ibid. Op. cit., p. 80, pl. 11, f. 6—15.  
 " *Alaridus caudatus*, Müller. Abhandl. Berl. Akad. (1852), p. 59.  
 1854. *Pygidium gyrans*, Gegenbauer. Zeitsch. für wiss. Zool., v, p. 345.  
 " " " Müller. Archiv, p. 75, taf. 4, f. 2—8.  
 " *Alaridus caudatus*, Ibid. Op. cit.  
 1858. *Pygidium gyrans*, Krohn. Müller's Archiv, p. 289.  
 " *Alaridus caudatus*, Ibid. Op. cit.  
 " *Micrura filaris*, Müller. Archiv, p. 330 (note).  
 1861. *Pygidium gyrans*, Claparède. Recher. Anat. sur les Annel., Turb., &c., p. 54, pl. 5, f. 3 and 4 (?).  
 1862. *Micrura fasciolata*, Diesing. Revis. der Turbell., pp. 258—260.  
 " " *filaris*, Ibid. Op. cit., p. 260.  
 " *Meckelia cæca*, Ibid. Op. cit., p. 286.  
 " *Nemertes pusilla*, Ibid. Op. cit., p. 298.  
 1863. *Micrura fasciolata*, Diesing. Nachträge z. Revis. der Turbell., p. 7.  
 1865. *Stylus fragilis*, Johnston. Catalogue Brit. Mus., pp. 24 and 293.  
 " " *fasciatus*, Ibid. Op. cit., pp. 24 and 293.  
 1869. *Micrura fasciolata*, McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 374.

*Habitat*.—In fissures of the rocks near low water, in the coralline region, and oyster-beds. Ranges from the Shetland Islands to the Adriatic.

*Body*.—Four to six inches in length, and about a line in breadth, flattened on the ventral surface, about as much tapered anteriorly as posteriorly, and with a slender styliform process attached to the tail.

*Colour*.—Fine reddish brown of various shades, banded across with white belts at somewhat regular intervals, and with the tip and sides of the snout pale. The styliform process is pale and translucent. Ventral surface paler than the dorsal, but also inclining to reddish brown, and marked by distinct lines or furrows, which are continuous with the white dorsal bands. The first white dorsal belt usually occurs a little behind the termination of the cephalic fissures, but occasionally the presence of some dark red pigment near the tip of the snout cuts a stripe off the pale portion. The white bars are sometimes lozenge-shaped, from a dilatation in the middle. Some specimens from the coralline ground off St. Andrews are of a very pale brown or fawn colour on the dorsum, darkest in front, without white stripes, the only markings being the transverse

wrinkles of the body. The pale portion at the tip of the snout, and especially its margins, are increased in breadth; the latter, indeed, being continuous with a pale lateral border (not due to the cilia) throughout the entire length of the animal. The under surface in such examples is of a dull whitish hue, with the exception of the reddish ganglionic region. A dull olive variety of large size (six to ten inches) also occurs in the recesses of the tangle-roots in the Shetland Islands. Some of the examples with white bands have also a whitish ventral surface; and occasionally the bands, even when present, are very inconspicuous.

*Head.*—Somewhat spatulate, flattened, tapered towards the front, which is rounded and furnished with a central papilla, wider than the rest of the body. There is a deep lateral fissure on each side, with a reddish coloration posteriorly. Just within the pale margin of the snout are numerous eyes, those in front being best seen from the dorsum, especially in pale specimens, and also from the cephalic fissures. They form a single converging row on each side, to the number of eight or twelve. Young specimens are furnished with two conspicuous eyes only. The mouth occupies the usual position behind the ganglia.

This is one of the most beautiful Nemertean, from the striking contrast in its colours and the soft and velvety aspect of its skin. It is evidently a dweller in crevices, and has a great tendency to hide under débris or other shelter in glass vessels; and if this protection be denied it, the animal frequently coils itself in a mass, either with or without enveloping mucus. Some are hardy in confinement and live for years, others are irritable and fragile, breaking themselves on the slightest interference into many fragments, the separation almost always occurring at the white belts. This rupture often takes place before they are removed from the collecting-bottle, especially if they do not have it all to themselves. Fragments of the posterior end of the body turn slowly in the vessel, and live a long time. Of the two well-marked varieties, viz., the banded and the uniformly tinted, the latter are the less fragile, and their bodies are more flattened. The styliform process at the tail can be elongated to an extreme degree. The skin presents an acid reaction.

The spermatozoa are fully developed in the beginning of November, causing pale transverse bars at the sides of the males. The same elements are fairly matured in Zetlandic examples in August.

It is doubtful whether the *Fasciola caudata* of O. F. Müller has any connection with this species, especially as it was found by O. Fabricius gregariously associated amongst littoral fuci on the shores of Greenland. The same author's *Fasciola flaccida* has closer resemblances both in description and figure; though, as regards the transverse white lines, it is to be remembered that he gives the same account of *F. viridis*. His figure and the remark concerning the fragility of the species show a close affinity. The *Planaria flaris* of this author, again, may be regarded as a young specimen, though he represents the tail too elongated. He found it on *Madrepora prolifera*. Montagu observes that the colour of his specimens (*Planaria lineata*, Mont. MS.) was "rufous brown, with about ten white lines across the back. Beneath pale, without the lines." The *Planaria rufa* of the same naturalist (MS., p. 232) is either a uniformly tinted example of this species, or a variety of *Lineus gesserenis*. It was found on a large oyster. Ehrenberg gave a good description and figure of the animal from specimens found in the Adriatic. He mentions the presence of five eyes on each side, and that the ovarian aperture (mouth) lies under the second dorsal white bar. He also alludes to the copious exudation of mucus with which it forms a sheath. I have followed J. Müller in including the young form, *Pygidium gyrans*, under this

species. Dalyell observed that his specimens (*Gordius fasciatus spinifer*) had a tendency to rupture at the white belts. Moreover, his examples reproduced bodies to the anterior regions, but no heads on the posterior fragments, though he did not doubt that regeneration would ensue in every case under more favourable circumstances. His *G. fragilis spinifer* is probably a specimen of this species uniformly tinted, and its subsequent fracture into many pieces is corroborative of this view. I am in doubt, however, whether his *G. viridis spinifer* (op. cit., p. 78, Pl. XI, f. 1) is a distinct form or only a variety of this or the succeeding species.

The *Meckelia annulata* of Grube, and the *M. Knerii* of Diesing, are closely allied to the foregoing. The absence of the caudal process in the former may have been accidental, while, as regards the latter, Prof. Grube may be wrong in supposing such only a reproduced tail.

### 3. MICRURA PURPUREA, Dalyell. Plate VII, fig. 3.

*Specific character*.—Eyeless. A bright yellow patch at the tip of the snout. Body of a uniform rich dark brown colour.

#### SYNONYMS.

1853. *Gordius purpureus spinifer*, Dalyell. Pow. Creat., vol. ii, p. 78, pl. 11, f. 2—4.  
 1858. *Micrura purpurea*, J. Müller. Archiv, p. 300.  
 1862. " " Diesing. Revis. der Turbell., p. 260.  
 1865. *Stylus purpureus*, Johnston. Catalogue Brit. Mus., pp. 24 and 293.  
 1868. " " McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.  
 1869. *Micrura purpurea*, Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 374, &c.

*Habitat*.—In fissures of rocks near low water, and between the valves of empty shells, or other crevices of the débris from the coralline ground on the east coast of Scotland. It seems to be generally diffused, and occurs of large size off the Shetland Islands.

*Body*.—Five to eight inches in length, flattened, slightly narrowed behind the head, and gradually tapered towards the rather blunt tail, from which the styliform process arises.

*Colour*.—Rich dark brown with a purplish lustre on the dorsum. The tip of the snout is pale, and immediately behind is a well-defined crescentic granular yellow patch. The convexity of the latter is directed forward. In some specimens the anterior margin of the patch only is yellow, while the rest is yellowish white or pure white. There is a slight reddish hue at the ganglionic region. The styliform process is pale brown. The ventral surface is very slightly paler than the dorsal, and from the translucency of the snout the yellow pigment-patch on the upper surface shins through.

*Head*.—With a truncate anterior margin which is also broad, so that it has a peculiar spade-shaped appearance, slightly wider than the succeeding portion of the body, and with three papillæ in front, a central and two lateral, the latter being small and inconspicuous. The lateral fissures are deep and well marked, the bottom tinted red posteriorly, and having anteriorly some yellowish grains continued from the pigment-patch of the snout. There is no trace of eye-specks.

*Micrura purpurea* appears for the most part to be a deep-water species. In regard to

colouring it is one of the most striking of the group, the bright yellow patch in front and the ever-varying purplish lustre of the cilia on the deep brown body forming manifold contrasts, at once pleasing and novel. It is active and voracious, and it is dangerous to leave two in the same vessel, especially if there is disparity in size, as the stronger devours the weaker. Like many of its allies, grave injuries are borne with impunity; thus a specimen which had been so severely wounded in January that it divided itself behind the head, reproduced early in May a small but complete body, furnished with the usual caudal styliform process, and this without a single renewal of the sea-water in the vessel. The head had diminished much in bulk, but was still the widest part of the animal. The body measured an inch and a half after nine months' growth. The introduction of a fresh and hungry specimen from the coralline region proved fatal to this example. The posterior end of the ruptured worm also lived many months, turning slowly round on the bottom of the vessel, and showing a pointed process above the aperture of the digestive chamber in front, while the ova in its interior had arrived almost at complete development in April.

Sir J. Dalyell procured the first specimen of this species from Shetland, and so introduced it to science and our fauna. He also figures an example with reproduced (pale) anterior and posterior extremities. Few authors seem to have observed this form, the above, indeed, being the only published notice I have been able to identify. This is the more remarkable, as it has frequently been sent from St. Andrews in the débris of the fishing boats on their return from deep water.

#### 4. MICRURA AURANTIACA, Grube. Plate VII, fig. 4.

*Specific character.*—Eyeless. A white patch at the tip of the snout. Body rounded, and of a fine brick-red hue.

#### SYNONYM.

1855. *Meekeia aurantiaca*, Grube. Archiv für Naturges., p. 148, pl. 7, f. 1.

*Habitat.*—Under stones in tide-pools to the north of Rat Island, Herm.

*Body.*—Three or four inches long, rather rounded on the dorsum and flattened inferiorly. A small caudal process or filament, as indicated in the figure, was noticed during delineation, but this was not present when I examined it subsequently.

*Colour.*—Dorsum fine brick-red, with a roseate lustre here and there from the cilia, and having a white patch a little behind the anterior border of the snout. The reddish pigment in front of the white spot is somewhat deeper in tint than the rest of the body. The under surface is pinkish-white.

*Head.*—Scarcely wider than the succeeding portion of the body, somewhat flattened, slightly narrowed towards the front, and with rather shallow lateral fissures, the upper lip of the latter projecting over the lower. No eye-specks are visible. The mouth forms an indistinct slit in the usual position.

In minute anatomy this species strictly agrees with the Lineidæ. The cells of the cutis are very distinctly marked, and the subjacent pigmentary region has a fine reddish hue on the dorsum.

The layer of longitudinal fibres underneath the latter is powerful. The proboscis is white, and furnished with small glands, somewhat like those in *L. gesserensis*.

Several specimens were brought alive to Scotland, but from their fragility they were in an imperfect state. After surviving a fortnight they deposited eggs, and died about the middle of September. It was interesting to observe the change of colour which ensued in certain fragments after rupture; inferiorly they were dull brownish-red, with the pinkish-brown ova projecting in masses, but by-and-by the latter were extruded, and the ruptured ends and the inferior surface resumed the usual whitish hue of the walls of the digestive chamber. On the whole they were inert animals, generally fashioning tubes on the side of the vessel and remaining therein.

I have incorporated the British form with Prof. Grube's species from Villafranca. His description is as follows:—"Body rounded, not changeable, 1—1.5 inch long, contracting into 7.5 lines long, and then ringed and wrinkled, 0.5 of a line broad. Orange-red, or sometimes brick-red, sides and under surface white; head white, only at the tip of the snout there is a violet spot, and then a broad white belt. The body tapers towards the posterior end, and terminates in a much thinner process, probably a short reproduced tail. The head is not pointed: lateral fissures and eyes not noticed." He had overlooked the lateral fissures, which are shallow. The description of the "growing tail" quite corroborates the correctness of my sister's drawing, for the styles had fallen off when I examined the specimens. Grube's figure shows a broader white belt anteriorly than I observed in the British forms, but such may have been due either to variation or want of scientific accuracy in his artist.

*Genus IX.*—MECKELIA,<sup>1</sup> *Leuckart*, 1827. (Char. emend.)

For the curious form described in the following paragraphs I have thought it better to appropriate the title of a genus established in 1827 by Leuckart in his 'Breves Animalium,' and set at liberty by the undisputed claim of priority. The name, it is true, was given to a form differing in some respects from the following; but the literature of the subject is already so burdened with generic names which have been fashioned on insufficient and unreliable data, that it is almost a duty to resent any addition thereto if it can be avoided. Priority, also, gives the present title a certain claim on our consideration.

*Generic character.*—Structure of the rounded body-wall as in *Lineus*. Cephalic fissures absent. Proboscis furnished with only three coats, external spiral, longitudinal, and glandular.

MECKELIA ASULCATA, n. s.

*Specific character.*—Eyeless. Body thick and round. Of a uniform pinkish hue.

*Habitat.*—St. Magnus Bay and adjoining seas, Shetland; and between tide-marks, Herm.

<sup>1</sup> Named in honour of Prof. Meckel. The same name was in 1830 given by Robineau-Desvoidy ('Essai sur les Myodaires') to a genus of Diptera.



