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THE COMMON FRESH-WATER OLIGOCHETA OF THE UNITED STATES*

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1. Introduction.

In accordance with the general purpose of these articles, as expressed above, the discussion will be confined to those Annelids of microscopic or near-microscopic size which are most commonly to be found in the United States, especially in the fresh waters. It is purposed merely to facilitate the work of the beginner on the members of the group until he shall have made such acquaintance with them and with the special literature of the subject as to be able to work effectively thru that literature.

With these limitations set on the purpose, it is manifestly undesirable to undertake to include a complete description of all the species and genera that have been noted for the region. Such an attempt would at once defeat the main end of the paper, which is to encourage the general student with the microscope to study one of the most interesting and widely distributed types of animals. Certain genera and species conceived to be of less interest to the beginning student, for one reason or another, and yet fairly demanding some notice are printed in smaller type.

2. Habitus.

The minute oligochetes are liable to be found in or near any of the fresh waters, even in regions of extreme cold. While they occur and may be taken free-swimming, in the running and open waters, they prefer in general the still and even stagnant water of lagoons and ponds and marshy pools along quiet streams where organic matter collects and decays. In such localities they are most at home in the upper surface of the mud at the bottom, in the scums of various kinds at the top of the water, in and on the stems and roots of plants submerged and decaying, among masses of algae, on the surface (and sometimes in the body openings) of larger aquatic animals.

Some of them (as *Fridericia*) are not strictly aquatic, but live in soil, or decaying wood, or in mosses, water-saturated but away

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from standing water proper. Some attack the tender parts of living plants and may be found parasitic in their tissues, where they produce disease and death. A few forms closely related to purely aquatic forms occur normally in quite dry places.

A number of genera are to be found in brackish waters, or even in littoral positions where only the sea water reaches them.

3. Collecting.

The habitats mentioned above will suggest the main facts to be kept in mind in collecting these minute annelids. After one becomes familiar with the species and their habits, it is possible to watch for the larger of them and to collect them directly; but for the most part it is necessary for the beginner to collect separate samples of all the materials which seem likely to be infested by them, being careful to keep adequate notes of the locality of each collection for guidance in case the debris proves fruitful. This material may then be gone over with more care in the laboratory.

The only special apparatus needed in collecting aquatic oligochetes is a fine skimming or towing net, and a fine meshed wire strainer with a handle a foot or so in length. These are convenient in collecting surface scums or mud from the bottom.

For discovering the smaller varieties in the material brought to the laboratory it is sometimes necessary to use special devices, altho most kinds may readily be detected by their motions in the jars of materials. Some species tend to collect at the sides of the vessels and at the top of the water, and may readily be picked off with a pipette. Others tend to form tubes of mud or other materials about their bodies and lie at the bottom or side of the vessel. It is sometimes necessary to wash out suspected material, a little at a time, in watch-glasses or other shallow vessels by playing a stream of water from a pipette over it. Frequently a black background is necessary. They often cling to the debris and to one another. The smaller species may frequently be found in knots of the larger forms.

4. Methods of Care and Culture.

This subject has not received the attention which it deserves from the students of the group, except for a few species. For this

reason only a few general hints will be given here. In a general way of course, the problem is, first, to duplicate as nearly as possible the natural conditions under which the animals flourish. Many of these worms are exceedingly delicate and tender, and any wide departure from the natural conditions may prove fatal. This means that the collector should keep notes of the circumstances of finding. The things most to be guarded are the amount and character of the water, the food supply, the oxygen supply, and the prevention of too great foulness from the decomposition of organic matter, and the multiplication of bacteria and infusoria. Changes to water of different quality, when necessary, should be made gradually unless it has been demonstrated that the worms are hardy to the change. When possible, therefore, enough of the water in which they are found should be brought to the laboratory to furnish the jar.

Cultures of mud-living forms may be kept from growing foul by allowing a slight drip of water to take place continuously into the container. This produces some agitation and a very quiet overflow and keeps down the bacteria. This plan is not safe for those that tend to come to the surface and inhabit the films that form there. Under these circumstances it is necessary to watch the culture closely and to remove some of the foul water and add fresh.

In the case of those forms (Naididae) that reproduce by fission, it is possible to arrange cultures which much surpass the natural conditions. This treatment consists in an enrichment of the food supply. No exact rules can be laid down, but it has been found possible by boiling the meal of Indian corn, or other suitable animal or vegetable substances, to get material the addition of small quantities of which to the culture will greatly stimulate growth and fission. The amount best to be used must be determined in each species by experiment. This experimentation to find the best possible conditions for growth is itself an interesting work and one worth doing for practical laboratory purposes. In cultures artificially fed it is all the more necessary to guard against the foulness and the attendant unicellular organisms.

The oxygen supply is important. The water may be frequently agitated, or a supply of green plants may be added to the jar. In general any increase in the depth of the water beyond that which

is necessary makes the getting of oxygen more difficult, except for those that come naturally to the surface. The types that live normally in moist places, rather than in water, should have their vivarium so arranged as to find it possible to crawl well above the water line in and upon the kind of material in which they ordinarily live.

5. The Study of the Living Specimens.

Many of these worms are practically transparent and thus present a specially favorable opportunity to study the internal organs and functions in life, without any treatment whatsoever. The only bar to such study is their activity. After they are transferred to the slide with a pipette the cover glass should be partially supported by thin wedges of wood or by wax feet, either of which can be regulated in such a way as to give greater freedom or greater pressure. In some cases a little increase of pressure will be all that is necessary to retard the motions sufficiently for successful study. In most cases, however, it may be necessary to use some stupefying agent. Probably the best general agent now in use is chloretone. A drop of a 2% solution placed at the edge of the cover-glass will usually stupefy the worm. Repeat as often as is necessary.

Some of the longer types coil up in such a way as to make stupefying necessary for any satisfactory study. In some instances it is necessary to bring about the stupefaction very gradually. In such cases it is necessary to do it in a watch glass by adding a drop of the chloretone to a somewhat larger body of water, and repeating at intervals until the worms are quiet and will remain uncoiled. Some of the more tender species begin to disintegrate in a little while, after such treatment.

