FRANK BEDDARD

EARTHWORMS AND THEIR ALLIES

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Содержание

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PREFACE

The importance of earthworms in questions relating to geographical distribution is so universally admitted that it seemed to me convenient to embody in a short volume the principal facts.

It became necessary in order to accomplish this task in an adequate fashion to preface the distributional facts with some anatomical and zoological data. I have reduced this section of the book to a minimum and I trust that the illustrations will enable the reader, who is not specially acquainted with the structure of these animals, to obtain an idea of their general features and variability in external character and internal anatomy. While the use of technical terms is inevitable in presenting such details, it will be found, I think, that a reference to the figures will render them intelligible.

Since this volume mainly deals with the phenomena of distribution, I have included in my survey nearly all of the usually admitted genera of worms, particularly of the terrestrial forms, which are in the light of our present knowledge the more important in considering this subject.

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CHAPTER I
STRUCTURAL AND SYSTEMATIC

The group of segmented, bristle-bearing, worms, termed Oligochaeta by zoologists, comprises what are popularly known as earthworms together with certain forms, inhabitants of ponds, lakes and rivers, which are not so well known as to have received a more distinctive name than merely 'worms.' Their next allies are apparently the leeches and – a little more remote – marine bristle-bearing worms termed Polychaeta; the three groups, together with perhaps a certain number of other forms belonging to smaller groups, constitute the Annelida which are a distinct and separate assemblage of invertebrate animals.

The most interesting features about these Oligochaetous worms are their very great anatomical variation and the facts of their distribution over the globe. Their importance as geological agents in levelling the ground was made known a long time ago by Darwin, and that aspect of earthworms has remained in much the same position as Darwin left it. We shall concern ourselves here only with the structure, habits, and range of the earthworms and their immediate allies, the aquatic Oligochaeta. These three aspects of the animals dovetail into each other more thoroughly than is the case with some other groups. This is due to the fact that they have of late years been very thoroughly studied from the anatomical and distributional side. So lately as 1889, M. Vaillant in a very comprehensive treatise was only able to enumerate 369 species, of which a large number were but incompletely differentiated, and some are no longer admitted. There are at the moment of writing perhaps 1500 species, the vast majority of which are well known owing to careful investigation. Furthermore there are but few parts of the world, and these are not of large area, from which earthworms at any rate have not been gathered. Though there can be no doubt that a very considerable number of species await discovery, it would seem that we are in possession of information which is not likely to be seriously affected by future researches.

The Anatomy of Earthworms

Although it is not contemplated to make the present volume a guide to the structure of this group of worms, it is necessary to give some little anatomical sketch of the group in order first of all to illustrate their diversity of structure, secondly to give reasons for the classification of them, and thirdly to enable the reader to realise certain structural details which it is absolutely necessary to give some account of in order to explain other matters.

It is for example impossible to attempt any account of the fitness of some of these animals for their terrestrial life and of others for an aquatic life without treating of anatomy to some extent.

I shall take one particular species as a type and indicate later the principal divergencies shown by other forms. According to the general opinion among those who have studied the Oligochaeta I take as a representative form a Megascolecid (this and the other families are dealt with *seriatim* on p. 14 et seq.), as this group is presumed to be the oldest, and within that group a representative of the genus *Notiodrilus* which is with some reason held to be the most primitive genus in the group. Finally I have no particular reason for selecting the species *Notiodrilus tamajusi* except that there happens to be a longer and fuller description of it than of many.

This earthworm is a native of Guatemala and is some six inches in length with a diameter of perhaps a quarter of an inch. The front part of the body is thicker than posteriorly. The body will be seen to be divided into some 218 rings by circular furrows which run right round the body. These divisions are termed segments or somites. At the head the mouth is surrounded by the first of these, and on the dorsal surface of that segment is a projection like an incomplete segment which is known as the prostomium. From the XIIIth segment to the middle of the XXth the body has a different appearance, and this region is known as the clitellum. Each of the 218 segments of the body except the first, and possibly one or two at the hinder end, is furnished with eight minute projecting bristles, the setae; these are disposed in pairs and all lie upon the ventral aspect of the worm. The movement of these by special muscles aids in locomotion.