This species can be only imperfectly described at present, as its distinction was not recognized on the sole occasion on which it was seen alive. The specimen found at Herm was of a rose-pink colour in front, pale posteriorly. There are no lateral fissures on the head. The mouth lies on the ventral surface some distance behind the tip of the snout, and in the preserved specimens forms a small puncture or dimple. The worm appears to attain the length of four or five inches.

Numerous specimens of an elongated example of the Anopla without lateral fissures occur in a collection brought by the Rev. L. Guilding from the West Indies, and now in the British Museum. All have a peculiarly corrugated and thickened anterior end, and a small round mouth like a puncture. Some measure about fifteen inches long.

Family III.—CARINELLIDÆ.

Genus X.—CARINELLA, Johnston, 1833.

Before the time of Dr. Johnston the typical animal of this genus, the *Gordius annulatus* of Montagu, had not been sufficiently distinguished from its congeners; and though he named the species in ignorance of the prior observations of Montagu, yet his generic title is more appropriate than that of *Meckelia*, in favour of which the original name was suppressed. The latter term was given to one of the Lineidæ, while the type here is totally different. *Carinella*, as its originator says, labours under the disadvantage of being a name which the scholar may "in vain puzzle himself" to find out "from what, and whence, it is derived." At first sight it seems to be a diminutive of *carina*, a keel.

*Generic character*.—Body elongated, tapering from the front backwards. Snout wider than the rest of the body, bluntly rounded anteriorly. Mouth sometimes small.

1. CARINELLA ANNULATA, Montagu, 1804. Plate VII, fig. 5; and Plate VIII.

*Specific character*.—Eyeless, with a white patch on the snout. Body rounded, of a rich red colour, striped longitudinally and banded across at somewhat regular intervals by white belts. Occasionally pinkish throughout.

SYNONYMS.

1804. *Gordius annulatus*, Montagu. Linn. Trans., vol. vii, p. 74.  
 1807. " " Turton. Brit. Fauna, p. 130.  
 1808. *Lineus annulatus*, Montagu. MS., p. 273, tab. 9, fig. a.  
 1812. *Gordius annulatus*, Pennant. Brit. Zool., vol. iv, p. 73.  
 1833. *Carinella trilineata*, Johnston. Loudon's Mag. Nat. Hist., vol. vi, p. 232, woodcut, f. 24, a. b.  
 1841. " " W. Thompson. Ann. Nat. Hist., vol. vii, p. 482.  
 " *Gordius annulatus*, Ibid. Op. cit., p. 482.  
 " *Polia crucigera*, Delle Chiaje. Descriz. e Notom. anim. invert., &c., tom. v, p. 40, tab. 174, f. 15—18, and tab. 176, f. 17.

1846. *Meckelia trilineata*, Johnston. Ann. Nat. Hist., vol. xvi, p. 435.  
*Valencinia ornata*, De Quatrefages. Ann. des sc. nat., 3<sup>me</sup> sér., Zool., tom. vi, p. 187, tab. 10,  
 f. 4 and 5.
1849. " Ibid. Voyage en Sicilie, vol. ii, p. 99, pl. 10, f. 1—3.
1850. " *annulata*, Diesing. Systema Helm., vol. i, p. 244.
- " " *ornata*. Ibid. Op. cit., p. 244.
1853. *Gordius anguis*, Dalyell. Pow. Creat., vol. ii, p. 85, pl. 10, f. 7—10, and pl. 13.
1854. *Valencinia ornata*, Müller. Archiv, p. 83.
1859. " " Leuckart. Archiv für Naturges., ii, p. 187.
1861. " " Grube. Ausflug nach Triest u. dem Quarnero, pp. 35 and 129.
1862. " " Diesing. Revis. der Turbell., p. 252.
- " " *annulata*, Ibid. Op. cit., p. 253.
1863. *Valencinia ornata*, Diesing. Nachträge z. Revis. der Turbell., p. 6.
1864. " " Grube. Die Insel Lussin u. ihre Meeresfauna, p. 94.
1865. *Meckelia annulata*, Johnston. Catalogue Brit. Mus., pp. 27 and 296-8, with woodcut, as  
 in 1838.
1866. " " Lankester. Ann. Nat. Hist., 3rd ser., vol. xvii, p. 389.
1867. " " Parfitt. Catal. Annel. Devon, p. 8.
1868. " " McIntosh. Rept. Brit. Assoc., 1868, p. 340.
1869. " " Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 372 et seq.

*Habitat*.—Under stones near low water, in obscure fissures of rocks, and also dredged in somewhat deep water. Often cast on shore amongst débris from the laminarian region. Generally diffused round the British coasts and the shores of France. In laminarian and coralline regions it prefers tangle-roots, the inner surface of bivalve shells, or the tubes of *Terebellæ*, *Serpulæ*, and other annelids.

*Body*.—Seven to thirty inches long, and about a line in breadth, somewhat narrowed behind the cephalic furrows, and gradually tapering to the tail. Dorsal surface rounded, ventral flattened.

*Colour*.—Various shades of brick-red, brownish-red or vandyke-brown (garnet-red, Montagu), and with a very regular arrangement of white stripes. The snout usually has a patch of white, with a crescentic margin anteriorly and posteriorly, so as to be narrowed in the middle, with a coloured portion in front. From the former a white central line proceeds backwards on the dorsum to the tip of the tail. A short distance behind the ciliated furrows of the head a circular white belt environs the body, and from each side of this ring a white stripe passes along the lateral aspect to the tip of the tail. At certain intervals, only two of which in front are distant, the body is encircled by white rings, which give a somewhat regularly segmented appearance to the elongated worm. Posteriorly, indeed, they are often equidistant, and in many there is a pale intermediate ring, sometimes faintly indicated by whitish pigment on the dorsum. Every alternate white ring in most of the specimens is double; that is, divided by a slight furrow. Col. Montagu mentions 220 as the number of white rings after the third, and Sir J. Dalyell counted 200 belts in a specimen eighteen inches long. There are likewise in many a series of white specks above the lateral white lines, generally commencing at the fourth or fifth space behind the cephalic furrows, though occasionally some occur on the third. These indicate for the most part the points at which the products of the generative organs escape. The under surface is

paler than the upper. The ventral aspect of the snout has a white patch continuous with, but narrower than, that on the dorsum. The only other markings on this surface are caused by certain pale lines and the circular white belts; but in a characteristic variety a median white stripe passes along the entire belly from tip to tip. The space behind the first white circle is usually paler than the rest. In a very large dark specimen, sent from Montrose by Dr. Howden, the white stripes anteriorly had a beautiful rose-pink shade. Pale red examples from fissures of rocks, when placed in glass vessels, gradually become brownish-red or quite brown by exposure to light.

*Head.*—Horseshoe shaped, wider than the rest of the body, not much flattened, and without eye-specks. Posteriorly it is gradually narrowed to the cephalic furrows, where a slight shoulder occurs. There is a curved streak in the bend of each ciliated furrow on the dorsum, perhaps in connection with the cephalic sac. These furrows are continued straight inwards on the ventral surface, so as to meet just at the anterior part of the mouth. The latter forms a longitudinal slit somewhat less distinct than in *Lineus*.

A well-marked southern variety occurs in the island of Herm. The head is peculiarly flattened, larger in proportion than in the common form, and pale at the tip. At first sight the body appears to be dull orange throughout, but minute inspection shows a pale lateral line on each side, with a series of minute pale spots above it, and traces of faint transverse bars on the dorsum.

This species, one of the most handsome and graceful of the whole order, lives a long period in confinement, constructing on the bottom and sides of the vessel numerous hyaline transparent tubes, in which it lies either doubled or coiled in various ways. The tube or case has a fine silky lustre or iridescence, appearing under a high power as an almost structureless membrane with a few minute adherent granules, and irregularly streaked with fine lines, from microscopic folds of the very thin tissue. The animal progresses somewhat slowly; and though devoid of eyes, it needs but a touch to become aware of the proximity and apparently the nature of any object, so that, for instance, it at once enters head foremost or backs into a tube. Small fragments of the body survive a long time, and move slowly about. In these the anterior end is somewhat pointed. Probably they develop into perfect animals under favourable circumstances.

The skin gives a marked acid reaction.

This is another addition to our marine fauna for which we are indebted to the industry and enthusiasm of Col. Montagu. He distinguished the common form and that with the ventral median white line, as well as noticed the white specks at the sides and the broader nature of some of the circular white belts. In the variety with the ventral longitudinal line he states that "the first annulation of white is very close to the anterior end, the second is distant about an inch, and the rest (about 220) are nearly equidistant." The drawing accompanying the manuscript by some accident shows dark instead of white lines on the dorsum. Four succeeding authors of note, viz. Dr. Johnston, Sig. Delle Chiaje, M. de Quatrefages, and Sir J. Dalzell, each described the same animal as a new species. M. de Quatrefages based the distinction of his *Valencinia ornata* from Col. Montagu's form on the fact that the latter did not note the remarkable enlargement of the head, and because his specimens came from the lamiaurian region, Montagu's from the coralline. Such data, of course, are unsatisfactory. Moreover, since we observe that a species so prominently barred as *Micrura fasciolata* occasionally presents none of these charac-

teristic markings, and that the variety of *Carinella annulata* from Herm showed few traces of stripes, we may be forgiven if we harbour some doubts as to the specific distinction of De Quatrefages' two species *ornata* and *splendida*. It is possible that *Tubulanus elegans* and *T. polymorphus* of Renier, Delle Chiaje, and others, may also have some connection with this species. Sir J. Dalyell compares *C. annulata* to a regular snake in miniature, of delicate form and proportions, and decked in lively colours. He observes that the mouth is at the very extremity, and opens by a wide horizontal gape, as if the creature had an upper and an under jaw, statements due to some erroneous recollections. He notices that a large number of reddish-brown ova were discharged from a specimen in June. M. de Quatrefages, again, mentions that specimens of his *Valencinia splendida* from Bréhat were loaded with ova in September and October.

## 2. CARINELLA LINEARIS, Montagu, MS.

*Specific character*.—Eyeless. Head spatulate, somewhat pointed in front. Milk-white.

### SYNONYM.

1808. *Lineus linearis*. Montagu, MS., pp. 274-5.

*Habitat*.—South coast of England, and Lochmaddy in the Hebrides, amongst sand at low water.

*Body*.—Five to six inches long, less than a line in breadth, flattened, slightly tapered towards the front, diminishing more decidedly posteriorly.

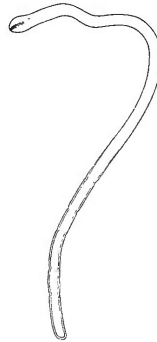
*Colour*.—Pure milk-white, with translucent margins towards the tail.

FIG. 13.



Anterior extremity of *Carinella linearis*.

FIG. 14.



*Carinella linearis* with the anterior end somewhat contracted.

*Head*.—Spatulate, assuming various aspects, sometimes pointed (woodcut, fig. 13), at

others blunt and rounded (woodcut, fig. 14). The snout has an opaque-white central streak. No pigment-specks are present.

The species was procured whilst digging for *Priapulius caudatus* and Annelids at Lochmaddy. Its habits and motions are like those of other species. As usual with white forms, immersion in spirit gives a yellowish hue. On transverse section its anatomy is found to agree with the foregoing, and especially with the variety from Balta having the bifid proboscis, for the inner (longitudinal) muscular coat of the body-wall shows a marked tendency to separation in the middle line of the dorsum.

I was inclined to consider this species a doubtful variety of *Carinella annulata*, until I saw the manuscript of the accomplished Montagu containing the description of "*Lineus linearis*." He says—" *L. linearis*, with a cream-coloured body. Long, slender, considerably extensible and tenacious; the anterior end largest, sometimes clavated and flattened, at other times pointed; frequently that part is observed to be alternately inflated and contracted, while the rest of the body is quiescent. Length 5 or 6 inches when extended, but usually contracted to 3 or 4. This species inhabits the sandy shore at Dawlish, about five or six inches beneath the surface at low water. Like the *marinus*, its motion consists of contortion and variation in size of different parts of the body at the same time. A tenacious slime exudes from its body, which, collecting sand, readily forms a covering like a Sahella."

The *Valencinia longirostris* of M. de Quatrefages has certain affinities with this form, although the snout, as shown in his figures, is much more pointed. It is to be remembered also that he found his species in a similar region and medium (sand and mud) at the *Îles Chausey*. The *Lineus albus* in the British Museum is one of the *Lineidae* from Cornwall.

The shape of the head of this animal, the absence of eyes, its habit of residing amongst sand, and other points, make it clear that there are grounds for specific distinction.

Genus XI.—VALENCINIA, *De Quatrefages*. (Char. emend.)

This genus was instituted by M. de Quatrefages for the typical and other forms of the previous genus, but lapses in virtue of the priority of other names. Since the term was applied to an allied form, it may not inappropriately be used for the description of the present species. The genus *Polia*, perhaps, has prior claims, but it is already employed by the entomologists.

*Generic character*.—Structure of the proboscis as in *Carinella*. The nerves lie in the longitudinal muscular coat. The snout is shaped as in *Lineus lacteus*, and furnished with a row of eyes on each side. The mouth forms a distinct fissure a considerable distance behind the ganglia.

VALENCINIA LINEFORMIS, n. s.

*Specific character*.—Roseate in front, yellowish-white posteriorly.

*Habitat*.—Amongst shell-gravel and the fine purplish ramose form of *Corallina officinalis* in five fathoms, Bressay Sound, between the Point of Scotland and the Green Head.