The student should persevere in these studies of the living forms, for there is nothing that will give as good results. Problems of structure which seemed hopeless at first glance will gradually become clear, and relations of parts are shown in this way which cannot possibly be seen in any other way. A few drops of a weak aqueous solution of methylen blue will sometimes bring out the outlines of the nervous system in a way that nothing else will. Only a few drops should be added to a watch glass of water and

the worm should be left in it for one-half hour to several hours. The result should be watched from time to time, as the effects of the stain are transient.

For the identification of the aquatic oligochetes it is always necessary to study the setae or bristles. These never show so well after being mounted in balsam. By allowing the water to evaporate and letting the weight of the cover-glass gradually rest upon the living worm the clusters of bristles will usually stand out in such a way that their number and shape can be made out very satisfactorily.

6. The Making of Permanent Preparations.

Because of the incessant activity of the worms, the student is tempted into thinking that a fixed whole-mount of the worm would be more satisfactory. Except for dissection or sectioning the hope to secure better results by killing are largely illusory. The killed specimens are always at best mere caricatures of the living. The fixing fluids coagulate the cell-contents and make them opaque. This can be overcome in some degree by clearing reagents. The most common use of these is to run the specimen up to absolute alcohol, and then clear in xylol or cedar-wood oil where it may be kept for temporary study; or permanent mounts may be made in balsam. Whole mounts, thus cleared after being properly stained, are useful for the location of certain structures. By staining the specimen in toto and then rapidly decolorizing the outside tissues completely in strong acid-alcohol before the inner cells have lost their color, one can sometimes make quite instructive preparations.

The chief difficulty in technic is to kill and fix so as to avoid distortion. It is next to impossible to kill them outright in such a way as to prevent them becoming so distorted as to make sectioning impossible. It is usual to stupefy them, as suggested above, with chloretone to the point where they do not contract when manipulated. In this stage they may be taken up with a pipette and placed straight on filter paper in the bottom of a shallow flat dish. By placing the mouth of the pipette on the filter paper and gradually withdrawing it across the paper as the water bearing the limp worm is forced out, even the longer worms may be laid out per-

fectly straight. Any curves may be straightened by a little jet of water or by a moistened camel-hair brush. By placing upon this another piece of filter paper and weighting it lightly with a piece of glass slide, the animal will be held in place while hot saturated solution of corosive sublimate or picric, or other desired fixative is dashed over it. Without these or similar precautions the worms will contract in spite of the stupefaction. By this device many worms may be laid out on the filter paper and fixed at the same time.

The writer has found, in the effort to get stages of budding in the Naididae, that it is better at times to risk the contractions and kill without stupefaction because of their tenderness and the tendency of the zoöids to separate during the stupefying process. In doing this most of the water is removed from the watch glass or other shallow dish, and an abundant flood of the heated agent is thrown over the animal when it is most nearly straight. Usually a number of the segments will be straight or nearly so, tho the specimen as a whole is not.

7. Structures Liable to be Used in Distinguishing the Species.

In the classification and identification of these worms much dependence must be put on the sex organs. It is unfortunate that these are mature only during limited portions of the year, and furthermore are always complex, often exceedingly complex, and difficult to work out in their entirety. For these reasons, features more readily determined, even tho more superficial and variable, are used as much as possible. Among these are:—the size, length, number of segments; the shape of the various parts of the body; the character of the head and prostomium; the shape of the brain; the setae; the fission zone; the specializations of the anal segment; the blood vessels, the color of the blood; the position and form of the nephridia; and the differentiations of the digestive tract.

In reckoning the position of any organ in terms of segments, most students of the group regard the ring that bears the snout or prostomium as segment 1, altho it does not bear setae. The first setigerous segment (in most cases) is therefore number 2. (Fig. 1.)

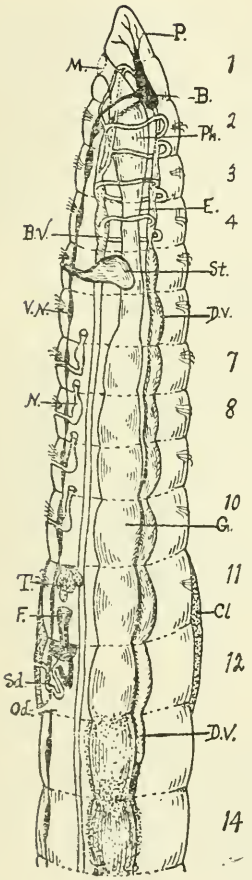

Fig. 1

Fig. 1.—A diagram illustrating the general structure of the anterior end of an oligochete (Enchytraeid) viewed from the side as a semi-transparent object. B, brain; B. V., ventral blood vessel; Cl., clitellum or girdle about sexual segments at maturity; D. V., dorsal blood vessel; E., esophagus; F., funnel of male (sperm) duct (Sd); M., mouth; N., nephridium; Od, oviduct (the ovary is on septum 11-12 behind the sperm duct); P., prostomium; Ph, pharynx; Sd, sperm duct; St, spermatheca; T., testis; V. N., ventral nerve cord.

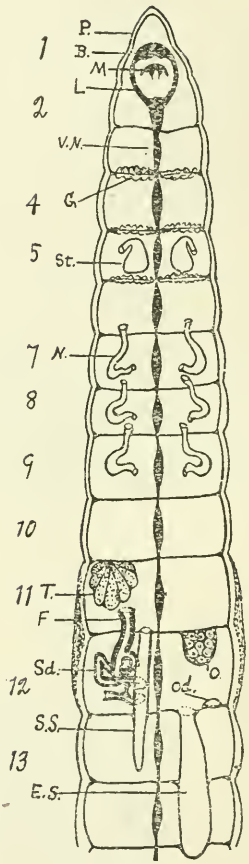

Fig. 2

Fig. 2.—An imaginary longitudinal section of Fig. 1, looking into the floor of the body-cavity from above, with the digestive tract removed. E. S., egg sac; G., glands on the septa between segments; L., nervous loop about the mouth; O., ovary; S. S., sperm sac; other letters as in Fig. 1. The male organs are omitted on the right side of the animal, and the female organs, on the left.