An examination with even a hand lens shows a number of external pores which are important. Anteriorly there is the mouth which is overhung by the prostomium referred to above. At the extreme hind end – and surrounded by the last segment of the body – is the vent. Along the middle line of the back are a series of pores, one just at the very anterior edge of each segment, through which, when the worm is dried and then slightly pressed, liquid is seen to be ejected. These are called the dorsal pores and they belong one to each segment with the exception of the first seven, or – in some cases – more, segments. In front of one or other of the pair of setae which is situated most laterally, *i. e.* furthest from the ventral median line, is an orifice on each side in all but the first one or two segments of the body. These paired pores are the external outlets of the excretory organs frequently termed on account of their regular repetition with the segments 'segmental organs,' but more conveniently to be named nephridia. In the clitellar region and in fact on each of the segments XVII, XVIII, XIX are a pair of pores of which those on the XVIIIth segment are the least conspicuous. The large pair of pores on each of segments XVII and XIX occupy the position of the ventralmost pair of setae, which are here absent, or rather replaced by a very long curved and ornamented seta, which projects out of the orifice. These two pairs of pores are the outlets of the prostatic glands as they have been termed. The minute pair of pores on segment XVIII do not take up the position of the ventral setae; for these are present and to the inside of each pore. A groove, shaped something like a reversed 3 or the Greek letter Σ, connects the orifices of each side of the body, the middle part of the groove, where the two semicircular halves of which it is composed meet, coinciding with the minute pores on segment XVIII which are the orifices of the sperm ducts.

On segment XIV are a pair of very minute pores a little in front of the ventralmost setae and thus very near together. These are the openings of the oviducts. Finally, near to the anterior border-

line of segments VIII and IX and on a line with the ventral pair of setae is a pore on each side through which the cavity of the spermathecae reaches the exterior.

So much then for the external characters of our worm. We next turn to the internal anatomy. When the worm is opened by a longitudinal section from end to end, and the two flaps of skin are turned outwards and pinned down, the internal structure is almost completely revealed. Running from end to end is seen the alimentary canal; the general cavity of the body (coelom) in which it lies, as do of course the other organs to be enumerated, is seen to be divided by cross divisions, the intersegmental septa, into a series of chambers which correspond with the external division into segments. The septa are in fact inserted on to the body-wall along the furrows which mark the divisions between adjacent segments. Anteriorly the large pharynx is responsible for confusing the arrangement of the septa, which become subdivided and fused or are prolonged a greater way backwards and thus present a less obviously segmental disposition. Certain of the more anteriorly placed of these septa are much thicker than the rest. This is the case with the septa which separate segments V to XII. The alimentary canal is perfectly straight and runs in the middle line, being supported by the septa which it perforates. The mouth leads into a buccal cavity which later becomes the pharynx, a portion of the tube which is much thickened by muscular walls dorsally. Then follows a very short section of the oesophagus and in the fifth segment this becomes the gizzard, a very characteristic organ with thick muscular walls quite smooth and with a very thick lining of structureless membrane. After this is a narrower tube, the rest of the oesophagus. Into this open in each of segments VII, VIII, IX a pair of calciferous glands; these are diverticula of the gut with much folded walls, the cells of which secrete carbonate of lime. In the XIIth segment or so, the oesophagus suddenly widens out to form the intestine which runs as such to the end of the body. This wider tube has a ridge running along its dorsal side, the typhlosole. Along the dorsal surface of the intestine and the oesophagus is seen a red tube, contractile during the life of the worm, which is the dorsal blood vessel and whose contained blood is coloured red, as is the blood of vertebrated animals, by haemoglobin. But in the earthworm the colouring matter is not situated in corpuscles as in the vertebrate. The dorsal vessel is connected by a few pairs of equally contractile transverse trunks with a ventral vessel which is not contractile. There are other branches of these main longitudinal trunks and some minor longitudinal trunks which we shall not stop to describe further. The nervous system of the worm consists of a pair of ganglia which lie above the gut in the third segment; they are connected by a commissure running round the gut with a chain of closely fused pairs of ganglia, one for each segment to the very end of the body. In each of the segments, except the first two or three, there are a pair of excretory organs known as nephridia; these are essentially coiled glandular tubes opening on to the exterior by the regularly placed pores already referred to in considering the external characters. The tube ends in a funnel-shaped, and therefore dilated, mouth, which opens into the segment in front of that which contains the rest of the organ; a nephridium therefore lies in two segments. The only other important organs which are left for consideration are those devoted to the reproduction of the species. The essential organs are the spermaries and the ovaries. Of the former there are two pairs of minute whitish bodies which lie in segments X and XI on either side of the nerve cord attached to the anterior septal wall of their segments. The ovaries are not in the following, but in the XIIIth, segment, and occupy an identical position in that segment. A short tube with a funnel or trumpet-shaped and wide orifice opens into the cavity of the XIIIth segment opposite to each, and, perforating the septum, opens on to the exterior on the XIVth segment. A similar but larger and more folded pair of trumpet-shaped funnels opens in the same way opposite to each spermary. But in this case the two tubes of the sperm ducts run backwards for some way and those of each side after joining open on to the XVIIIth segment by the pores already mentioned. On the XVIIth and XIXth segments open two glands which are long and tubular in form and much coiled. These are the spermiducal glands and each opens in common with a muscular sac containing the long and ornamented seta referred to in describing the various external orifices. It will be noticed that the sperm duct has no direct connection with these glands