*Body*.—Six to eight inches or more in length, and about a line in breadth, generally resembling that of *Lineus lacteus*, except in the greater tendency to encircling furrows.

*Colour*.—Richly roseate in front, the rest of the body being pale pinkish-yellow or yellowish-white.

*Head*.—Spathulate, as in the above-mentioned species, the lateral fissures, of course, being absent. The eyes are also fewer in number and smaller, but similarly arranged. The mouth is large and situated far backwards, the position and size being equally interesting in this group.

So like was this species to *Lineus lacteus* (Plate V, fig. 3), that most examples were consigned to spirit before a more critical examination discovered the essential differences. Those specimens, even, which were destined for transmission southward proved so delicate as to break into short fragments in a day or two. The structure of the body-wall and the proboscis at once distinguishes it from the *Lineida*, while the fact that the nerves in the longitudinal muscular coat do not quite reach its outer border separates it from its ally *Carinella linearis*.

Family IV.—CEPHALOTHRICIDÆ.

Genus XII.—CEPHALOTHRIX,<sup>1</sup> *Ersted*, 1844.

This genus was established by A. S. Ersted in his 'Entwurf Plattwürmer' for the reception of animals identical with the *Planaria linearis* of Jens Rathke. The typical form was distinguished by several names, and a variety included also under the genus *Astemma* of the same author, for I consider the distinctions as to the presence or absence of eye-specks and the vague remarks about respiratory fissures of little consequence.

*Generic character*.—Head cylindrical, slightly tapered in front; eyeless, or with a few obscure pigment-specks. Cephalic fissures and sacs absent. Mouth situated a considerable distance behind the snout.

CEPHALOTHRIX LINEARIS, *Jens Rathke*. Plate IV, figs. 4 and 5.

*Specific character*.—Body extremely attenuated, pale yellowish or skin-colour; often with reddish grains towards the tip of the snout.

SYNONYMS.

1799. *Planaria linearis*, Jens Rathke. Skriver for Naturhist. Selsk., v, p. 84, tab. 3, f. 11.  
 1829. " *filiformis*, Johnston. Zool. Jour., vol. iv, p. 56.  
 1837. *Nemertes (Borlasia) ruffrons*, Johnston. Mag. Zool. and Bot., vol. i, p. 538, pl. 18, f. 4 and 5.  
 1844. *Cephalothrix bisculata*, Ersted. Entw. Plattw., p. 81, woodcut 12.  
 " " *caca*, Ibid. Op. cit., p. 81, tab. 3, f. 39.  
 " " *linearis*, Ibid. Op. cit., p. 82 (note under *C. cacca*),

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Κεφαλή, the head, and Σριξ a hair. There is a genus of Lamellicorn beetles (established by Hope in 1837) called *Cephalotrichia*.

1844. *Astemma rufifrons*, Örsted. Op. cit., p. 82, woodcut 13 (?)  
*Cephalothrix bioculata*, Ibid. Kroyer's Nat. Tids., iv, p. 573.  
 " *cæca*, Ibid. Op. cit., p. 574.  
 " *Planaria linearis*, Ibid. Op. cit., p. 573.  
 " *Astemma rufifrons*, Ibid. Op. cit., p. 574.  
 " *longum*, Ibid. Op. cit., p. 574.  
 " *rufifrons*, Ibid. De Region. Marin., p. 79.  
*Cephalothrix bioculata*, Ibid. Op. cit., p. 79.  
1846. *Borlasia* ? *filiformis*, Johnston. Ann. Nat. Hist., vol. xvi, p. 434, pl. 15, f. 1, a, b.  
1850. " *rufifrons*, Diesing. Syst. Helm., vol. i, p. 241.  
 " *longa*, Ibid. Op. cit., p. 241.  
 " *cephalothrix*, Ibid. Op. cit., p. 241.  
 " *filiformis*, Ibid. Op. cit., p. 242.  
 " *linearis*, Diesing. Syst. Helm., vol. i, p. 242.  
*Cephalothrix Örstedii*, Ibid. Op. cit., p. 246.  
1853. *Gordius gracilis*, Dalyell. Pow. Creat., vol. ii, p. 74, pl. 9, f. 8—11.  
1859. " " Leuckart. Aro biv f. Naturges., ii, p. 187.  
1861. *Cephalothrix lineata*, Claparède. Recher. Anat. sur les Ann., Turb., &c., p. 82.  
1862. *Borlasia longa*, Diesing. Revis. der Turbell., p. 249.  
 " *rufifrons*, Ibid. Op. cit., p. 249.  
 " *cephalothrix*, Ibid. Op. cit., p. 250.  
 " *filiformis*, Ibid. Op. cit., p. 250.  
 " *linearis*, Ibid. Op. cit., p. 250.  
*Cephalothrix Örstedii*, Ibid. Op. cit., p. 254.  
*Mackelia caeca*, Ibid. Op. cit., p. 286.  
*Cephalothrix ocellata*, Keferstein. Zeitsch. f. wiss. Zool., Bd. xii, p. 63, taf. 6, f. 11—16.  
 " *longissima*, Ibid. Op. cit., p. 65, taf. 6, f. 6—10.  
1863. *Borlasia linearis*, Diesing. Nachträge zur Revis. der Turbell., p. 5.  
 " ? *longissima*, Ibid. Op. cit., p. 6.  
 " *Ommatoplea ocellata*, Ibid. Op. cit., p. 7.  
*Gordius gracilis*, Ibid. Op. cit., p. 15.  
1865. *Astemma rufifrons*, Johnston. Catalogue Brit. Mus., pp. 19 and 288.  
 " *filiformis*, Ibid. Op. cit., p. 19.  
1866. " *rufifrons*, Lankester. Ann. Nat. Hist., 3rd ser., vol. xvii, p. 388.  
 " *filiformis*, Ibid. Op. cit., p. 388.  
*Cephalothrix lineatus*, Ibid. Op. cit., p. 388 (?)  
1867. *Astemma rufifrons*, Parfitt. Catalogue Nat. Hist. Devon., Annelids, p. 5.  
 " *Cephalothrix filiformis*, McIntosh. Rept. Brit. Assoc., 1867, Trans. Sect., p. 92.  
1868. " " Ibid. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.  
1869. " " Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 376 et seq.

*Habitat*.—Under muddy stones between tide-marks, often in great numbers, and on oysters and other shells and ascidians in the laminarian region. Ranges from Shetland to the Channel Islands.

*Body*.—About three or four inches long, flattened, tapering towards the snout, and much more towards the tail; most variable in appearance, now stretched to a mere thread, and again shortened to a worm of some volume, or thrown into alternate dilatations and contractions. It is marked along the centre by the pale streak of the proboscidian sheath.

*Colour*.—Variable. Sometimes the animal is of a pale cream-colour throughout, with no special pigmentary accumulation. A patch of yellowish pigment occurs in other cases on the snout, and the œsophageal region is yellowish; or the yellowish, orange or reddish pigment is increased towards the tip of the snout, and the œsophageal region is reddish-orange. The succeeding part is also faintly tinged in those most deeply coloured, the rest of the animal being of the usual dull whitish or skin colour, and more opaque than the former. In a female specimen laden with ova, sent from the St. Andrews rocks in April, the entire digestive cavity was of a fine dark green hue (Plate IV, fig. 5), a condition probably due to the absorption of colouring matter from the food, as specimens kept in vessels beside the ova of *Phyllodoce maculata*, Johnst., become similarly tinged towards the posterior part of the digestive tract.

*Head*.—Rounded, slightly tapered to a blunt point, not distinguished from the rest of the body; without eye-specks, and devoid of furrows or fissures. The mouth forms a conspicuous slit a little behind the commencement of the œsophagus, and the pouting lips would seem to be occasionally used as a kind of sucker, since a jerk occurs on raising the body from this point.

*C. linearis* is easily kept in confinement, moving about actively, or reclining at ease along the vessel as a slender thread. It is fond of associating with fellows of the same or a similar species, forming a tangled bunch or grouped as a radiating series of living filaments. In progression the mobile snout is used as an exploratory organ, being thrust hither and thither with ceaseless energy under a glass cover, and pushing aside its own yielding body in any direction. The latter is also frequently drawn through a loop of mucus like a thread of coherent yet fluid substance, which becomes thickened or attenuated by each successive contractile wave; and it is sometimes bent in a peculiar manner from twists round loops of mucus or the bodies of others. The skin is strongly acid to test-paper.

The ova and spermatozoa are ripe from January to June.

I have taken the *Planaria linearis* of Jens Rathke to be the present species. It was noticed by Col. Montagu and afterwards by Dr. Johnston in Britain. The *Lineus spiralis* of the former (MS.) is probably a variety to which the description exactly applies, with the exception of the "red spiral intestine." The proboscis may occasionally be tinted. The presence of pigment or eye-specks does not seem to be of sufficient weight to separate Ersted's *C. bioculata* and *C. cæca*, if, indeed, the former is to be included in this genus at all. The *Astemna rufifrons* of the same author is only a variety of the present species with a greater development of pigment in the snout. The woodcut (op. cit., fig. 13), however, very much resembles a compressed anterior region of *Lineus bilineatus* viewed as a transparent object. It is somewhat doubtful if his *Astemna longum* ("Kroyer's Naturhist. Tidsskrift") is a *Cephalothrix*, though he places it next *A. rufifrons*. Sir J. Dalycell was the first to notice the development of this species, which he saw producing a rope of spawn in June. He correctly describes the young as having two eyes. The *Polia filum* of De Quatrefages has much resemblance to *C. linearis*; indeed, his remarks can only apply to this form or to *Nemertes carcinosphila*, and the probability is in favour of the former, though he had omitted to notice the mouth. The enlarged drawing of the ganglia given by this author still further indicates the connection. This arrangement is never seen in an example of the Enopea. The *C. lineata* (Erst.) which M. Claparède found at Skye is evidently this common species. There is also nothing in the descriptions and figures of Prof. Keferstein's *C. ocellata* and *C. longissima* to distinguish them from each other or from



this form. The presence of dark pigment-specks is of no greater value specifically than the anterior red pigment in the British examples. There is considerable variation, but no character of sufficient importance to merit specific distinction. The form of the papillæ of the proboscis (which are stated to be hook-shaped) and other minute points in the author's descriptions require confirmation.



## EXPLANATION OF THE LETTERS USED IN THE PLATES.

The following letters have been employed both in the ENOPLA and ANOPLA to designate similar structures :—

- a.* Proboscis.
- f.* Superior ganglionic commissure.
- g.* Inferior do. do.
- j.* Esophageal region.
- j.* Digestive canal proper.
- k.* General stroma of the snout.
- m.* Cephalic sac.
- m.* Duct of do.
- n.* Great lateral nerve.
- o.* Proboscidian sheath.
- ov.* Ovaries, ova, or their indications.
- p.* Dorsal blood-vessel.
- r.* Lateral do.
- v.* Mouth.
- z.* Anus.
- ψ.* Muscular ribbon of proboscis.

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### Letters confined to the ENOPLA.

- ac.* Reflection of the proboscis in front of the ganglia.
- b.* Epidermis.
- ab.* Channel in the snout for the proboscis.
- c.* Cutis.
- d.* Circular muscular coat.
- e.* Longitudinal do.
- h.* Superior lobe of the ganglion.
- i.* Inferior do. do.
- l.* Cephalic blood-vessel.
- g.* Anastomotic do.
- Δ.* First region of the proboscis.
- ∞.* Second do. do.
- ∞.* Third do. do.

- ε. Globule in marginal stylet-sac.  
 β. Stylets in do. do.  
 δ. Duct of do. do.  
 ε. Muscular chamber behind the floor of the anterior region of the proboscis.  
 η. Floor of the anterior chamber of the proboscis.  
 θ. Muscular investment of the granular basal apparatus.  
 λ. Granular basal apparatus.  
 μ. Ejaculatory duct.  
 μ'. Aperture of do. into chamber ε.  
 ν. Marginal stylet-sacs.  
 π. External granular glands.  
 ς. Reservoir.  
 σ. Glands of do.  
 . . . Spiral muscular fibres of the walls of the reservoir.  
 τ. Longitudinal do. do.  
 φ. Duct of communication with the posterior chamber.  
 χ. Wall of the posterior chamber.

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Letters used in describing the anatomy of the ANOPLA.

- a. Tube for the proboscis in the snout.  
 b. Cephalic fissures.  
 c. Ciliated epidermis.  
 d. External layer of cutis.  
 d'. Basement-layer.  
 d''. Pigment-layer in *Lineus gesserensis*.  
 e. External (longitudinal) muscular layer.  
 e'. Circular muscular layer.  
 e''. Inner (longitudinal) do. do.  
 h. Ganglia.  
 h'. Superior lobe of the ganglion.  
 h''. Inferior do. do.  
 s. Vascular lacunæ behind the ganglia.  
 u. Vascular meshes around the œsophageal region.  
 v. Larger vascular space at each side of the sheath for the proboscis in front.  
 y. Constriction between the œsophageal and succeeding alimentary regions.

## A P P E N D I X.

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THE delay which has taken place in the preparation of the coloured plates has enabled me to make a few remarks on certain recent papers bearing on the subject. Several of these are by A. F. Marion, who has already (p. 40) been alluded to as the discoverer of an hermaphrodite Nemertean, which he found, with developed generative organs, in the month of March in the Mediterranean.<sup>1</sup>

In a communication entitled 'Histologie du Système nerveux des Nemertes'<sup>2</sup> the author describes the lateral nerve-trunk as enveloped in a fine membrane, and gives an interesting account of the fibres after they have entered the ganglia. He mentions that the nerve-cells in the latter are chiefly elliptical and apolar, though multipolar are also present. He further notes that in certain forms a pulpy granular mass occurs between the external sheath and the internal fibres of the lateral nerve, probably referring to the fibro-granular matrix described on page 110, and shown in Plate XXI, fig. 6, *n'*, of the present work. In these forms, moreover, the cephalic ganglia are composed of the same pulpy mass, without a trace of cells.