a. *Head and Prostomium.*—The mouth is on the ventral portion of the first segment, and arching over it and extending in front of it is a projection (prostomium) which may become very pronounced as a snout or proboscis. Within the first segment is the brain and the nervous loop around the gullet, and the eyespot when present. In the most of the Naididae, (Fig. 4, H.) the 4 segments near the mouth differ from the general segments of the body in that they have no dorsal setae, tho the ventral ones may be well developed. These modified segments are sometimes spoken of collectively as the "head." The degree to which segments are specialized in this region is a distinguishing quality of some value. Usually the septa which divide the body cavity into chambers are wanting in the anterior segments, as are also the nephridia.

b. *Setae.*—Fig. 3 will give the student some idea of the main classes of setae found in the aquatic worms. These structures are chitinous, are produced by epidermal cells, have muscles attached

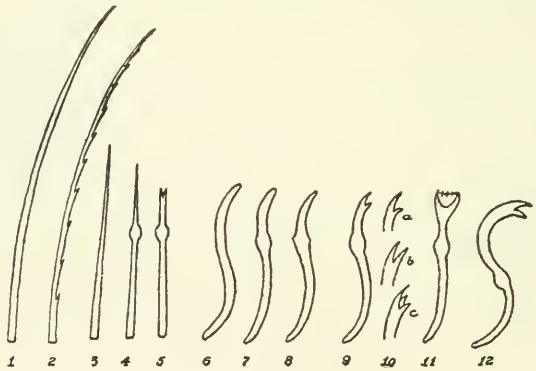

Fig. 3

Fig. 3.—Different types of setae. Setae 1-5 are essentially straight; those 6-12 are described as sigmoid (ʃ -shaped). 1 and 2 are capilliform; 3, 4, needle-like; 5, hastiform; 6 and 8 are uncinate, with hook poorly developed; 9, 10a, 10b, biuncinate; 10c, pectinate; 11, palmate; 5 and all the biuncinate setae are bifid.

to their inner ends, and protrude beyond the surface. The different types of setae and the names commonly applied to them in this paper are shown in Fig. 3.

The setae are usually found in 4 bundles to each segment and are ordinarily arranged somewhat as in Fig. 6.

c. *Fission Zone.*—This is found only in the Aeolosomatidae and the Naididae. It is formed by the special activity of a single segment which grows and proliferates new cells in such a way that the anterior end of the segment forms all the organs suitable to the posterior end of a worm of the species; and what is perhaps more remarkable, the posterior half of the dividing segment produces the segments (4 or more) with their contained organs, that

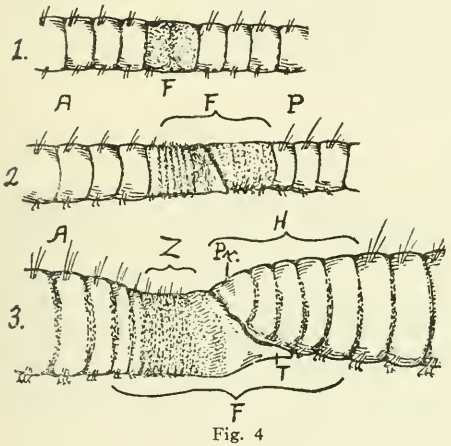

Fig. 4

Fig. 4.—Fission Zone in Dero, three stages; A., Anterior zooid; F., the dividing segment and its descendants; H., head (4 segments and prostomium (Pr.) of posterior zooid (P.); T., tentacular process of anal segment of anterior worm; Z., zone in front of anal segment where new segments are formed. The region Z, the anal segment, and region H have all arisen from one segment of the original worm (F).

constitute the head for the worm back of the dividing zone (Fig. 4). In those species in which fission occurs this method of multiplication is so effective that the sexual method is rarely put into use, and in some species is wholly unknown.

d. *The Anal Segment.*—In the great majority of these worms this region is quite simple and conforms to a general type. The segment is usually characterized by smaller size, by less developed setae and other segmental organs, and by a general appearance of youth. The anal opening is usually terminal (Fig. 5) and the posterior part of the intestine may be lined with cilia to its opening. The very last segment may be quite specialized. In Dero, for example, there are projections from the rim of the segment, and lobings of the anal opening protrude in such a way as to form a kind of ciliated pavilion characteristic of the genus (Fig. 5, L). This surface is believed to assist in respiration.

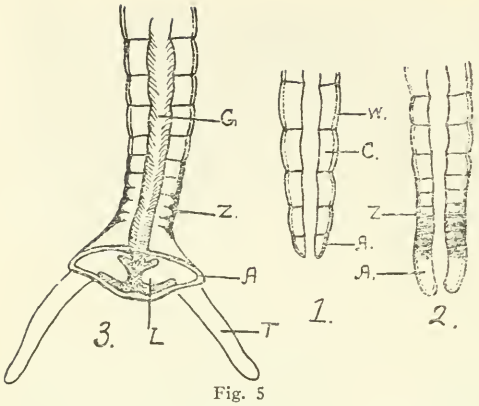

Fig. 5

Fig. 5.—Diagram showing posterior end of three worms. A., anal segment; C., coelom; G., gut; L., ciliated lobe of the respiratory pavilion in *Dero;* T., non-ciliated tentacle; W., body wall; Z., zone in front of anal segment where new segments are formed.

e. *Blood Vessels.*—The following general plan may be taken as representative of the more important blood vessels of the smaller oligochetes:

(1) A dorsal longitudinal vessel above the gut which is contractile. This commonly runs the length of the animal; but it may begin in the region of the *clitellum* (Enchytraeids: Fig. 1) being lacking in the posterior part of the body; or it may be lacking anteriorily. It is usually contractile.

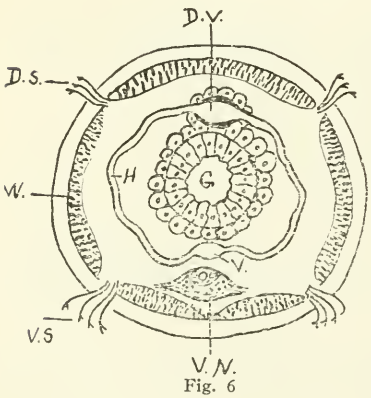

Fig. 6

Fig. 6.—A diagram of a transverse section of a worm. D. S., dorsal setae; D. V., dorsal blood vessel; G., gut; H., transverse or peri-visceral blood vessels, often contractile ("hearts"); V., ventral blood vessel; V. N., ventral nerve cord; V. S., ventral setae; W., body wall made up of "skin" and muscles.