but only indirectly through the external gutter which connects the three male orifices of each side of the body. Segments IX-XII inclusive contain certain sacs which depend from, and are formed as outgrowths of, the septa of those segments. These are the sperm sacs in which the male germ cells undergo their development. A corresponding body (but very much smaller) is sometimes found in relation to the ovary but has not been actually described in the particular species dealt with here. Finally, in segments VIII and IX are a pair (that is four altogether) of roundish sacs, with two or three minute diverticula, known as the spermathecae. In the diverticula of these sacs are stored the sperm derived from another individual.

This completes the general sketch of the structure of *Notiodrilus tamajusi* which we have selected as a type. In this same genus are a large number of species which differ from that selected in various small structural points. Thus in *N. annectens* (Beddard), a species from New Zealand, the spermaries and ovaries are attached to the posterior, instead of to the anterior, wall of their segments, and there are neither calciferous glands nor modified setae upon segments XVII and XIX. In all essentials however the two types agree and are thus to be looked upon as referable to the same genus. Starting from the structure of these types we may now sketch in quite a brief way the main divergencies of structure shown in the group of Oligochaeta.

We shall naturally begin with the family Megascolecidae of which a type has just been described.

Within the limits of the same sub-family as that which contains *Notiodrilus*, *i. e.* the Acanthodrilinae, the changes of structure affect all the principal organs of the body except the nervous system, but are not very large and vary from genus to genus. They are mainly perhaps in the direction of reduction and simplification. Thus in *Chilota*, *Maheina* and *Yagansia* the spermaries are reduced to one pair in either the Xth or XIth segment, while in *Yagansia* one pair of spermathecae and of spermiducal glands have also disappeared. In *Microscolex* the spermaries remain normal, but one pair of spermathecae and of spermiducal glands have disappeared, the remaining organs of these series being in the IXth and XVIIth segments respectively. In *Microscolex*, *Chilota* and *Yagansia*, moreover, there is a further degeneration in the disappearance of the calciferous glands. These glands are often absent and sometimes less developed in the New Zealand *Maoridrilus*, which is otherwise not a degenerate form and differs characteristically from *Notiodrilus* by the fact that the paired nephridia alternate in position in successive segments, being now in front of the dorsal, and in other segments in front of the ventral, pairs of setae. While these genera are somewhat degenerate, the New Zealand *Plagiochaeta* has undergone specialisation in an upward direction. For the setae of each segment are increased to a large number much exceeding eight.

It is not a long step to the sub-families Diplocardiinae and Trigastrinae. In the first of these, an American race confined to the northern and central parts of that continent, the male pore shows a tendency to move backwards, being situated on any of segments XVIII-XXI. The two spermiducal glands follow it, but are always placed one pair in front and one behind, as in *Notiodrilus*. In this group we get a new feature of specialisation in the duplication or triplication of the gizzard.

So too with the Trigastrinae where there are either two or three gizzards; but in this sub-family another modification has become apparent. The paired nephridia have disappeared and their place is taken by several, often quite numerous, pairs of much smaller nephridia called on that account 'micronephridia' instead of 'meganephridia.' To this sub-family belong the especially African but also American and Malayan *Dichogaster*, whose name is derived from the important fact that it possesses two gizzards.

Not far off is to be placed another sub-family, that of the Octochaetinae, which is New Zealand and Indian in range, the intermediate countries being, strange to say, not populated by this race of Oligochaeta. The group contains several genera of which *Octochaetus*, *Eutyphoeus*, and *Dinodrilus* are the best known. All these worms agree in the main features of their anatomy with *Notiodrilus*; but they have diverged in different directions. Thus in *Octochaetus* the typical two pairs of gonads and

glands belonging to the generative system have been retained, while the nephridial system consists of micronephridia; in *Eutyphoeus*, one pair of spermiducal glands has disappeared, and as a general rule the species of this genus have only one pair of spermaries and the corresponding pair of sperm ducts. They are close to *Octochaetus*. The third genus mentioned, *Dinodrilus*, is a New Zealand form specialised in possessing 12 setae in each segment. Otherwise it is not far removed from *Octochaetus*.