Another French author, M. Léon Vaillant,<sup>3</sup> next advances certain remarkable opinions concerning contested points in the Nemerteans. He revives the idea, as he says, of Max Schultze and De Quatrefages, that the proboscis is the digestive organ. The works of the latter author have already been fully gone into, but I am unacquainted with the paper in which the former has propounded this erroneous idea; indeed, the contrary opinion has been taken in the review of his labours (see pp. 28, 29, &c.). His assertion that the marginal stylet-sacs furnish the stylet for the central apparatus through the ducts of the former organs has already been disposed of (pp. 57 and 67). His remarks that the posterior chamber of the proboscis has an aperture leading into "the general chamber of the body" (the proboscidian sheath being unknown), and that *Valencinia longirostris* (one of the Anopla) takes nourishment by the proboscidian aperture, scarcely require refutation.

A. F. Marion published an important article on the subject in his recent 'Recherches sur les Animaux inférieurs du golfe de Marseille,'<sup>4</sup> which, indeed, mainly consist of an account of an hermaphrodite Nemertean named *Borlasia Kefersteini*, already alluded to in the "Zoography" (p. 40). The form was dredged by the author at the above-mentioned locality amongst the roots of sea-weeds, and, in conjunction with three other species of similar organization, its examina-

<sup>1</sup> 'Comptes Rendus,' tom. 69, 1869.

<sup>2</sup> *Ibid.*, tom. 68, 1869, p. 1474.

<sup>3</sup> 'La Revue scientifique de la France et de l'Étranger,' &c., 2e série, 21st Sept., 1872. I am much obliged to Mr. Waterhouse, of the Zoological Department, British Museum, for a perusal of this note.

<sup>4</sup> 'Ann. des. sc. nat.,' v<sup>e</sup> sér., tome xvii, Nos. 3 & 4, 1st March, 1873.

tion afforded, he says, an opportunity of giving a very complete description. He follows Prof. Keferstein in his classification, and therefore the observations on this head in the "Zoography" are equally applicable here. He is also rather behind date in his remarks on the value of the stylet-region in the discrimination of species.

In what he calls the granular coat of the skin he found small brilliant bodies, sometimes in the form of prisms, sometimes in the form of buckles. This peculiar condition has not been observed in the British Nemerteans. Only longitudinal muscular fibres were present in his species, but he does not say that he made any transverse sections. In consonance with the structure of the Enopla, to which the form belongs, there ought to be external circular as well as internal longitudinal fibres. I cannot agree with his proposition that naturalists generally consider the proboscis an organ of offence and defence, for observations on the living animal, and the anatomy and physiology of the organ in both Enopla and Anopla, render this view quite theoretical. He is safe, however, in objecting to the interpretation of his countryman, M. Léon Vaillant, previously narrated.

A vital discrepancy is the affirmation that the mouth in his species (one of the Enopla) opens behind the ganglia, because in every example (British and foreign) of this group seen by me the position of the oral orifice is quite in front of the ganglia and ganglionic commissures, and thus, very properly, forms one of the most important distinctions between them and the Anopla, in which (latter) the mouth invariably opens behind the ganglia. As an accompaniment to this croneous view the author has quite overlooked the characteristic œsophagus, which forms a longitudinally plaited ciliated sac (essentially differing in appearance from the rest of the digestive chamber) behind the ganglia. The oral slit shown in his figure might pass for one of the longitudinal rugæ of the organ. It is by no means easy to arrive at an accurate knowledge of the anatomy of these animals, and hence the greatest care and patience are necessary.

He further observes that the proboscis is fixed to the wall of the "general cavity of the body," a position it does not occupy, since it is enclosed in its special sheath of two coats, and to the inner surface of which the terminal rihands are duly fixed. M. Marion's interpretation implies a total want of this sheath, which, I am sure, a single transverse section would at once render apparent. He next narrates that the anterior region of the proboscis is covered with papillæ, but he would have been more exact if he had mentioned that these organs are internal, for on glancing at his figure (Pl. 17, fig. 3, op. cit.) it is difficult to say whether they are wholly internal or also common to the external surface. To have got the figure the organ must have been turned inside out at its anterior part. The basal apparatus of the central stylet is described as brownish. It is only so by transmitted light—from the dense mass of white granules. The terminations of the ducts of the marginal stylet-sacs have never, in any form observed by us, been close to the aperture for the central stylet in the floor of the anterior chamber, but at some distance therefrom. The statement, also, that below the stylet-sacs the fibrous tissue is furnished with fine pigment-granules is not sufficiently comprehensive, for no mention is made of the regularly arranged circle of granular glands ( $\pi$  in our figures), neither is any help on this point obtainable from the plate.

Another discrepancy is the arrangement of the duct from the reservoir (his *poche de réserve du liquide venimeux*), which canal he describes and figures as extending forward to open into the floor of the anterior chamber near the point of the central stylet. If the author had watched an organ under careful pressure he would have seen the granular gland-cells from the posterior

chamber (his *région glandulaire de la trompe*) roll forward into the reservoir, and find exit singly into the muscular cavity ( $\epsilon$  in our figures) behind the floor of the anterior chamber, and which the author actually represents without comment. Moreover, that afterwards they passed into the cavity of the anterior chamber by the aperture for the central stylet. With regard to his discussion concerning the venomous nature of the fluid in the reservoir, I would not, for my part, say that it is poisonous. It is clear, from the minute anatomy of the organ, that the fluid cannot enter a wound inflicted by the stylet until the latter is withdrawn; and, as stated previously (p. 62), the proboscis is a somewhat precarious aggressive weapon. The jerking movements observed by the French author in the protruded proboscis are common enough in a structure so muscular and mobile, but they may be explained otherwise than on the supposition of attacking prey. My experience of the organs in the Anopla, also, does not coincide with his observation that they subserve the same function, viz. the secretion of poison. Neither has anything been observed to support the view that other marine animals, such as Crustacea, manifest great repugnance to the Nemertean, nor is it probable that nature furnished the latter with cilia (in lieu of urticating organs) to warn their fellows of their deadly approach.

The author admits that he has only imperfectly examined the organs of circulation, a fact apparent from his remark (and figure) that a central dorsal vessel springs from the middle of the cephalic arch at the tip of the snout. As formerly shown (p. 79), the dorsal vessel arises from the two lateral—by the anastomotic—behind the ganglia.

He indicates the discovery of a curious species, having small clear processes like buckles in its cutis, and analogous to the bodies in the muscles of Echinoderms; hence he calls it *Borlasia echinoderma*. The basal apparatus of the central stylet in this species is truncate posteriorly, as in *Prosohoclumus Claparedii*. Some interesting details are given of its nervous system, amongst others the curious fact that the first eleven pairs of lateral nerves (from the great lateral trunks) go to a series of eyes furnished with refracting globules. The anterior eyes are supplied, as usual, by branches from the ganglia.

The paper concludes with an account of the reproductive organs of *Borlasia Kefersteini*. The statement that on attaining full development the ova and spermatocytes burst their envelopes and escape into the "general cavity of the body" is not in accordance with our observations. The apertures along the sides, which the author failed to see in this small species, render such a supposition unnecessary, though, of course, not impossible. His asking if, like Keferstein, we are to consider the cephalic sacs and "fossettes céphaliques" the channels whereby the reproductive products are expelled, is not in keeping with a thorough knowledge of the subject. In the viviparous *Prosohoclumus Claparedii* even the largely developed young are confined to certain definite spaces in the body of the parent, but their actual mode of exit in this species is still involved in obscurity. It is to be remembered in connection with the subject that in *Nemertes carcinophila*, also occasionally a viviparous species, the sexes are separate.

The author's allusion to the literature of the subject is meagre, and though several of his views are nearly identical with, or modifications of, those promulgated long ago by his distinguished countryman, M. de Quatrefages, he does not even mention his name. The plate of figures accompanying the paper is considerably behind date in accuracy.

An important memoir (an abstract of which has only been published) in connection with the homologies of the subject is that 'On the Anatomy and Histology of the Land-Planarians of

Ceylon," by Mr. H. N. Moseley, now one of the naturalists in the "Challenger" expedition. The author specially examined the genera *Bipalium* and *Rhynchodemus*; and since my observations on the former had been made some years ago, and printed off several months before the above paper reached the Royal Society, a comparison of the results will be interesting. He agrees with me in affirming that the skin closely conforms to the Planarian type. The flask-shaped cells filled with "stäbchenförmigen Körpern" below the cutis he thinks homologous with the "nail-like bodies of the Nemertines;" but if he means by the latter expression the proboscidian stylets, the homology is not very apparent, any more than the conjecture concerning their possible alliance with the bristles of the Annelida. He makes the curious statement that "it is commonly said that whilst in all other Vermes the external muscular layer is circular, and the longitudinal internal, in Turbellarians the reverse is the case;" but he might have observed, in a paper on the "Anatomy of the Nemerteans,"<sup>2</sup> that considerable differences exist in the arrangement of the muscular coats of the great groups—for example, between the Enepla and Anopla, the external muscular layer in the former being circular, while in the latter it is longitudinal. With regard to the nature of the pale areas described on p. 143, and which Mr. Moseley calls primitive vascular trunks, I was in doubt after the examination of my specimen, though I could not see anything nervous about them. If such be a water-vascular system it is totally different from the circulatory trunks in the Nemerteans, which I hold to be the blood-vessels of the animals. Some interesting theoretical remarks are appended to the communication.

The latest publication pertaining to the subject is by M. E. Zeller,<sup>3</sup> on the "Structure of the Proboscis of *Borlasia Kefersteini*," Marion, the author having worked under the direction of the latter. He is of opinion that the species must be united with that parasitic on the branchial tissue of *Phallusia mamillata*. It is therefore probably a similar—if not the same—form as Delle Chiaje or Leuckart and Pagenstecher long ago described (see p. 2, &c.). Unfortunately the author is not more precise than M. Marion with regard to the anatomical position of the proboscis, which, he states, is attached to the "walls of the general cavity." The complex structure of the anterior region is not precisely detailed, and the same remark is applicable, as in the case of M. Marion, to his definition of the granular basal apparatus of the central stylet, which is held to be brownish. He, however, has evidently more acquaintance than his colleague with the muscular cavity ( $\epsilon$  in our figures) behind the floor of the anterior chamber, though his description is somewhat obscure. Three marginal stylet-sacs are mentioned as characteristic of the species. The dark layer above the styliferous apparatus would have been whitish by reflected light. He agrees with M. Marion in calling the reservoir a poison-sac, but is not definite enough in his account of the termination of its duct (which opens into the chamber  $\epsilon$ ). The physiological observations on the ejection of the proboscis have been anticipated.

<sup>1</sup> 'Proceed. Roy. Soc.,' vol. xxi, No. 142, received January, 1873; also in 'Annals Nat. Hist.,' vol. xi, 4th ser., No. 64, April, 1873, &c.

<sup>2</sup> 'Trans. Roy. Soc. Edinb.,' vol. xxv, p. 305, 1869.

<sup>3</sup> 'Ann. Nat. Hist.,' vol. ii, 4th series, No. 65, p. 398, May, 1873 (from the 'Comptes Rendus,' April 14th, 1873).

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ERRATUM.

Delete the first synonym (date 1776) on p. 156, and the allusions thereto on pp. 10 and 158.





PLATE XI.

FIG.

1. Transverse section of the cephalic ganglia of *Amphiporus lactifloreus*, in the line of the commissures, the superior of which, from the flattening of the preparation, is shown very plainly. *a*, proboscis; *d*, circular muscular fibres of the body-wall; *k*, muscular and cellular stroma of the region.  $\times 90$  diam.
2. Section through the body of the same animal some distance behind the ganglia. The sheath for the proboscis now separates the latter from the oesophagus, which has attained considerable size. The lateral nerve-trunks have nearly reached their proper position, viz. to the inner side of the internal muscular layer of the body-wall; *s*, granular masses (from the digestive cavity proper) at the sides of the oesophagus.  $\times 55$  diam.
3. Section of the same specimen behind the foregoing and towards the posterior end of the oesophageal apparatus. *u*, ova pressed forward by the contraction of the textures.
4. Transverse section of the anterior region of the proboscis of *Amphiporus pulcher*. *a*, central cavity; *b*, the papillary glandular layer; *c*, internal circular muscular coat; *d*, inner longitudinal layer; *e*, reticulated or beaded layer; *f*, external longitudinal muscular layer; *g*, external (elastic) layer; *h*, basement-layer.  $\times 55$  diam.
5. Transverse section of the stylet-region of the proboscis of *A. lactifloreus*, in the line of the marginal sacs. The circumference of the preparation is somewhat distorted from pressure.  $\times 350$  diam.
6. Transverse section of the same region in another specimen, in which the knife has pressed aside the basal apparatus of the central stylet ( $\lambda$ ), and in which the ejaculatory duct ( $\mu$ ) has been cut obliquely. In this and the preceding preparations the peculiar arrangement of the muscular fibres of the region is represented.  $\times 210$  diam.
7. Longitudinal section of the anterior region of the proboscis of *Amphiporus lactifloreus*.  $\times 90$  diam.
8. Longitudinal section of the same region of the proboscis.  $\times 350$  diam.
9. Transverse section of the same part of the proboscis. *e'*, the ends of the longitudinal bands of the reticulated layer, which have assumed a finely granular aspect in the preparation.  $\times 350$  diam.
10. Glandular papillæ in the anterior region of the proboscis of *A. lactifloreus*, seen in the ordinary condition of the organ under pressure.  $\times 210$  diam.
11. Central stylet and basal apparatus of *Nemertes Neesii*.  $\times 350$  diam.
12. Central stylet of *N. Neesii*.  $\times 700$  diam.
13. Developing or recently repaired central stylet-apparatus of *Tetrastemma candida*.  $\times 700$  diam.
14. Stylet from a marginal sac of the same animal.  $\times 700$  diam.
15. Central stylet and a portion of the basal apparatus in a large *Nemertes gracilis*.  $\times 350$  diam.
16. Extremity of the posterior region (c) of the proboscis of *A. lactifloreus* distended with fluid. *u*, a group of the peculiar moving granules.  $\times 90$  diam.
17. Posterior end of a young example of *Tetrastemma dorsalis*, showing the usual hernia of the proboscis under pressure.  $\times 350$  diam.