(2) A ventral vessel running the whole length of the body. This is not contractile.

(3) Transverse or lateral vessels which connect the dorsal and ventral trunks, forming loops around the gut (fig. 6). These may occur in practically all the segments of the body, as in the Tubificidae and Lumbriculidae; or in only a few (1 to 4 or 5) in the anterior end of the body, as in the Naididae and Enchytraeidae. They may send branches to the body walls and to other organs.

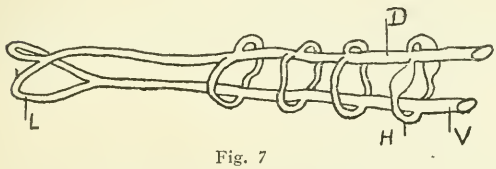

Fig. 7

Fig. 7.—Diagram of anterior blood vessels of one of the Naididae (e. g. Pristina). D., dorsal vessel; H., circular or transverse (sometimes contractile) vessels connecting D with V, the ventral vessel; L., loop in prostomium connecting longitudinal vessels.

(4) Blind contractile branches from the dorsal vessel or from the transverse vessels (Fig. 12) characterize the Lumbriculidae.

f. *Nephridia.*—These organs are very characteristic of the aquatic oligochetes, in common with other annulates. Each nephridium is related to two segments. It begins in the posterior part of a segment, ordinarily as a tube with a trumpet-shaped opening extending forward from the face of a septum (Fig. 8). The tube then penetrates the septum, and in the anterior portion of the next posterior segment is a more or less massive part often much coiled and glandular. From this a tubular outlet, which may have a bladder-like enlargement, leads thru the body wall to the outside. The relative size and differentiation of these portions is a matter of much variation in the different groups. They do not occur in all the segments of the body, but are usually lacking in the special-

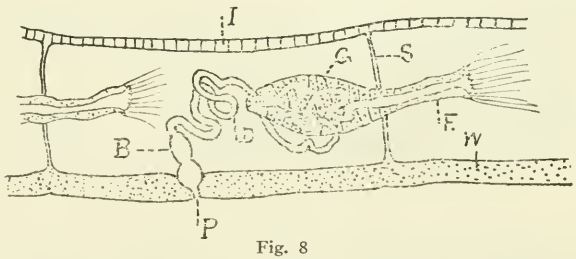

Fig. 8

Fig. 8.—Nephridium. Diagram showing relation of nephridium to the segments. Only the part of the segment between the ventral body wall (W) and the intestine (I) is shown. B., bladder; D., duct; F., funnel of nephridium; G., glandular part; P., external pore; S., septum.

ized "head" segments and in those in which the sex-organs are found. There are some strong evidences for thinking that some, at least, of the sex-ducts arise from the modified nephridia.

g. *The Sex-organs.*—As in many hermaphrodite animals the sex-organs in Oligochaeta are very complex. There are two main classes of organs:—those concerned in producing the sex cells,—ova and sperm; and the supplementary organs that are concerned in the maturing of these cells and in bringing together the ova and sperm in fertilization. It is this latter group that gives the complexity.

Male Organs

Producing sperm:—the testes, of which one or more pairs arise from the peritoneal epithelium especially on the posterior surface of certain definite septa (Fig. 9, O., T.).

Storing and ripening sperm:—sperm sacs (*vesiculae seminales*), which are pouches of the septa bounding the segments that contain the testes. These sacs may grow until they extend thru several segments and may become quite complex in form (Figs 9, 11, 13).

Carrying the sperm to the exterior:—sperm ducts and their accessory structures. The sperm ducts are usually long and coiled and may become very much differentiated along their course and at

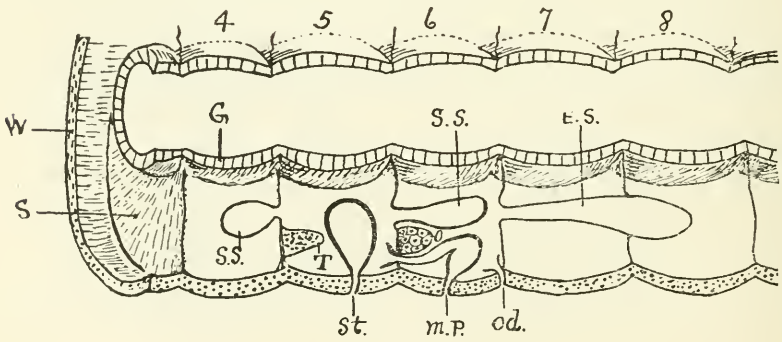

Fig. 9

Fig. 9.—Diagram of sex organs in one of the Naididae (e. g. Dero or Nais) viewed from the side. The left portion of the animal (not quite one-half) and everything dorsal to the digestive tract (G) is considered to be removed. The segments are numbered. E. S., egg sac; M. P., pore of the sperm duct whose funnel opens into segment 5; O., ovary; Od, oviduct; S., septum; S. S., sperm sacs; St., spermatheca; T., testis; W., body wall.

the opening. The regions that should be noticed and are subject to variation are: (1) the inner opening, often ciliated and funnel-shaped, where the sperm enter; (2) the tubular portion which may be variously supplied with glands (spermiducal or "prostate" glands), more commonly associated with the outer end of the duct; (3) special enlargement ("atrium") into which one or more sperm ducts may empty; and (4) a special copulatory organ (penis) which is a modification of the outer end of the sperm duct or of the tissues immediately associated with it (Fig. 14).

Female Organs

Producing ova:—the ovaries, homologous with the testes and arising in an entirely similar way. There are usually one or more pairs (Fig. 11, O.).

Storing and ripening of the ova:—egg sacs (*receptacula ovorum*) formed as are the sperm-sacs by the pouching of the septum of the segment containing the ovaries. The egg sac is more frequently single than the sperm sac. The egg sacs may grow posteriorily thru many segments, pushing the various septa before them (Fig. 11). In many instances the sperm sac, arising as it does anterior to the egg sacs, may be pushed into the egg sacs. The immature eggs escape from the ovary and, instead of lying free in the body cavity as in the Polychetes, pass into this sac until mature or until fertilization is possible.

Carrying the ova to the outside:—oviducts, similar in general to the sperm ducts but usually much reduced, in some instances being little more than a pore thru the body wall (Fig. 9, Od).