A fifth sub-family is also easily referable to the type whose structure has been dealt with as a preliminary to the present survey. That sub-family is the Ocnerodrilinae which is American and African in range. These worms are somewhat degenerate in comparison with their allies. Thus the calciferous glands are reduced to a single pair or to a single gland in the IXth segment, the nephridia though regular and paired have no covering plexus of blood vessels, and the worms themselves are slender and delicate, being indeed often aquatic in habit. The spermiducal glands, which are as in the former sub-families independent of the sperm ducts though sometimes opening in common with them into a short pocket-like ingrowth of the skin, are reduced in their minute structure and much simpler than in the other types.

The genus *Kerria* is the least reduced perhaps. It has the male pores on segment XVIII with a pair of spermiducal glands on the segments preceding and following this in the typical Acanthodriline fashion. There are two pairs of spermathecae in VIII and IX, but the spermaries are reduced to one pair in X. The gizzard is present. Ocnerodrilus is a little further reduced from this last. The gizzard has gone; there is but one pair of spermiducal glands (as a rule) opening in common with the extremity of the male duct on to segment XVII; the spermathecae also are reduced to one pair, but there are two pairs of spermaries. The African *Nannodrilus* is more robustly built. There are two gizzards, the male duct opens into a muscular pouch, into which also open one of the two or three pairs of spermiducal glands. There are two or three other genera and sub-genera not showing any great divergencies from the range of structure indicated in briefly defining those enumerated above.

Finally, we have the largest of all the sub-families of this family, viz. that of the Megascolecinae. These worms are mainly tropical in range and also mainly found in the Indo-Australian portion of the world. In them the sperm ducts open in common with the usually single pair of spermiducal glands and prevalently upon the XVIIIth segment. The glands moreover have not always, though they often have, the tubular form shown in all the sub-families hitherto considered. In many forms they are branched and lobate glands, and if there are two pairs one may be of one type and the other of the second and derived type, as for instance in *Megascolex ceylonicus*. Furthermore, it is much commoner among the genera of this sub-family for the setae to become numerous and to spread right round the segment; this condition is seen in the genera *Pheretima*, *Megascolex*, *Diporochaeta*, *Perionyx*, *Plionogaster*. The spermathecae also are commonly more than the typical two pairs of the forms already considered, and in certain species (for example *Pheretima hexatheca*) there are as many as six pairs of those organs which are moreover – and in this they resemble the majority of species of the last sub-families – nearly always furnished with a diverticulum or diverticula. The nephridia are either paired or numerous and these various characters allow of the sub-family being split up into sixteen genera or thereabouts.

As an example of another type of organisation and as contrasting with *Notiodrilus* we may now briefly describe the structure of the genus *Pontoscolex* (better known as *Urochaeta*), a member of the American and African family Geoscolecidae.

The worm is some four inches long and composed of as many as 212 segments. Each of these except the first has eight setae which for the first few segments of their occurrence are disposed in four pairs in the usual fashion. Behind this point however the setae cease to present this symmetrical arrangement and are irregularly disposed so that a given seta is not in the same line with the corresponding seta of the segments in front or behind. There is thus no region of the body which has not a seta implanted upon it; and the effect is therefore comparable to the condition obtaining in those worms, such as *Pheretima*, where circles of numerous setae are met with. There are however only

eight in a given segment. The clitellum extends from segment XV to XXII or XXIII and is developed only dorsally and laterally. It has setae like the rest of the body; but those upon the clitellum are longer and more markedly ornamented than are those of the body generally. The latter are not only sculptured with fine ridges but are bifid at their free extremity. The prostomium is often apparently completely absent. It is however really present but is retractile. As to the pores which are visible externally the dorsal pores are completely absent. The pores of the nephridia lie in front of the dorsal pair of setae or in a line corresponding to the position of those setae where the arrangement has become irregular. The spermathecal pores are three pairs and are in the very front of segments VII, VIII, IX. The male pores, very inconspicuous, lie on the ventral side of segment XXI just within the clitellum. The oviducal pores are on segment XIV.