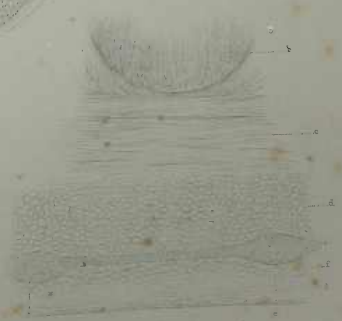
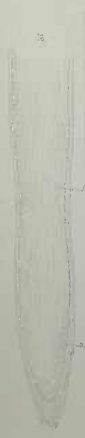
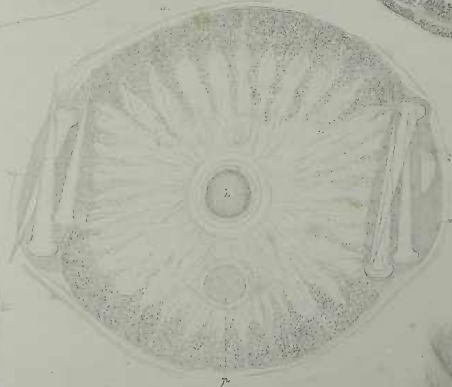
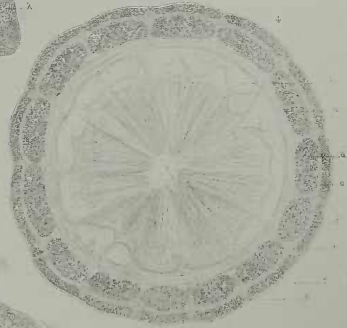
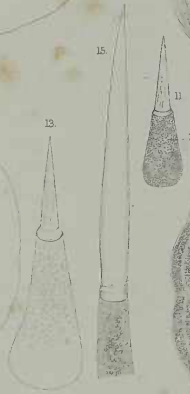
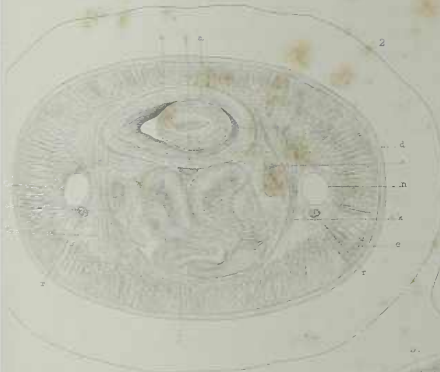
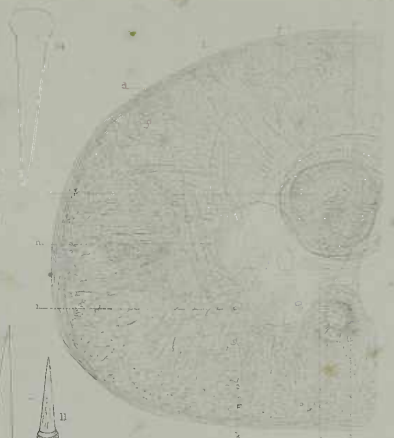






PLATE XII.

FIG.

1. Structure of the stylet-region in a large *Amphiporus lactifloreus*. The specimen had two marginal sacs on one side.  $\times 350$  diam.
2. Structure of the stylet- and reservoir-regions in the same form. Considerably magnified.
3. Abnormal stylet-region in the same species. *a*, perfect stylet-sac of the left side; *b*, shriveled sac of the right side.  $\times 210$  diam.
4. Termination of the posterior chamber of the proboscis (*c*) of *A. lactifloreus*, with muscular ribands.  $\times 210$  diam.
5. The central (*a*) and marginal stylets (*b*) from a young *A. lactifloreus*, on the first appearance of the former.  $\times 700$  diam.
6. Structure of the stylet-region of the proboscis of *Amphiporus pulcher*.  $\times 90$  diam.
7. Central stylet-apparatus of the same species. *a*, central stylet; *b*, reserve-stylet *in situ*.  $\times 210$  diam.
8. Structure of the stylet-region in *Tetrastemma melanocephala*.  $\times 90$  diam.
9. Structure of the stylet-region in *Tetrastemma flavida*, with the reservoir somewhat contracted.  $\times 210$  diam.
10. Extremity of the posterior chamber of the proboscis of *Tetrastemma dorsalis*, apparently after rupture of the muscular ribands from the sheath of the organ.  $\times 350$  diam.
11. Structure of the stylet-region of the proboscis in *Nemertes gracilis*.  $\times 210$  diam.
12. Structure of the stylet-region of the proboscis of *Nemertes Neesii*.  $\times 210$  diam.
13. Portion of the posterior chamber of the proboscis of the same species, showing the characteristic plaits of the mucous surface.  $\times 90$  diam.
14. Structure of the stylet-region of the proboscis of *Nemertes carcinophila*.  $\times 700$  diam.

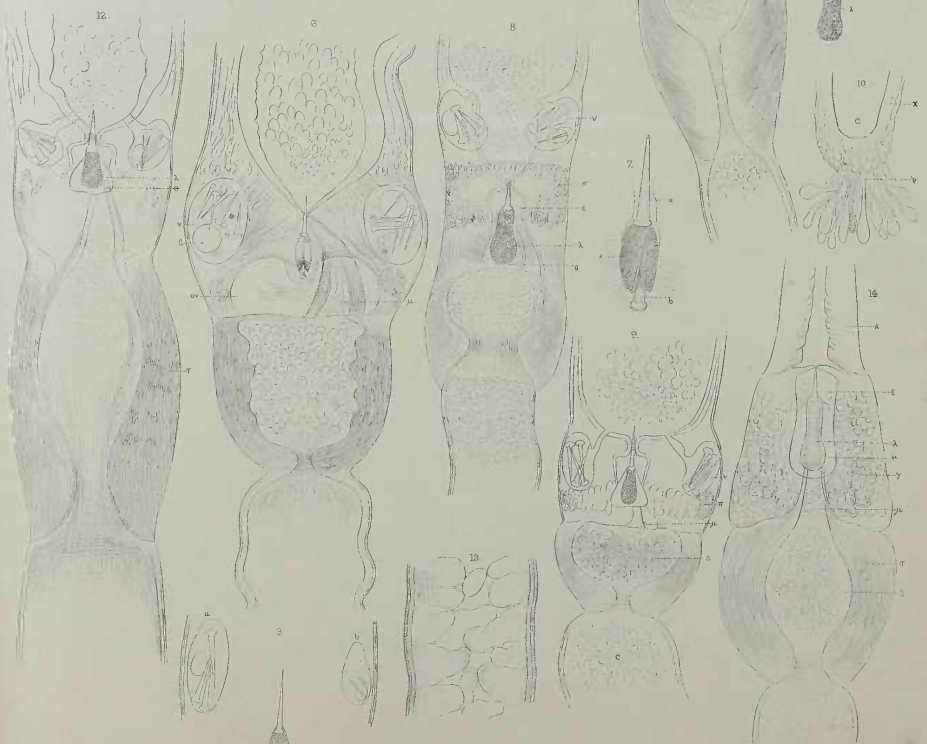
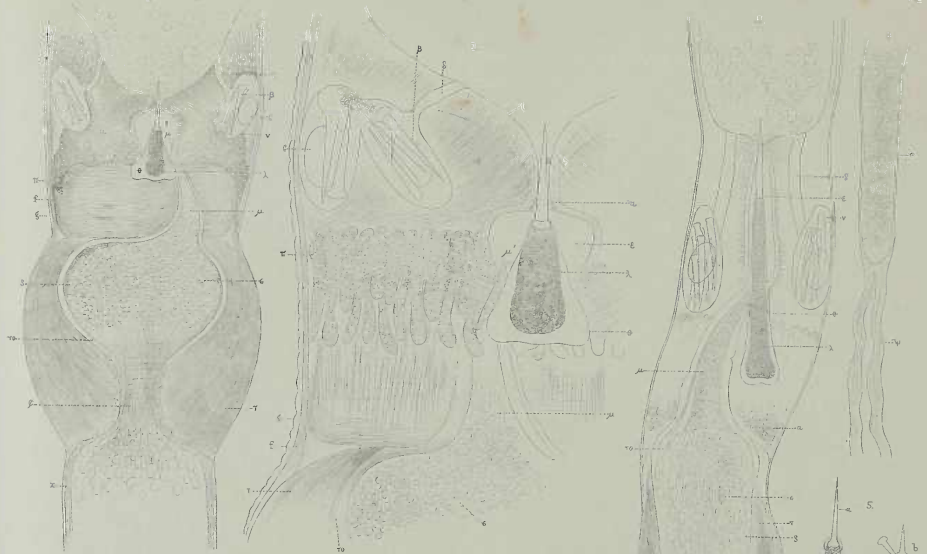








PLATE XIII.

FIG.

1. Structure of the stylet-region of the proboscis of *Prosochocimus Claparedii*. Degeneration of the marginal sacs has ensued from long confinement.  $\times 90$  diam.
2. Aspect of the developing proboscis (*a*) of *Tetrastemma melanocephala*, about the fifth day after the removal of the original organ.  $\times 55$  diam.
3. Structure of the stylet-region of a developing proboscis of the same species. *f*, canal, which by-and-by is occupied by the central stylet. The organ is contracted.  $\times 350$  diam.
4. Central stylet and basal apparatus with radiating fibres in *Tetrastemma vernicula*.  $\times 350$  diam.
5. Stylet-region of the proboscis of *T. candida*, with the ejaculatory duct pressed to the left side. The marginal stylet-sacs are out of focus.  $\times 210$  diam.
6. Central stylet and basal apparatus of a small specimen of the same species.  $\times 420$  diam.
7. Structure of the stylet-region in *Tetrastemma dorsalis*, somewhat contracted, with the floor of the anterior chamber pouted forward, and the reservoir shortened in its antero-posterior diameter.  $\times 210$  diam.
8. Stylets of the same species. *a*, central stylet; *b*, stylet from a marginal sac.  $\times 700$  diam. *c*, central stylet and its basal granular apparatus.  $\times 420$  diam.
9. Stylets of *Tetrastemma flavida*. *a*, central stylet; *b*, stylet from a marginal sac.  $\times 700$  diam. *c*, central stylet and its basal apparatus.  $\times 420$  diam.
10. Superficial structure of the stylet- and reservoir-regions of *A. lactiflores*. Considerably magnified.
11. Isolated marginal stylet-sac of the same species. *a*, fibres which probably act as constrictors of the aperture of the duct. The laminated arrangement of the calcareous layers of the stylets is indicated in this figure.  $\times 350$  diam.
12. Stylet-region of the proboscis of a young animal of the same species, illustrating the first appearance of the stylets and the development of the parts. The organ is drawn as it bulged from a wound in the body-wall of the specimen.  $\times 700$  diam.
13. Stylet-region of a young *A. lactiflores*, some weeks older than that represented in the previous figure.  $\times 350$  diam.
14. Proboscis of an adult of the same species, gently but completely extruded under chloroform, so as to render the central stylet prominent.  $\times 55$  diam.
15. Transverse section of the contracted reservoir-region of the proboscis of the same species, showing the complex spiral arrangement of the fibres. The organ is cut towards its posterior end.  $\times 55$  diam.
16. Transverse section of the posterior chamber of the proboscis in a large example of the same species.  $\times 90$  diam.
17. Structure of the stylet-region in a developing proboscis of *Nemertes gracilis*.  $\times 350$  diam.
18. Central stylet and its basal apparatus in the same species, turned round so as to demonstrate the curve of both.  $\times 100$  diam.
19. Proboscis of *Amphixiporus pulcher* treated as in fig. 14.  $\times 55$  diam.
20. Fragment of the cesophageal region of the digestive tract from a living *A. lactiflores*. *a*, inner edge of ciliated fold; *b*, sulcus between two folds.  $\times 350$  diam.







PLATE XIV.

FIG.