Receiving or copulatory organs:—the spermathecae (*receptacula seminis*) are sacs, usually in pairs, into which the sperm from another worm pass at copulation (Fig. 9 S. S.). They are retained here until they are passed out by muscular contraction upon the eggs of the individual when these are laid. Around the escaping eggs and sperm the clitellum forms a secreted cocoon in which development proceeds. The spermatheca may be simple, or may be branched and lobed. In some types it opens into the gut as well as to the outside world. The meaning of this last fact is not known.

8. Topics for Investigation Suitable to the General Student of of the Group.

The group of oligochetes is one in which much remains to be done in the United States. The morphology of only a few species has been completely worked out. The following are some of the directions in which profitable work may be done both by amateurs and professional biologists:—the working up and reporting on the local species from many parts of the country, leading to a fuller knowledge of the distribution of the species; the discovery of new or intermediate forms; the more exact study of the physical conditions preferred by various species; the study of the best methods of culture and propagation in artificial and controlled conditions; the behavior and the reactions of these various species to the environment, especially as relates to food, water-preferences, mating, and the like; the degree and character of the variations within the species and genera in respect to structure and behavior; the facts concerning reproduction, both sexual and asexual. To the expert, the group offers very favorable material for the study of divers philosophical questions of biology.

9. Systematic (General).

PHYLUM ANNULATA.—This phylum is a rather natural group, including organisms with bilateral symmetry and bodies made up of a series of rings or segments. These segments appear not merely as external rings but show also in the internal organs in various ways. Paired appendages occur usually on each segment (except in the Leeches), and take the form of unsegmented bristles or setae. There are two main Classes:—

Class 1. Those having setae, with the cœlom divided into segments, and no suckers.....Chaetopoda ("bristle-worms").

Class 2. Those without setae, having a sucker at each end of the body, cœlom not well differentiated into segments.... .....Hirudinea (leeches).

The CLASS CHAETOPODA includes two principal Orders:—

Order 1. Worms chiefly terrestrial or from fresh water; setae small, not very numerous, usually arranged in 4 bundles in each segment of the body, and arising di-

rectly from depressions in the body wall; the segments with the exception of the first and the last are similar in appearance; hermaphrodite, and having complex reproductive organs .....Oligochaeta.

Order 2. Marine worms with numerous setae which arise from limb-like projections from the side of the body (parapodia); a number of the anterior segments are usually highly specialized as compared with those that follow; reproductive organs simple and repeated in many segments; sexes separate, sex organs simple..Polychaeta.

The Order Oligochaeta may be separated again into two Sub-orders somewhat less natural and satisfactory than the above divisions:

Sub-order 1. Worms, usually small and aquatic in habit; reproductive maturity at a definite period of the year; the clitellum, or girdle, characteristic of sexual maturity only and poorly developed, being only one cell thick; egg sacs large; the ducts which convey the sperm to the exterior open in the segment next back of that in which they originate internally (Figs. 1, 9, Sd.).....Microdrili.

Sub-order 2. Much larger worms and chiefly terrestrial, having characteristics for the most part opposite to those mentioned in 1.....Megadrili (earthworms).

10. Systematic (Special).

A Key to the Principal Families of Aquatic Oligochaeta (Microdrili) that have been described for the United States.

A. Small (from 1 to 15 or 25 mm.) aquatic worms; capable of multiplication by fission (i. e. non-sexually) as well as sexually; usually quite transparent.

Very small (1-10 mm.); no complete septa; prostomium ciliated on ventral surface; some (or all) of the ventral setae capilliform (occasionally some *f*-shaped), never bifid at free end.....
.....Family Aeolosomatidæ (p. 300).

Somewhat larger (2-25 mm.); complete dissepiments dividing the cœlom into chambers; bifid setae common together with other kinds.....
.....Family Naididae (p. 301).

B. Do not reproduce by fission; usually less transparent than A; mostly longer (often very much longer) worms.

Setae never bifid at the extremity, short, 2 or usually more in each bundle; worms 5-30 mm. in length; integument inclined to be whitish and opaque; some aquatic, some terrestrial and burrowing in organic matter, some parasitic on plants.....Family Enchytræidae (p. 306).

Some bifid setae usually in each bundle; worms usually exceed 20 mm. in length.

Bundles each contain a pair of *f*-shaped (sometimes bifid) setae; no capilliform setae; blind contractile appendages on the dorsal blood vessel or on its lateral branches (Fig. 12).....Family Lumbriculidae (p. 309).

Bristles usually uncinate and pectinate (Fig. 3; *6, 8, 10c*), but capilliform bristles may occur in the dorsal bundles; lateral blood-vessels form a loop around the gut in nearly every segment; no contractile appendages on the dorsal blood-vessel.Family Tubificidae (p. 312).

FAMILY AEOLOSOMATIDAE

This family contains at present only one genus, Æolosoma. The worms of this genus are very small and beautifully transparent. They are easily recognized by the presence in the integument of minute globules usually strikingly colored. They reproduce by fission, are more capable of changing their form than most of the worms, and have cilia about the mouth and prostomium. They are more hardy than most of the small forms and may be found abundantly at the surface of cultures that are too foul for other species. They are widely distributed and when found at all are usually abundant.

Key to the Species

Integumental globules colorless.

Prostomium not wider than the segments back of it; setae capilliform and *f*-shaped; first pair of nephridia at the posterior end of esophagus. Philadelphia; Illinois.....*A. niveum* Leidig.

Integumental globules colored orange to dark red.

Head (prostomium) about equal in width to the following segments; setae curved and nearly of uniform length; no nephridia in the region of the esophagus (i. e. anterior to the widening of the gut). Philadelphia.....*A. quaternarium* Ehrenberg.

Head broader than the following segments; setae nearly straight; two pairs of nephridia in front of the widening of the gut. Illinois; Missouri; Massachusetts.....*A. hemprichii* Ehrenberg.

Integumental globules colored pale yellow to olive green.

Head broader than the following segments and pointed in front; setae both capilliform and sigmoid; two pairs of nephridia in esophageal region. Illinois; Missouri.....*A. tenebrarum* Vejdovsky.

As in *A. tenebrarum,* except that the setae are capilliform and sigmoid in the anterior segments and sigmoid alone in the posterior segments. Kansas.....*A. leidyi* Cragin.