As to internal anatomy the general plan of the segmentation shows no great differences. Certain septa only show a difference, *i. e.* those separating segments VI-XI which are specially thickened. In the alimentary canal a gizzard in segment VI is to be noted and three pairs of calciferous glands in segments VII-IX. The nephridia are paired structures and commence early. The first two or three segments are occupied by a pair of large glands opening into the buccal cavity which are apparently a slightly modified pair of nephridia and are generally termed 'peptonephridia' since they are associated, as it would appear, with the function of alimentation and are not purely excretory organs. There is but a single pair of spermaries in segment XI, and of ovaries in segment XIII. The sperm ducts open on to the exterior in the position already mentioned and they are not associated at their pore with any glands comparable to spermiducal glands. A pair of sperm sacs depend from segment XI and traverse a considerable number of segments, being thus long and tongue-shaped instead of short and limited to one segment. The spermathecae are three pairs of elongated sacs in segments VII-IX, without any diverticula at all.

It will appear therefore that many and considerable differences divide *Pontoscolex* from *Notiodrilus* and indeed from all of the Megascolecidae whose structure has been touched upon in the foregoing pages. The most important of these are the ornamented setae and their arrangement and the modification of the setae upon the clitellum: the absence of diverticula to the spermathecae: the absence of terminal glands associated with the male ducts. Although taken in their entirety these characters are distinctive of the American Geoscolecidae (sub-family Geoscolecinae), there is no one of them which is not to be found in some Megascolecid. Thus the subgenus *Ilyogenia* (of *Ocnerodrilus*) has sometimes no spermiducal glands: the genus *Perionyx* has spermathecae without diverticula in some species, and other genera of Megascolecinae are in a like condition. The setae of *Dichogaster* are sometimes ornamented, while in *Pheretima houlleti* the clitellar setae are different from those upon the other segments.

We can in fact only define the family Geoscolecidae by an assemblage of characters which are mainly these: dorsal pores absent, only a few in the neck region being occasionally present; setae generally ornamented, those of the clitellum being larger and more marked than the others; spermathecae without diverticula; often instead of a pair of those pouches in the segment a large number of very small sacs, as in *Microchaeta*, *Kynotus*. Sperm ducts without terminal glandular or muscular sac, except in a few cases; setae always eight in a segment except in the genus *Periscolex* which has acquired the 'perichaetous' condition. The range of variation shown in the anatomy of the Geoscolecidae will be best taken in connection with the several sub-families into which it has been subdivided. In the first of these, the Geoscolecinae, no great differences divide the genera from that selected as the type, viz. *Pontoscolex*. The long sperm sacs attain to an extraordinary length in *Trichochaeta* (or *Hesperoscolex*) where the single pair extends through no less than 109 segments. Though as a general rule the sperm ducts open directly on to the exterior they do so through the intermediary of a large pouch in *Glossoscolex* (= *Titanus*). In *Onychochaeta* the setae on the last segments of the body are very much enlarged and thus form a more effective means of holding on to the soil than is possessed by other species.

The sub-family Hormogastrinae which contains but a single genus *Hormogaster* is remarkable for being limited in range to the Mediterranean coasts. The genus is mainly distinguished by possessing three gizzards; otherwise it is not very different from the sub-family just described. The African and Madagascar forms are associated (together with a few Asiatic forms) into a third sub-family Microchaetinae. These worms frequently possess a considerable number of very small spermathecae in segments XII, XIII or thereabouts instead of the usual paired arrangement. They have too very often glands connected with the enlarged setae already mentioned which are however (in the genus *Kynotus* at any rate) usually in front of the clitellum. The latter organ, contrary to what we find among the Geoscolecinae, is often behind the point of orifice of the male pores. This is so with *Kynotus*.

The last sub-family, Criodrilinae, has but three genera *Criodrilus*, *Sparganophilus* and *Alma*. These worms do not show any very marked differences from other Geoscolecids. *Alma* is noteworthy for the facts that the male pores are borne upon long processes of the body which bear specially modified setae and that one species at any rate has gills.