1. The anatomy of *Tetrastemma candida*, chiefly with respect to the digestive and proboscidian systems. Considerably magnified. *h*<sup>2</sup>, abnormality of the right ganglion.
2. Structure of the head of a young *Tetrastemma melanocephala*, showing the ganglia and the relation of the pigment-patch to the eyes. Considerably magnified.
3. Digitate or lobate arrangement of the digestive canal of *Nemertes gracilis*.  $\times 24$  diam.
4. Head and anterior portion of *Nemertes carcinochila*. *f*, powerful transverse fibres which retain the posterior part of the oesophagus *in situ*.  $\times 180$  diam.
5. Superficial structure of the reservoir in *Nemertes Neesii*, showing the elaborate interlacing of the fibres.  $\times 210$  diam.
6. Stylet from a marginal sac of *Tetrastemma candida* (same animal as in fig. 6, Plate XIII).  $\times 700$  diam.
7. Stylet from the central apparatus of the same specimen.  $\times 700$  diam.
8. Stylet from a marginal sac of *Tetrastemma melanocephala*.  $\times 700$  diam.
9. Stylet from the central apparatus of the same specimen.  $\times 700$  diam.
10. Marginal stylet of *Tetrastemma Robertiana*. *a*  $\times 350$  diameters, *b*  $\times 700$  diam.
11. View of the under surface of the snout of *Amphiporus pulcher*. The mouth is indicated at *w*, the cephalic furrows and their branches at *m'*, and the situation of the ganglia at *i*. Enlarged under a lens.
12. Transverse section of the wall of the oesophagus of *A. lactifloreus*, after mounting in chloride of calcium.  $\times 210$  diam.
13. Compound cells from the wall of the digestive cavity of *Tetrastemma dorsalis*.  $\times 350$  diam.
14. Cephalic ganglia of *Tetrastemma flavida*.  $\times 210$  diam.
15. Eye of *Amphiporus pulcher* from a dead and slightly injured specimen.  $\times 210$  diam.
16. Portion of a sperm-sac from *Tetrastemma flavida*, exhibiting a streaky and granular aspect from the varying nature of the contents.  $\times 350$  diam.
17. Granules from a developing sperm-sac of *T. dorsalis*.  $\times 400$  diam.
18. Spermatozoa of *Amphiporus lactifloreus*.  $\times 800$  diam.

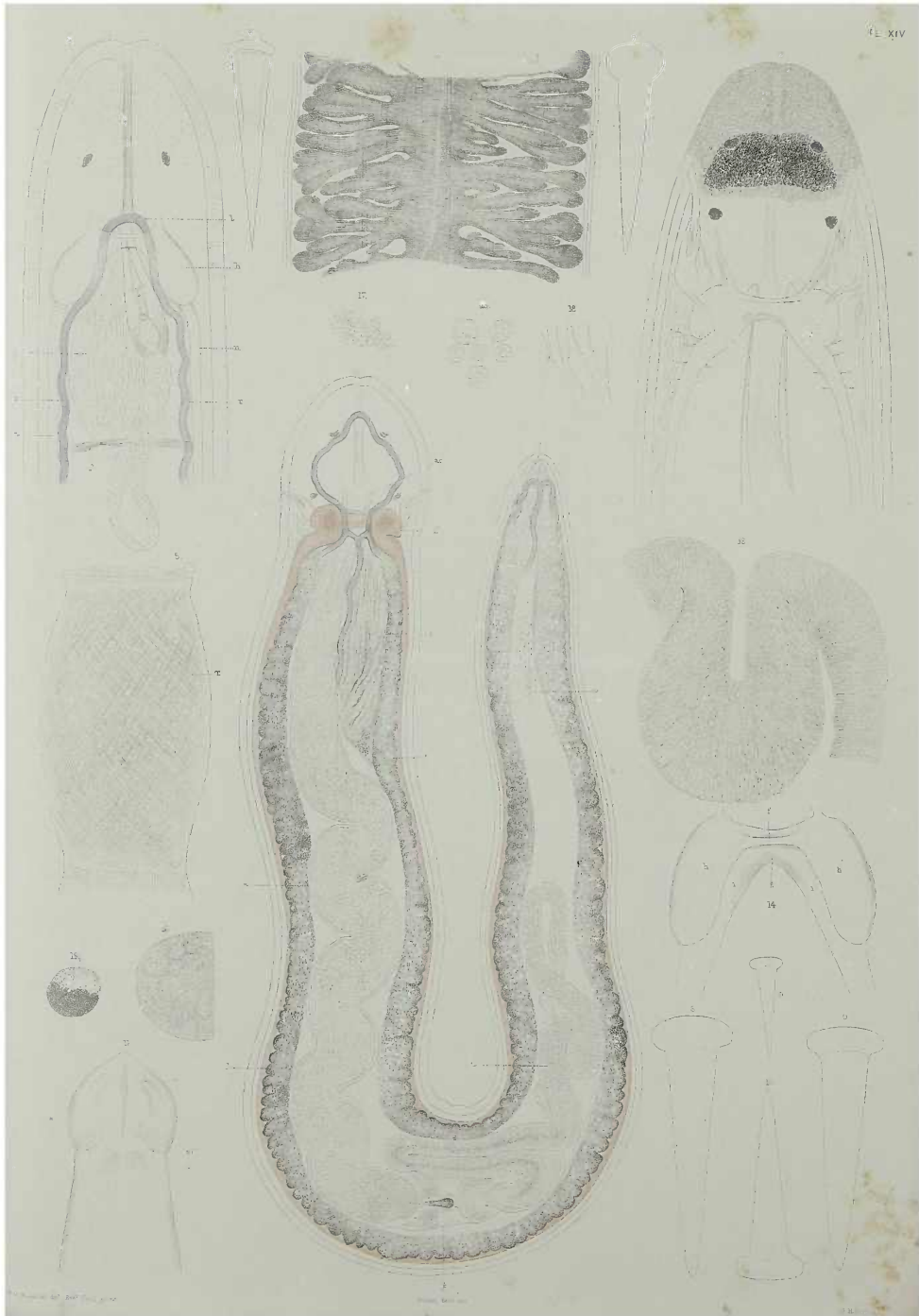








PLATE XV.

Fig.

1. Transverse section somewhat behind that shown in Plate XI, fig. 1. The instrument has passed obliquely across the body so as to cut the ganglia at different distances from the front. On the right only the tip of the superior lobe remains, while the commencement of the great nerve-trunk—in full bulk—is cut beneath.  $\times 90$  diam.
2. Snout and anterior region of *A. pulcher*. *g, g*, glandular masses.  $\times 55$  diam.
3. Arrangement of the circulatory and nervous systems in *A. lactifloreus* (a small specimen).  $\times$  about 40 diam.
4. Portion of the head of the same species considerably flattened.  $\times 210$  diam.
5. Head of *Nemertes Neesii*.  $\times$  about 60 diam.
6. Nerve-cells from a cephalic ganglion of *A. lactifloreus*.  $\times 400$  diam.

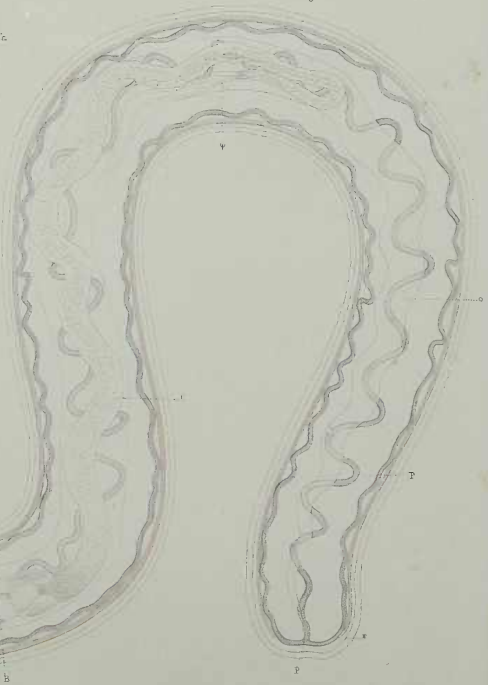
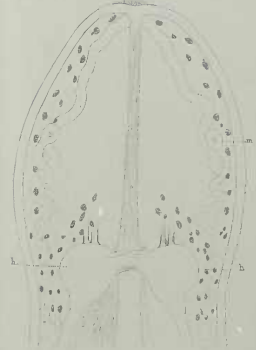
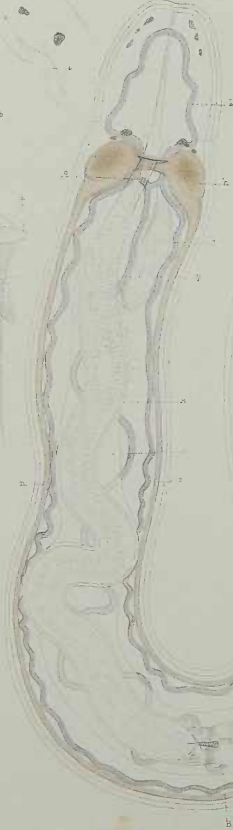
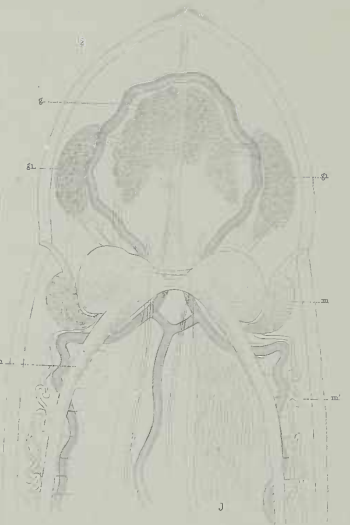
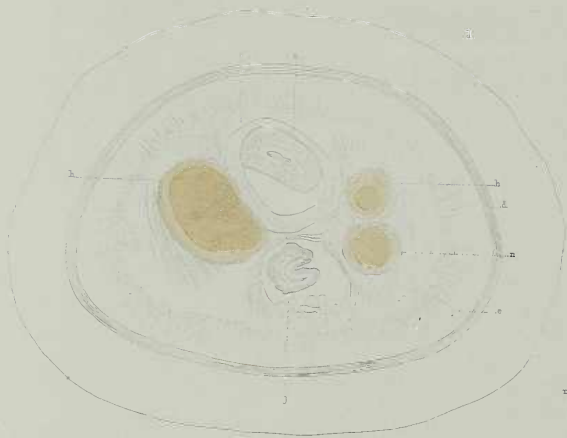






PLATE XVI.

FIG.

1. Anterior end of *Tetrastemma dorsalis*. *a*, proboscis, whose fibres have temporarily assumed a spiral aspect from twisting. *b*, tube connected with the cephalic sac of the right side. Considerably magnified.
2. Longitudinal section of the body-wall of *A. lactifloreus*, in a somewhat shriveled condition. *f*, *f*, ovisacs from which the contents have fallen. Other letters as usual.  $\times 90$  diam.
3. Nervous plexus from the lateral trunk (*n*) in *A. pulcher*.  $\times 210$  diam.
4. Transverse section of the anterior part of the stylet-region proper, showing the divergent arrangement of the oblique fibres and the position of the longitudinal series.  $\times 210$  diam.
5. Three sperm-sacs (*ef*) with a portion of the body-wall of *A. lactifloreus*.  $\times 90$  diam.
6. Spermatozoa of *Tetrastemma vermicula*.  $\times 1000$  diam.
7. Spermatozoa of *Tetrastemma dorsalis*.  $\times 400$  diam. This drawing was made many years ago, and probably represents imperfectly developed hodies.
8. Unimpregnated ovum of *A. lactifloreus*. *a*, outer coat; *b*, inner coat; *c*, vitellus; *d*, "micropyle," or cicatrix-like arrangement.  $\times 90$  diam.
9. The same ovum some hours after impregnation. The vitellus (*c*) is now divided into two portions.  $\times 90$  diam.
10. The same ovum a few hours later. The vitellus is in four portions.  $\times 90$  diam.
11. Ovum of the same species in the mulberry-stage.  $\times 90$  diam.
12. Ovum just before the extrusion of the embryo.  $\times 90$  diam.
13. Arrangement of the ova in the ovisacs of *Tetrastemma vermicula*. *a*, proboscis; *o*, proboscidian sheath.  $\times 24$  diam.
14. Ovum of the same species.  $\times 90$  diam.
15. Ovum of *Nemertes gracilis* after impregnation. *a*, outer coat; *b*, inner coat; *c*, vitellus.  $\times 90$  diam.
16. The inner coat and vitellus of an ovum (of *N. gracilis*) at the same stage of development, with the relations of the spermatozoa.  $\times 210$  diam.
17. Ovum of *N. Neesii*.  $\times 55$  diam.
18. Portion of the mucous sheath with the ova of *Nemertes carcinophila*.  $\times 24$  diam.
19. Ovum of the same species immediately after deposition.  $\times 350$  diam.
20. Another ovum, about the tenth day, showing the ciliated embryo revolving therein.  $\times 350$  diam.