FAMILY NAIDIDAE

The Naididae are all aquatic and are small transparent worms. Their usual method of reproduction is by fission, altho sexual stages are known to occur in most of the genera. When present the sexual organs are found well forward, in segments 5 and 6, (occasionally in 7 and 8). There are usually 4 groups of setae on each segment, but the dorsal pair of bundles may be wanting. The dorsal setae are regularly lacking in the first 4 or 5 segments. Dissepiments are well developed. The genera are distinguished on the basis of the character of the setae and the segment on which the first pair of the dorsal bundles occur, on the presence or absence of "eye-spots," on the shape of the prostomium, and on the presence or absence of special respiratory lobes (Fig. 5, L.).

Key to the Principal Genera

Dorsal setae present.

Capilliform setae in the dorsal bundles.

Dorsal bundles begin on segment 2.

Capilliform setae together with shorter needle-like or biuncinate setae; prostomium round or with short snout only.....Genus Naidum (p. 302).

Usually only capilliform setae in the dorsal bundles; prostomium in form of long snout or tentacle.....Genus Pristina (p. 302).

Dorsal bundles begin on segment 6.

Posterior end without respiratory lobes (Fig. 5. L).

Capilliform setae shorter or only a little longer than the width of the body.

Prostomium not developed into a snout.....Genus Nais (p. 303).

Prostomium developed into snout.....Genus Stylaria (p. 303).

Capilliform setae twice as long as the width of the body and best developed on segment 6.....Genus Slavina (p. 303).

Posterior end supplied with a series of ciliated lobes serving for respiration.....Genus Dero (p. 304).

No capilliform setae (only bifid) in dorsal bundles.....
.....Genus Ophidonais (p. 305).
Dorsal setae wholly lacking; ventral setae present.....
.....Genus Chætogaster (p. 305).

Genus Naidum, O. Schmidt.

Prostomium rounded or slightly pointed. Dorsal bristles begin on segment 2, and contain both capilliform and biuncinate setae. Only biuncinate setae in the ventral bundles. A single species recorded for United States.

Naidum osborni Walton. Length 1.6 mm; segments in an individual 15 to 16. Eyes absent. Digestive tract differentiated into pharynx (segments 1-3), esophagus (4-7), stomach (segment 8), and intestine. Dorsal bristle bundles contain one capilliform and one biuncinate seta; the ventral bundles of 4 biuncinate setae. Cedar Point, Sandusky, Ohio.

Genus Pristina, Ehrenberg.

Dorsal bundles of setae begin on segment 2 and contain capilliform setae only (or occasionally hastiform also); eyes absent; prostomium developed into a snout. The sexual condition is known for one species (*P. leidyi*) in which the testes and spermathecae are found in 7 and the ovaries in 8.

Species

P. flagellum Leidy. Length 6-7 mm., with 40-60 segments. Dorsal setae of segment 3 not longer than others; capilliform setae without fine teeth. Last segment with three finger-like processes; a short, dorsal median and two longer lateral ones. Penna., Ill., N. J.

P. leidyi Smith. Length 4-8 mm., and about 30 segments to the individual. Dorsal setae of segment 3 times as long as others; capilliform setae about 35μ and, except in 3, finely toothed. Proboscis about 3 times as long as width of body. Nephridia commence in segment 9. Havana, Ill.

P. serpentina Walton. Length 2.2 mm., with about 15 segments in an individual; proboscis 0.2-0.3 mm. long. Dorsal bristles on segment 3 not longer than others; capilliform setae about 300μ and finely toothed. Ventral setae 5-6 in a bundle, biuncinate, with teeth almost equal. Cedar Point, Sandusky, O.

Genus Nais, Muller.

Prostomium rounded; dorsal bundles begin on segment 6 and contain capilliform setae, and may also have shorter uncinate or straight setae with divided ends; those in 6 not longer than others. Testes and spermathecæ in 5; ovaries in 6. Eye-spots usually present.

Species

N. elinguis Müller. Length 1.5 mm. Dorsal bundles with 1-3 (usually 2) setae, 1 capilliform and the other hastiform. Eye-spots present. Illinois; Penna.

(Besides this, Walton has recently described 4 species of this genus from Lake Erie, Sandusky, O. These were based on a few specimens and will not be described here; but their finding indicates that this genus is probably well represented in America and will well repay study.)

Genus Stylaria, Lamarck.

This genus agrees with Nais in practically everything except in the fact that it possesses a well developed snout, and in the somewhat better differentiation of the digestive tract into esophagus and crop or stomach. Beddard and some others place the species in the genus Nais.

S. lacustris (Linnaeus). Length 10-15 mm.; segments 25; proboscis well developed, about 1 mm. in length; eye-spots present; dorsal bristle bundles begin on segment 6 and contain capilliform setae only. This is either a well distributed and very variable species, or a number of species have been referred here at one time or another. Leidy named two species of Stylaria which from his descriptions cannot be distinguished from *S. lacustris*. Penna.; Mass.; Ill.; Ohio.; Mo.

Genus Slavina, Vejdovsky.

This genus is placed by some writers with Nais, and is to be distinguished from it chiefly by the fact that the capilliform setae are confined to the dorsal bundle of segment 6, or are very much longer and are more numerous in 6 than in those that follow. Capilliform setae are without teeth. Prostomium rounded.

S. appendiculata (D'Udekem). Length 5-15 mm., with about 35 segments. One or more rows of sensory papillae encircle the worm in each segment. Havana, Ill.

S. gracilis (Leidy). Length 10 mm., with about 50 segments. Three capilliform setae in the bundles of segment 6 and only one on those following. Pennsylvania.

Genus Dero, Oken.

This is a widely distributed genus which is especially interesting and easy to recognize because of the ciliated respiratory processes from the body wall of the anal segment, which contain blood vessels (Fig. 5, *3*). Dorsal bristle bundles begin on segment 6 and contain capilliform and hastiform setae. Prostomium rounded and eyes absent. Esophagus and stomach differentiated. Nephridia begin in segment 6. Testes and spermathecae in 5 and ovaries in 6, as in typical Naididae.