Another type of structure is offered by the Eudrilid earthworms which form rather a restricted family. These worms are as a rule quite easy to distinguish by their external characters only. For the apertures of the spermathecae and sperm ducts are apt to be very large and conspicuous. They are also generally unpaired, a character which is however not confined to the Eudrilidae; for there are Megascolecids, such as *Fletcherodrilus*, and Geoscolecids in which the same unpaired character occurs. The principal feature of the family is that the ovaries are commonly enclosed in sacs – comparable to the sperm sacs which frequently envelop the spermaries in other earthworms – and that these sacs not only contain the mouths of the oviducts but are directly continuous with the single or double spermatheca. This is usually a large sac, always single or consisting of one pair only, which opens on to the exterior close to the oviducal pores; these spermathecae in the Eudrilidae are not comparable to the spermathecae of other earthworms; for they are in a way comparable to the sperm sacs, being formed as outgrowths of the septa. There is some variation of structure within the family. In a number which are associated into a sub-family Eudrilacea there are two paired calciferous glands and a single unpaired one, while the paired nephridia open by a large pore on to the exterior. In a parallel sub-family, the Pareudrilacea, the calciferous glands are apt to be more numerous and have a totally different structure: they have been apparently converted into non-digestive glands bearing some relation to the vascular system. The nephridia moreover do not open on to the exterior by single pores, but form a network within the thickness of the body wall and then open by numerous pores. There is however no resemblance here to the micronephridia of *Dichogaster* and other Megascolecids. In *Libyodrilus* (as an example of the Pareudrilacea) each nephridium forms a network out of the duct leading to the exterior. In the interior of the body a series of paired meganephridia are visible.

The earthworms of Europe belonging to the family Lumbricidae offer again a rather different type of structure, which is more reminiscent of the Geoscolecidae than of the Megascolecidae or Eudrilidae. In this family there are no glands appended to, or in the neighbourhood of, the orifices of the sperm ducts, such as are found in the other forms. As in the Geoscolecidae the clitellum is furnished with setae somewhat different in form from those which deck the body generally. These setae are never more than eight in a segment. Dorsal pores (absent in Geoscolecidae and in Eudrilidae) are invariably present. The spermathecae are without appendices and nearly always simply paired, though rarely we get numerous much smaller spermathecae in a single segment, as in *Kynotus* among the Microchaetine Geoscolecids. Internally the most striking feature of this family is to be seen in the position of the gizzard at the end of the oesophagus and at the beginning of intestine. The apertures of the male pores are – save for two or three exceptions where they are further forward – invariably upon the fifteenth segment, and the clitellum, often very long, usually begins behind this point, features which are also seen in *Kynotus*.

Finally we have the Moniligastridae which differ from all the types hitherto considered in a few rather important particulars. These worms are named on account of the fact that they possess several gizzards upon the oesophagus, a character which is however met with in the Megascolecid genus *Plionogaster* and in certain Eudrilids, *e. g. Hyperiodrilus*. The main peculiarity of the family is that the sperm ducts are very short and open on to the next segment to that which contains the spermaries, as in the water-living Oligochaeta generally. The terminal sac into which the male ducts open is moreover rather like that of such a family as the Lumbriculidae.

The Aquatic Families of Oligochaeta

It would seem to be quite possible that when the fresh waters of the world have been as well examined for Oligochaeta as have so many parts of the land areas, the number of purely aquatic Oligochaeta will be found to equal those inhabiting the land. In any case we are quite justified at the present moment in stating that there are rather more families of these smaller Oligochaeta than there are of the bulkier terrestrial forms. But while there are certainly seven or eight distinct families, these do not between them contain at present so many genera as do the fewer families of earthworms; and the number of species of the latter that are known to science enormously exceeds that of the 'Limicolae' as the fresh-water worms were at one time called in common. The fact that there are purely marine forms of these water worms was hardly appreciated at the time that the term Limicolae was used; now however we are acquainted with a few such forms, and even with some which live at will in either fresh, salt, or brackish water. Of these something will be said later.

These forms have also been collectively treated of as Microdrili, a term which expresses the undoubted fact that they are all of small size and sometimes even minute; others however reach the dimensions of the smaller species of earthworms. There are a certain number of characters shared by the various families which may be considered first of all, before dividing them into their several subdivisions. These aquatic Oligochaetes are usually tender and transparent, the muscular layers of the body wall being much reduced as compared with the tougher terrestrial forms. The clitellum is also thinner and consists of a single layer of cells only, thus contrasting with the double layered clitellum of earthworms. As a rule the alimentary tract is simplified, there being no gizzard or glandular appendices of the oesophagus comparable to the calciferous glands of most earthworms. But this rule is not without exceptions; for we find in *Haplotaxis* a gizzard occasionally developed, and in the remarkable genus *Agriodrilus* from the Baikal lake a continuous gizzard formation along the oesophagus, while the Enchytraeidae may show something very like calciferous glands: and even a Tubificid, called by Pierantoni *Limnodriloides*, has a pair of diverticula of the gut.