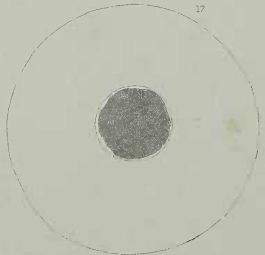
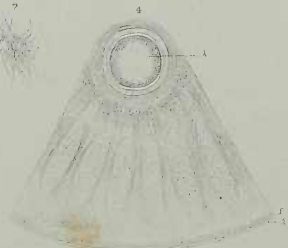
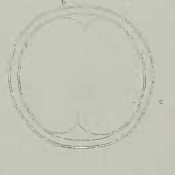
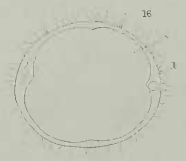
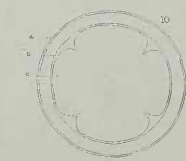
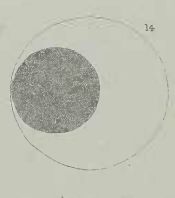
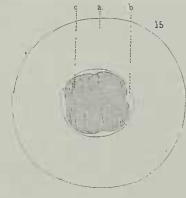
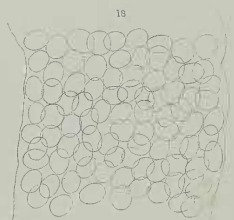
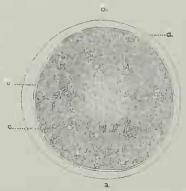
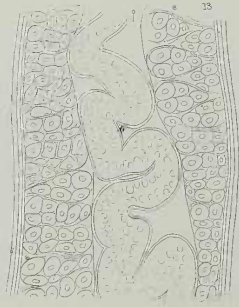
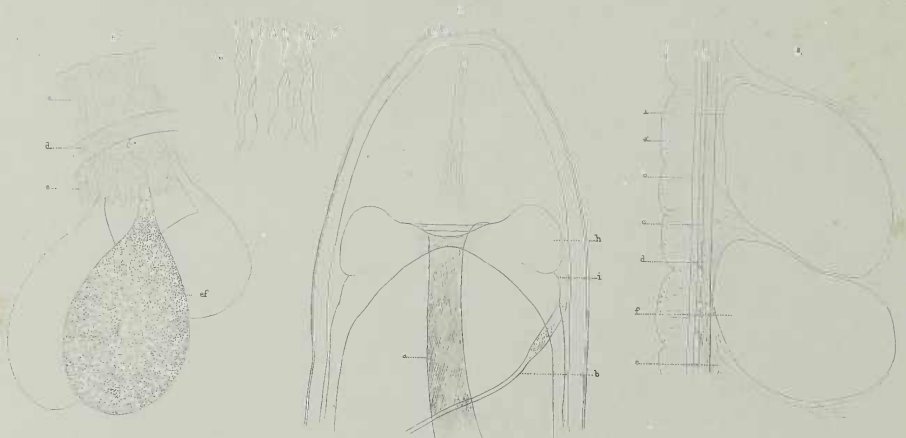








PLATE XVII.

FIG.

1. A young specimen of *A. lactifloreus* on extrusion from the egg. Somewhat compressed.  $\times 55$  diam.
2. Another specimen eight days older than the preceding. *b*, stylet-region; *c*, point where the posterior chamber of the proboscis becomes lost, after curving forward.  $\times 90$  diam.
3. Outline of a young specimen of *Tetrastemma dorsalis* shortly after extrusion from the egg.  $\times 350$  diam.
4. The same compressed, so as to exhibit its cellulo-granular structure.  $\times 350$  diam.
5. Young specimen of *T. dorsalis*, about a week older than the preceding. *a*, cutaneous textures; *b*, cells and granules of the alimentary tract; *c*, stylet-region.  $\times 210$  diam.
6. A specimen eight days older than the foregoing, showing a considerable advancement in all the organs.  $\times 210$  diam.
7. A young example of *N. carcinophila* extruded from the body of the adult under pressure. It has the same appearance when originating in a free ovum.  $\times 350$  diam.
8. Spermatozoa of *Nemertes gracilis*.  $\times 700$  diam.
9. Spermatozoa of *N. carcinophila*.  $\times 950$  diam.
10. Spermatozoa of *Amphiporus pulcher*.  $\times 700$  diam.
11. Magnified view of the ganglionic region of a large *A. lactifloreus*, in which a parasitic ovum (*y*) lay imbedded in a granular lobulated mass (*y*).
12. Parasitic ovum immediately after removal. *a*, opaque mass of cells and granules; *b*, ventral disc; *c*, oral disc; *d*, capsule, to which some shreds of the surrounding tissue are adhering. Considerably magnified.
13. The same ovum some hours afterwards, showing slight contraction of the discs.
14. Parasite extruded from the capsule. *a*, opaque cellular and granular mass; *b*, ventral disc; *c*, oral disc; *d*, oesophageal bulb; *e*, alimentary caeca; *f* and *g*, large circular granular bodies.
15. Streaked arrangement of the cutis from the dorsum of *Lineus gesserenensis*.  $\times 210$  diam.
16. View of the cutis of the same species (at a pale portion) as a transparent object.  $\times 210$  diam.
17. Portion of the skin of a living *Carinella annulata*.  $\times 350$  diam.
18. Pigment-cells from the anterior dorsal region of *Lineus gesserenensis*.  $\times 350$  diam.
19. Papillae on the snout of the same species.  $\times 210$  diam.
20. Tip of the snout in the same species, with the proboscis partly extruded.  $\times 210$  diam.
21. Posterior extremity and styliform process of *Micrura fasciolata*. *a*, central cavity, containing fluid; *s*, anus.  $\times 210$  diam.
22. Posterior extremity of a young example of *L. gesserenensis*, showing the anal papilla.  $\times 210$  diam.
23. Corpuscles of the extruded fluid (page 114) from *Borlasia Elizabethae*. Highly magnified.
24. Anterior extremity of *Carinella annulata*. *a*, aperture in snout for proboscis; *b*, cephalic furrows; *c*, cephalic blood-vessel; *m*, cephalic sac; *w*, mouth. Magnified.
25. Spermatozoa of *Amphiporus bioculatus*.  $\times 700$  diam.
26. Spermatozoa of *Tetrastemma Robertiana*.  $\times 400$  diam.

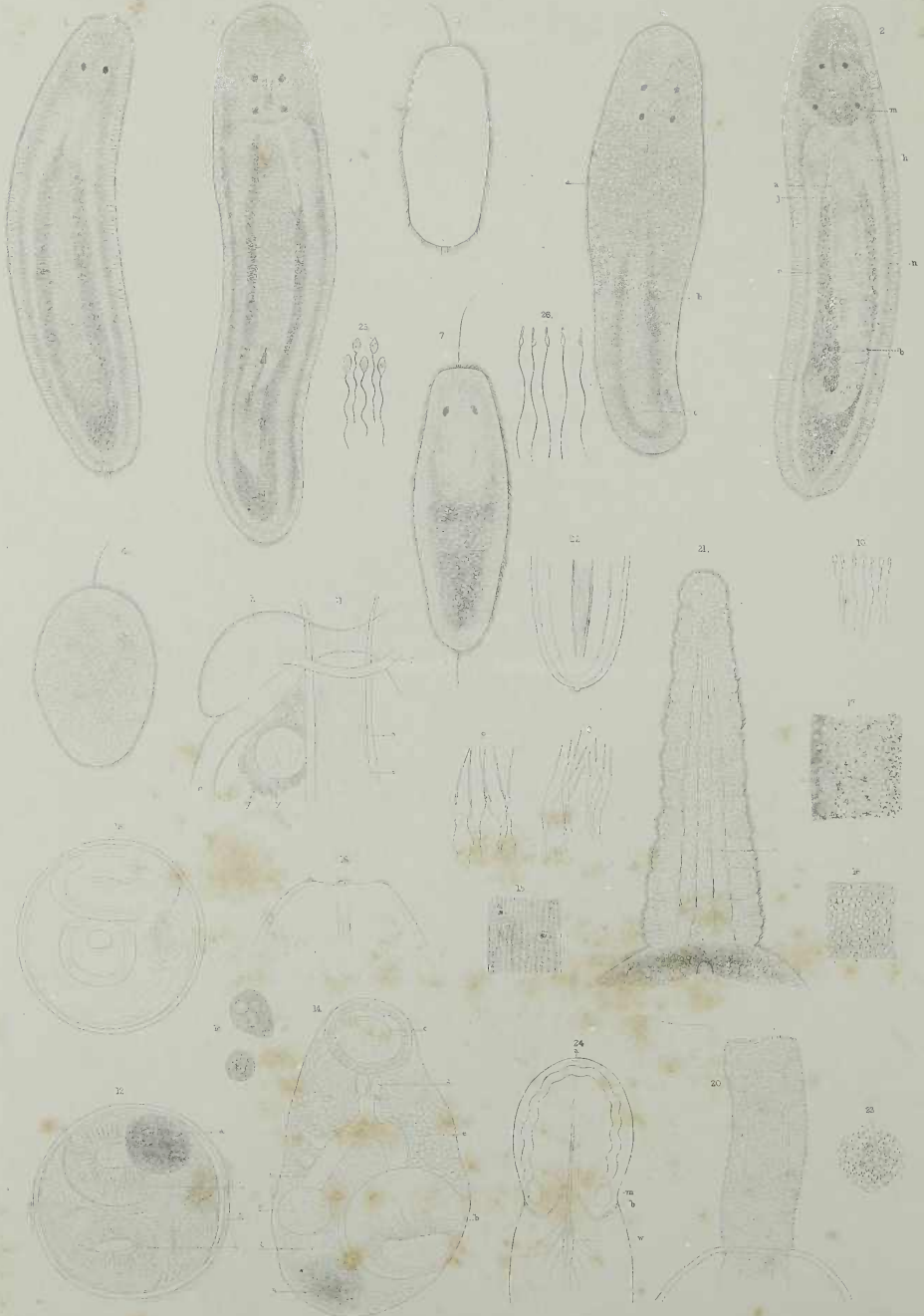






PLATE XVIII.

FIG.

1. Dorsal view of the head of *Lineus marinus* after long confinement. The blanching of the cutaneous tissues renders the eyes conspicuous. Magnified under a lens.
2. Ventral view of the same specimen exhibiting the mouth (*w*). Similarly magnified.
3. Profile of the same head, showing a cephalic fissure with its reddish coloration posteriorly.
4. Transverse section of the body-wall of *Lineus gesserensis*.  $\times 350$  diam.
5. Transverse section of the body-wall of *Lineus marinus* at a somewhat narrow portion. *d*, external cuticular layer; *x'*, pigmentary layer divided into two strata by a definite black band (2); 3, curious translucent stratum cut into regular spaces. Other letters as usual.  $\times 210$  diam.
6. Longitudinal section of the same tissues. 4, 4, sections of the transverse connecting trunks between the lateral and dorsal vessels; 5, granular stroma within the inner longitudinal muscular coat, supporting the former and various other tissues.  $\times 90$  diam.
7. Transverse section just behind the tip of the snout of *L. gesserensis*. The grouping of the pigment (3) readily enables the observer to distinguish the dorsal from the ventral surface; 2, powerful series of fibres arching over the channel for the extrusion of the proboscis, and radiating into the surrounding stroma (*k*).  $\times 55$  diam.
8. Transverse section somewhat behind the preceding, and through the anterior part of the cephalic fissures. The channel for the proboscis has become more central in position. The superior pigmentary belt (3) is somewhat narrower, and an inferior (4) has now appeared. The central channel has a layer of longitudinal muscular fibres internally, and a powerful series of oblique and circular fibres (2, 2) form a very efficient exterior investment.  $\times 55$  diam.
9. Transverse section of the cephalic ganglia of a smaller specimen than the preceding.  $\times 55$  diam.
10. Horizontal section of the snout of the same species through the ganglia, exhibiting the relations of the latter and the reticulations of the cutaneous tissues in front of them.  $\times 90$  diam.
11. Transverse section of a specimen of *L. gesserensis* (after spawning) a little in front of the tip of the tail.  $\times 90$  diam.
12. Elements from the glandular papillæ of the proboscis of the same species, after their escape into the water.  $\times 700$  diam.
13. Elements from the proboscis of *Micrura fasciolata*. Similarly magnified.
14. Portion of the inner surface of the proboscis of *L. gesserensis*, showing the glandular papillæ. Slightly compressed.  $\times 700$  diam.
15. Snout of *Cephalothrix linearis* with the proboscis slightly everted, so as to exhibit the acicular papillæ.  $\times 350$  diam.
16. Fragment of the wall of the proper digestive chamber of *L. gesserensis*. The cilia mark the inner surface.  $\times 350$  diam.
17. Parasitic ciliated animal from the tissues of the same species. The letters *a*, *b*, *c*, and *d* correspond with the groups of segments described in the text.  $\times 350$  diam.
18. The foregoing parasite at an earlier stage of development.  $\times 350$  diam.
19. The last-mentioned specimen subjected to slight pressure, so as to exhibit the segments.  $\times 350$  diam.

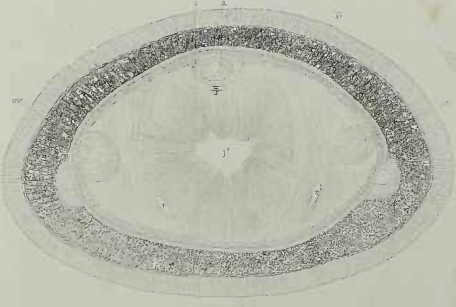
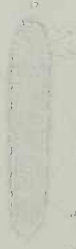
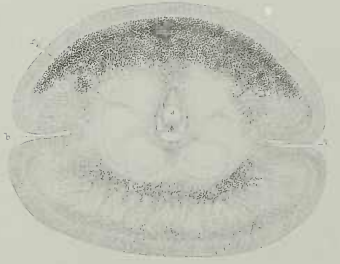
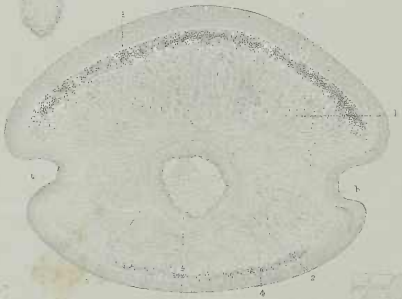
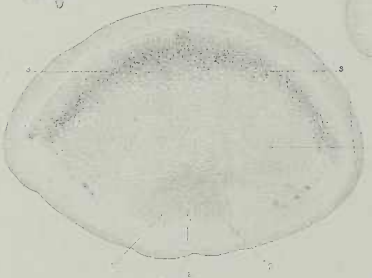
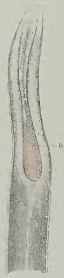
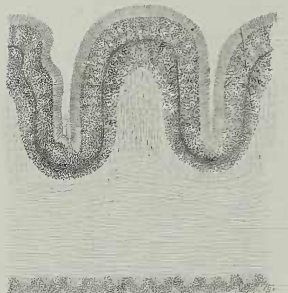








PLATE XIX.