Key to the American Species

All processes of the anal segment ciliated.
  Ciliated processes rounded, in blunted lobes.....*D. obtusa.*
  Ciliated processes elongated .....*D. limosa.*
Non-ciliated processes (from ventral margin of the anal segment) as well as the ciliated.
  Ciliated lobes poorly developed, not finger-like.....*D. vaga.*
  Ciliated processes long and finger-like.....*D. furcata.*

Species

D. obtusa d'Udekem. Single individual 3-4 mm. in length; 25-40 segments. Ciliated lobes short and blunt; the dorsal lip of the branchial surface with two grooves, but not drawn out into processes. "Hearts," or circum-esophageal loops of the blood vessels, 4. Mass.; Ill.; Mo.; etc.

D. limosa Leidy. Length 7-15 mm.; segments 40-60; dorsal lip of branchial area is drawn out into 2 moderately long processes; 5 pairs of "hearts." Penna.; Ill.

D. vaga Leidy. Length about 8 mm., with 25 segments. Two long non-ciliated processes from the ventral margin of branchial area; the ciliated surface ridged and forming a sort of pavilion, rather than lobed. Three pairs of "hearts." The worm forms a tube of small living plants, as *Lemna,* or of non-living objects, and carries this around; this species remains at the surface of the water and is thus more readily discovered than the other species. Penna.; Mass.; Ill.; Ohio.

D. furcata Oken. Two long non-ciliated ventral processes and 4-6 ciliated respiratory processes, arranged in pairs. First dorsal

setae on segment 5. Five pairs of contractile loops or "hearts." Ill.; Mo.

Genus Ophidonais, Gervais.

There is a present tendency to include this genus with Nais. It has the dorsal setae, but lacks the capilliform setae found in the bundles of that genus. All setae are short and nearly straight. Other characteristics much as in Nais.

O. serpentina Müller. Length 15-30 mm. No proboscis. Dorsal setae short, straight, and bifid. Four dark pigment bands around the anterior end of the body, one band on each of segments 2-5. Havana, Ill.

Genus Chaetogaster, v. Baer.

The setae in this group are all ventral, and only uncinate setae are found. The first setae occur in segment 2 and none are found on segments 3-5. The prostomium is rudimentary, and the mouth is large and terminal and used somewhat as a sucker in locomotion. One pair of transverse blood vessels form a loop about the esophagus (Fig. 10). When sexually mature, testes are found in segment 5, ovaries in segment 6, and spermathecæ in segment 5. Members of the genus are found in widely different parts of the world. One species, at least, occurs parasitic or symbiotic on fresh water snails.

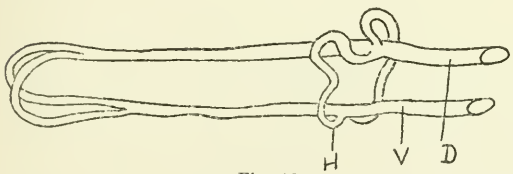

Fig. 10

Fig. 10.—Blood vessels in *Chaetogaster*. Letters as in Fig. 7.

Key to the Species

Parasitic ..... *C. limnei*
Free,—not parasitic.
Prostomium indistinct.
Esophagus 1/5 length of pharynx..... *C. pellucidus.*
(Much like Ch. limnei).
Esophagus 1/3 length of pharynx..... *C. diaphanus.*

Esophagus equal in length to the pharynx.....*C. langi.*
Prostomium distinct; esophagus 1/2 to 1 length of pharynx.....
.....*C. diastrophus.*

Species

C. limnei v. Baer. Length 2 mm.; setae 8 to 16 in each bundle; esophagus much shorter than pharynx; first enlargement of intestine covered with an anastomosing network of blood vessels; lives on or in the bodies of certain species of pond snails. New England, Illinois, Missouri.

C. pellucidus Walton. Length 1.5 mm., with 9-11 segments. More transparent than the preceding; setae 6-7 in each bundle; esophagus very short; first enlargement of intestine surrounded by 12 or more pairs of blood vessels, which, however, do not anastomose. Cedar Point, Ohio.

C. diaphanus Gruithuisen. Length 6-15 mm. Very transparent; esophagus very distinct but much shorter than pharynx. This is the largest of our species, and may be found with several individuals in a chain. It is well distributed. Mass.; Ill.; Mo.; Penna.; etc.

C. langi Bretscher. Length 1-2 mm. Esophagus long. Setae 4 in a bundle. Lake Erie, Cedar Point, Ohio.

C. diastrophus Gruithuisen. Length 2-5 mm. Prostomium more distinct than in the preceding; esophagus as long or nearly as long as the pharynx; setae 4-7 in a bundle. Mass., Ill., Mo. (It is probable that Leidy's *C. gulosus* is identical with this, as *C. diastrophus* is widely distributed and has essentially all the characteristics mentioned by Leidy.)

FAMILY ENCHYTRAEIDAE

This is a family in which are a great many species of small worms, both aquatic and terrestrial. Only a few types, however, have been described for the United States; and it is reasonably certain that there are still numerous members of the family in America to be discovered. The main features that distinguish this family are:—a decided prostomium; both dorsal and ventral bundles of bristles, with setæ nearly straight or curved but never capilliform

nor biuncinate; integument whitish and often somewhat opaque, tho some are nearly transparent; there is no reproduction by fission; the sex organs are further back than they are in the Naididae, the testes being in segment 11 and the male pores in 12, the ovaries in 12, and the pores of the oviducts between 12 and 13. There is a pair of spermathecae in segment 5. (See Fig. 1, St.) The dorsal blood vessel does not run the whole length of the body but arises from the intestine in the general region of the clitellum (Fig. 1), and runs forward connecting with the ventral vessel by peri-visceral loops in the first few segments.

Only one genus, Fridericia, of this family has been even fairly worked up for the fresh waters of the United States. In addition to the genera and species of Enchytraeids described or referred to below Eisen has described forms from Mexico to Alaska which are probably confined to the Pacific coast; two species of Fridericia and two of Henlea have been discovered for Urbana, Ill., by Mr. Paul Welch, the description of which is yet unpublished. A few worms believed to belong here were partially described by Leidy years ago.

Genus Fridericia, Michaelsen.