Other internal organs show certain points of likeness in all or in the great majority of the aquatic families. Thus the nephridia are without a plexus of blood capillaries surrounding them, a state of affairs which also occurs in some of the slender Ocnerodrilinae among the earthworms. These paired organs also are very frequently not found in the anterior segments of the body and these include also as a general rule the segments in which the reproductive elements are formed. Save for an exceptional case among the genera of Enchytraeidae the dorsal pores are not found among the Limicolae, but in some cases at least a single pore, the head pore, is found. The sperm ducts, which among earthworms usually (and indeed always save in the anomalous Moniligastridae) traverse a considerable number of segments on their way from the internal opening into the body-cavity to the external pore, do not show the same phenomenon among the Limicolous Oligochaeta. They are sometimes indeed limited to a single segment, that is to say the funnels and the external pore lie in one segment. In other cases they open on to the exterior in the segment next to that which bears the funnel, and it is only rarely that they traverse more than one segment. There are also points of difference of general applicability to be noted in the sperm sacs and egg sacs. The latter are large and extensive, which is not the case among earthworms, and the former are as a rule more extensive in the number of segments that they occupy than among the terrestrial forms. Another difference which they show is that their cavity is quite simple and not divided up by trabeculae into numerous intercommunicating chambers as in the earthworms. Finally the eggs of the aquatic Oligochaeta are large and full of yolk and thus contrast with the very small ova of the earthworms which are moreover much more abundant. These features are either of general or universal occurrence and together form an assemblage of characters which mark out the aquatic families of Oligochaeta from their, at least mainly, terrestrial allies.

We may also refer to certain structures which although not universal among these aquatic families are nevertheless found only in them – that is, are not found in any family of the terrestrial worms of this order. The most salient of such characters are the long and hair-shaped setae tapering to a fine point and often provided with a series of delicate branches like a feather; such setae are often of very great length and they occur in their various modifications among the Aeolosomatidae, Naididae, and Tubificidae. It is clear that these delicate setae, though they may not be due in any way to the aquatic life, are rendered possible by it. To drag such tender processes through stiff clay would surely break and tear them out. It may be also mentioned that among the aquatic families as a rule the intersegmental septa do not show that thickening in some of the anterior segments of the body which is so general a feature of the land-dwelling species. Finally it is only among the aquatic forms, and among them only in the families Aeolosomatidae and Naididae, that asexual reproduction by budding takes place. Indeed so common and usual is it in the genera of these families that even yet there are considerable lacunae in our knowledge of the organs of reproduction in the said families.

Together with these general similarities are many points of structural difference among the worms inhabiting ponds, lakes, and rivers, which allow of their being divided into a number of quite distinct families.

One of the most distinct of these families and lying in any case quite at the base of the series is the family Aeolosomatidae which includes a number of distinct species of delicate and transparent worms, and in whose integument are embedded round cells bearing a large brightly coloured oil drop; this is reddish or green in colour, or – and this more rarely – colourless, but still recognisable as an oil drop. The green sometimes even verges upon blue on the one side and yellow on the other, while the red may approach brown or purple. These worms are assigned for the most part to the genus *Aeolosoma* which is found in all of the great continents and of which seven or eight species are known. To a more doubtful genus *Pleurophleps* are assigned a few small worms which have the general appearance of *Aeolosoma*, but are without the coloured or colourless oil drops in the skin. These worms have a very large prostomium which is ciliated on the lower surface, and the body is not markedly segmented externally by constrictions or internally by septa. The bristles are slender and hair-like, but among them are in some species the shorter stouter bristles bifid at the free tip, which are so general among the aquatic families of the Oligochaeta. These worms are not uncommon objects in pools containing weed; and they are to be found usually crawling among the weed. They consist as a rule of but few segments to most of which a pair of nephridia belong. The ovaries and the spermaries are only known in a few forms and appear to be unpaired and lie respectively in the fifth and sixth segments. There are 1-3 pairs of spermathecae, and the sperm ducts if distinct from, are at least very like, nephridia. The ova appear to make their way to the exterior by a large aperture in the ventral middle line of a middle segment of the body. The vascular system contains uncoloured blood and is greatly simplified.