FIG.

1. Enlarged view of the anterior region of *Lineus gesserenis*, as a transparent object.
2. Anterior portion of *Lineus sanguineus*. *y*, peculiar incurvation of the wall of the alimentary canal, marking the boundary between the œsophageal and the succeeding division of the digestive apparatus.  $\times 90$  diam.
3. Anterior portion of *Lineus lacteus*.  $\times 90$  diam.
4. Portion of the middle region of *L. gesserenis*, representing the arrangement of the vessels in the living animal. Considerably enlarged.
5. Arrangement of the vessels at the posterior extremity of the same species. Similarly magnified.
6. Posterior portion of a specimen of the same species having an unusually distinct anus (probably from partial repair after injury). *a*, mass of granular and cellular débris revolving in the direction of the arrow by aid of the elia of the digestive cavity; *b*, anus.  $\times 210$  diam.
7. Transverse section of the proboscis of *Borlasia Elizabethæ*.  $\times 210$  diam.
8. Transverse section of the proboscis of *Microgaster fusca*.  $\times 350$  diam.
9. Highly magnified view of the anterior end of *Cephalothrix linearis*. *ö, ö*, bridles of the sheath for the proboscis.
10. Gregariniform parasite from the digestive canal of *Lineus lacteus*.  $\times 350$  diam.
11. Outline of one of the same parasites after prolonged immersion in water.





PLATE XXII.

FIG.

1. Transverse section of the cephalic ganglia of *Lilineus gesserenensis*. The pale central portions are caused by the imperfect penetration of the fluid in mounting.  $\times 210$  diam.
2. Transverse section of the curious variety of *Carinella* from Balta. *d*, external layer of cutis; *d'*, basement-layer; *e*, longitudinal muscular layer; *e a*, dorsal subdivisions of the latter coat in the central line; *e'*, circular muscular coat; *j*, section of the œsophageal region of the digestive tract; *j a*, distinct band of muscular fibres enclosing the latter; *n*, lateral nerve; *o*, sheath for proboscis; *r*, vascular spaces.  $\times 55$  diam.
3. Transverse section of the post-ganglionic region of *Lilineus lacteus*, showing the long vascular lacunæ (*s, s*) in front of the œsophageal region. The slice of the proboscis has fallen out of its sheath (*o*).  $\times 90$  diam.
4. Anterior end of a contracted specimen of *L. gesserenensis*, turned round so as to exhibit the marked separation between the œsophageal region and the digestive cavity proper.  $\times 90$  diam.
5. Adventitious granular mass (*a*) in a longitudinal section of the dermal tissues of *Lilineus marinus*. *b, b*, spaces from which similar structures have fallen. Other letters as in previous figures.  $\times 210$  diam.
6. Aggregations of fatty granules from the discarded coating of the embryo of *Lilineus gesserenensis*.  $\times 210$  diam.
7. Anterior end of a fragment of *Lilineus sanguineus*, about three weeks after rupture. *a*, terminal aperture; *d*, cutaneous layers.  $\times$  about 40 diam.
8. Posterior end of the same fragment, similarly magnified. *z*, anus.
9. Anterior portion of a fragment in a more advanced condition. *d'*, developing proboscis; *h*, indication of ganglia.
10. Anterior region of a complete, or nearly complete, animal developed from a fragment; *j*, œsophageal division of the alimentary canal; *m*, cephalic pit and sac; *w*, mouth.
11. View of a similar specimen; the regenerated anterior portion, consisting of the head and the œsophageal region of the digestive chamber, is recognized by its pallor; *b*, cephalic fissure. Magnified under a lens.

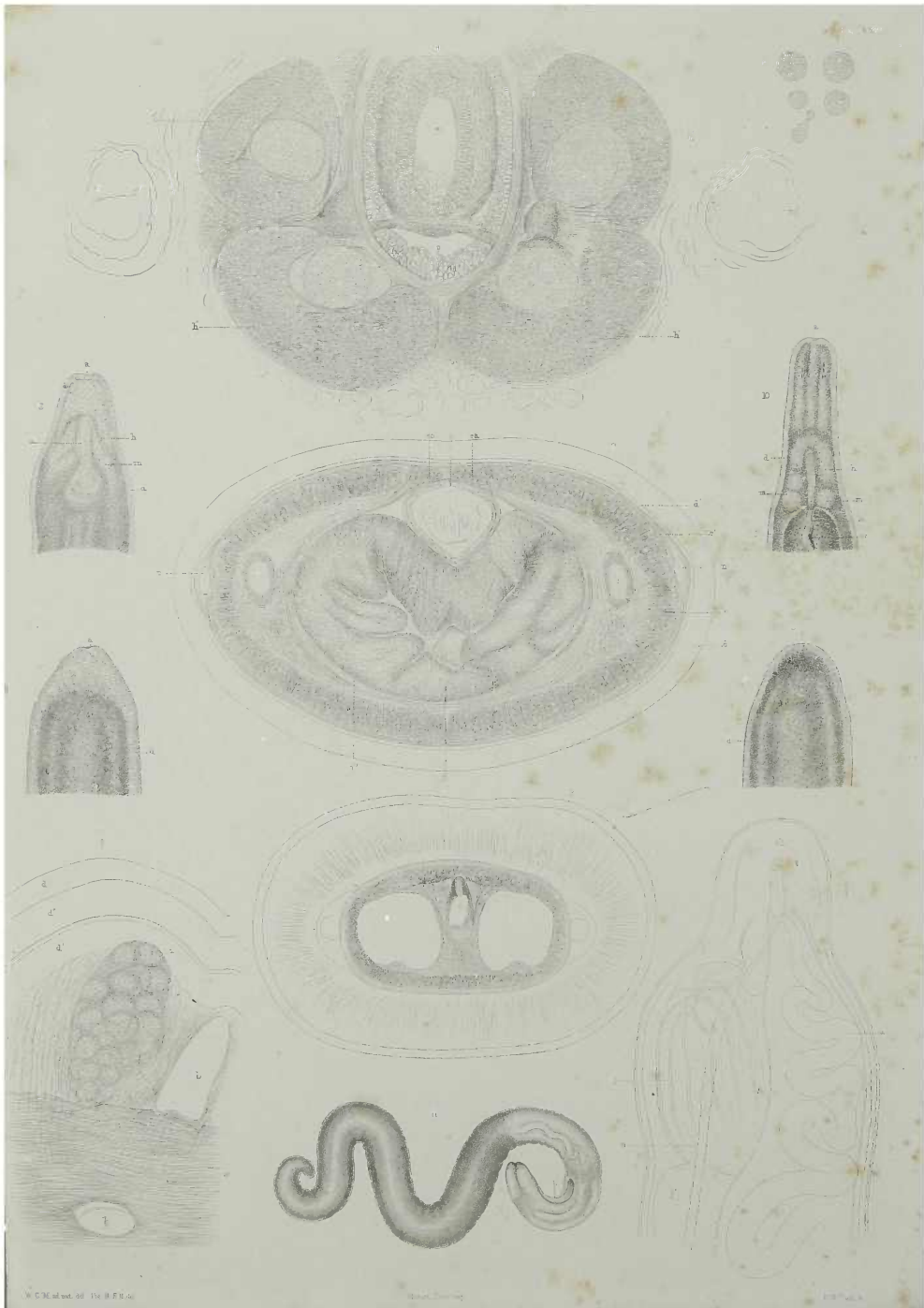


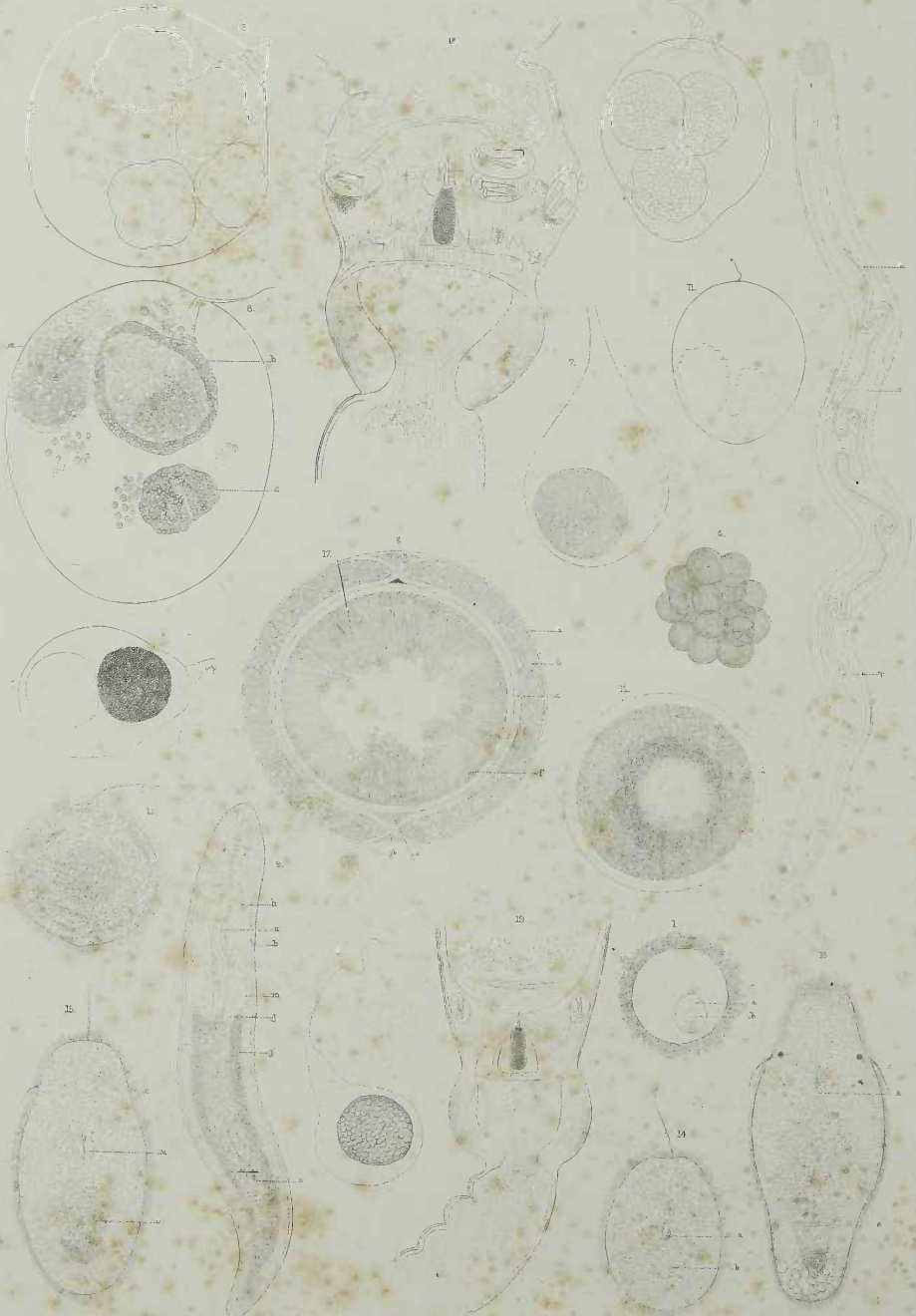


PLATE XXIII.

FIG.

1. Pale oily region with germinal vesicle (*a*) and germinal dot (*b*), in an ovum removed from the body of the female *Lineus gesserenis*. × 350 diam.
2. Flask containing two ova from the mucous cord of the same species after deposition. One is simply outlined, but the other is shaded to indicate the natural opacity. × 55 diam.
3. Flask on the second day, showing the yolk divided into four portions. × 55 diam.
4. Ovum some hours older and somewhat compressed, exhibiting the further subdivision of the yolk. × 55 diam.
5. Flask having its single ovum in the mulberry-stage. × 55 diam.
6. Flask containing three ova in the same condition. × 55 diam.
7. Flask having a ciliated embryo (about the 12th or 13th day); it remains in this condition some weeks. × 55 diam.
8. Flask enclosing two young animals, somewhat compressed. *a*, embryo forced from its ciliated cellulo-granular fatty coating, the bulk of which lies at *c*; *b*, embryo still within the ciliated coating. × 55 diam.
9. A young specimen of *L. gesserenis* immediately after leaving the flask; *b*, opening of the right-cephalic sac. × 90 diam.
10. Magnified view of a young example of the same species after it has attained a considerable degree of advancement. It still possesses only two eyes.
11. Flask from the mucous cord of *Lineus hyaricus*. The contained embryos are nearly disintegrated from decomposition. × 55 diam.
12. Ovum of *Cephalothrix linearis* immediately after deposition. × 350 diam.
13. Embryo of the same species shortly after extrusion from the egg. × 350 diam.
14. A young specimen, two days older than the preceding. *a*, mouth; *b*, granules of digestive cavity. × 210 diam.
15. An example about three days older than the last (fig. 14). × 210 diam.
16. A young specimen of *Cephalothrix linearis* after shedding the long anterior whip of cilia, but having the lateral tufts (*c*) and eyes. *a*, mouth; *b*, granules of digestive cavity. × 210 diam.
17. Transverse section of the proboscis of *Cerebratulus angulatus*, O. F. Müller. *ga*, the inner wedge of longitudinal fibres described in the text; *gb*, the outer band of longitudinal fibres. The other letters as usual. × 40 diam.
18. Stylet-region of *Amphiporus hastatus*, somewhat contracted. It has the same letters as other figures of the ENOPLEA. × 55 diam.
19. Stylet-region of *Amphiporus bioentatus*. × 55 diam.







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