The next family to the Aeolosomatidae in zoological position is clearly the Naididae. These are also small worms, but show in some respects a higher grade of organisation than their allies. While asexual generation is general, the reproductive organs are more commonly found than in *Aeolosoma*, though there are still many hiatus in our knowledge of the same in certain genera. Where they are known it has been found that the spermaries and ovaries are very far forward in the body, in the fifth and sixth segments respectively. The spermathecae are in segment six and the male ducts open into a terminal chamber, called 'atrium,' which is on the whole not unlike that of the Tubificidae. The blood in these worms is red as in the higher types, and thus differs from that of the genus *Aeolosoma*. The setae are rather varied, being in some cases long and slender, sometimes greatly exaggerated in length as in *Ripistes*; other setae are forked at the free end, and in *Paranais* this is the only kind of setae met with. A marked feature of this family is that the dorsal bundles of setae do not always begin like the ventral setae upon the second segment of the body. Indeed in *Schmardaella* there are no bundles of dorsal setae at all. The Indian genus *Branchiodrilus* is remarkable for the fact that it has paired

processes of the body which may be termed gills and which in some segments involve the dorsal setae. Another kind of gill is found in the genus *Dero* (which has many species) and in the allied *Aulophorus*. These are placed round the vent, and are ciliated. Other genera are *Nais*, *Chaetogaster*, *Vejdovskyella*, *Amphichaeta*, *Stylaria*, *Macrochaetina*, *Pristina*, *Naidium*.

Several genera, *Pristina*, *Nais*, *Dero*, are found in many parts of the world; but it is not possible at present to consider very seriously the facts of their geographical distribution.

Next to the Naids a group of aquatic worms present themselves for consideration which are usually placed in three distinct families, which families are however rather hard to define. These three families are the *Tubificidae*, *Phreodrilidae*, and *Lumbriculidae*. The Phreodrilidae were at one time placed with the Tubificidae by Michaelsen. It is now perhaps the general opinion that they form a family of their own, at any rate since the discovery of two other genera *Phreodriloides* and *Astacopsidrilus*, besides the original genus founded by myself, and named *Phreodrilus* from the fact that the species was found in a deep well in New Zealand.

The distribution of this family especially of the genus *Phreodrilus* is extremely interesting. The genus *Phreodrilus* is the only one genus of the aquatic Oligochaeta which has, like *Notiodrilus*, a circumpolar range, the pole being the south pole. It occurs in New Zealand, in Kerguelen, and, if we are to accept the opinions of Drs Michaelsen and Benham that my genus *Hesperodrilus* is to be merged in *Phreodrilus*, in Patagonia also.

In this genus the male pores are upon the XIIth segment while the spermaries lie in segment XI. Moreover the spermathecae lie behind the male pores. In the Tubificidae on the other hand it is at least the rule for the spermaries and male pores to be pushed a segment further forwards. And the spermathecae are before the male pores. *Phreodriloides* is like *Phreodrilus* but has no spermathecae. It is also New Zealand in range. *Astacopsidrilus* is Australian and is semi-parasitic upon the Crayfish *Astacopsis*, whence its generic name. *Phreodrilus branchiatus* is one of the few forms of Oligochaeta that possesses gills. Of these there are a series of pairs on about the last eleven segments of the body. They are lateral in position, and thus contrast with the also gilled *Branchiura sowerbii*, where the gills, also on the posterior segments of the body, are more numerous and lie dorsally and ventrally, a pair to each segment.

The Tubificidae differ from the Phreodrilidae mainly in the points already noted. There are a considerable number of genera of which the following are the best known, viz., *Tubifex*, *Limnodrilus*, *Limnodriloides*, *Branchiura*, *Lophochaeta*, *Ilyodrilus*, *Psammoryctes*, *Clitellio*, *Telmatodrilus*, *Bothrioneuron*, *Lycodrilus*.

The Tubificidae are mainly northern temperate forms, and a few of them such as *Clitellio arenarius* and '*Peloryctes inquilina*[1]' are found on the sea coast. There are also a few of this family in the southern hemisphere. These forms include *Clitellio abjornseni* from Australia, and a few species of *Branchiura* from New Zealand and the islands of the Antarctic ocean. There is also to be mentioned *Rhizodrilus* (or *Vermiculus*) *aucklandicus* from the island of that name in the New Zealand area. The only tropical species appears to be the Indian and Malayan *Bothrioneuron iris*, though this genus also occurs in Europe and in southern South America. It is quite likely however that *Branchiura sowerbii*, a species known at present from tanks in hot houses, may be a tropical American species.

The family Lumbriculidae is yet more restricted in its range. It has not yet been met with away from the temperate northern hemisphere, and the great variety of species recently described from Lake Baikal by Dr Michaelsen is a very remarkable fact. The Lumbriculidae are entirely fresh water in habit and not even partially terrestrial. The following are the principal known genera: *Lumbriculus*

[1] With many synonyms, including *Tubifex ater* (see p. 53).

Конец ознакомительного фрагмента.