Terrestrial worms with dorsal pores (openings thru the body wall into the cœlom in the region of the head or further back) such as are found in the larger oligochetes. Setae straight and 2 or multiple of 2 to the bundle; if more than 2, the inner pair are younger and smaller. Salivary glands present. Dorsal blood vessel begins behind the clitellum. Spermathecæ (Fig. 1. St.) usually with outpocketing lobes and may open into the gut as well as to the outside.

Six species have already been described for the United States and as yet very few localities have been carefully studied. It is questionable whether these six are distinct. For example, *F. parva* and *F. bulbosa* have much in common, and *F. agilis* and *F. agricola* are very similar. The chief points of distinction among the species are:—size, complexity of the salivary glands, complexity of the spermatheca and the relative length of sac and duct, and the form of the nephridia.

Key to the Species

Spermathecæ simple (i. e. without diverticula).
  Salivary glands simple.
    Duct of spermatheca twice as long as the sac.....*F. bulbosa.*
    Duct of spermatheca four times as long as the sac.....*F. parva.*
  Salivary glands slightly branched.....*F. alba.*
Spermathecæ with diverticula.
  Salivary glands simple.....*F. longa*
  Salivary glands branched.
    Duct of spermatheca three times as long as sac.....*F. agilis.*
    Duct of spermatheca six or seven times as long as sac...*F. agricola.*

Species

F. bulbosa Rosa. Length 8 mm., 42 segments. Setae 4 per bundle in anterior segments, 2 posteriorly. Lumen of nephridia in front of septa short, wide and straight. Spermathecæ without diverticula, and duct about twice the length of the pouch. Philadelphia; Mass.

F. parva Moore. Length 12 to 15 mm., with 46 segments. Setae 4 per bundle back to the segment 25, and 2 on others. Spermatheca without diverticula, duct 4 times the length of the pear-shaped sac. Dorsal pores begin on segment 7. Dorsal blood vessel arises in 17. Brain 3/5 as broad as long, greatest width a little posterior to the middle. Prostomium conspicuously roughened with rounded nodules. Philadelphia.

F. alba Moore. Length 15-22 mm.; segments 56-58. Setae long and slender, and 4 to the bundle except on 2 or 3 posterior segments; may be as many as 6 or 7 in front of the clitellum. Spermatheca similar to *parva,* but sac more spherical. Salivary glands slightly branched, with only 2 or 3 branches. Dorsal vessel arises in segment 22. Dorsal pores begin in 6. Almost aquatic, living in wet leaves and moss. Penna.

F. longa Moore. Length 25-30 mm.; segments 60-69. Setae anterior to clitellum 4; posterior, 2. Spermathecae with 5-8 diverticula arranged in a whorl about central part of sac; duct 2 or 3 times as long as sac. Salivary glands simple and open in segment 5. Brain 2/3 as broad as long, convex behind. Segments studded with rounded knobs. Penna.

F. agricola Moore. Length 20-25 mm.; segments 65. Setae 4 in bundle for first 30 segments, later 2. Spermathecæ with a pair of sacculations from the main organ, and with ducts 6-7 times length of sac. Salivary glands conspicuous and divided into 5-7 slender tubular branches. Brain as in *longa*. Dorsal pores transverse and slit-like and begin on 7. Lives among underground bulbs of garlic. Delaware.

F. agilis Smith. Length 25-30 mm.; segments 55-65. Setae 2 in bundle, occasionally 4. A head pore, and the dorsal pores begin in 7. Spermathecae with 9 well developed diverticula, and with duct 3 times length of sac. Salivary glands large and branched. Dorsal blood vessel begins in 19. Brain concave on anterior margin and convex behind. Illinois.

Some Uncertain Genera and Species

GENUS ENCHYTRAEUS.

This genus is somewhat poorly defined, being distinguished from Fridericia by the absence of the dorsal pores (except the head pore), by the equal straight setae except for a curve at the free end.

Enchytraeus albidus, a marine form found along the sea coast from Maine to N. J.

Enchytraeus socialis Leidy. Length 5-10 mm.; about 50 segments; 5-7 simple setae per bundle; clitellum begins on segment 13. Found under the damp, decaying bark of stumps and trees. Eastern Penna.

GENUS DISTICHOPUS.

A genus poorly described by Leidy, but later studied and described by Moore. Similar in many respects to Fridericia, but different from it in the fact that the dorsal setae are entirely wanting; ventral setae 4, or 3, or none to the bundle.

D. sylvestris Leidy. Length 20-30 mm.; segments 68. Salivary glands in segment 5, branched; dorsal blood vessel arises back of the clitellum in segment 13-14.

FAMILY LUMBRICULIDAE

The worms of this family are aquatic and somewhat larger than those of the preceding families, and not really microscopic except that they are more or less transparent, and many points of structure and function can be observed directly by the general student. They reproduce sexually only, and the sex organs are rather more variable than in the families already studied. The spermathecæ are further back (8-12) and frequently more than one pair; there are two sperm ducts on each side arising in two successive segments and uniting to form a right and a left spermiducal gland

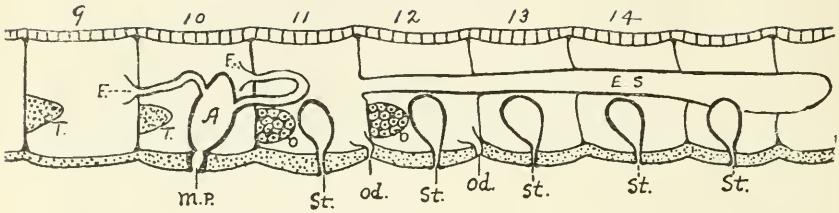

Fig. 11

Fig. 11.—Diagram of the sex organs in one of the Lumbriculidae. A., "atrium;" E. S., egg sac; F., funnels of sperm ducts; M. P., the male pore or external opening from the atrium; O., ovaries; Od., oviduct and female opening; St., spermathecae; T., testes. Numerals indicate the segments.

(Fig. 11). The setae are *f*-shaped, simple or biuncinate and in pairs. The dorsal blood vessel, or the transverse vessels arising in each segment from it, have blind contractile pouches or appendages (Fig. 12) except in a certain number of anterior segments. This is distinctive of the family. Three genera recognized by Michaelsen are recorded for the United States:—Lumbriculus, Eclipidrilus and Sutroa.

Key to Distinguish the Genera

Setae bifid at extremity; prostomium rounded.....Lumbriculus
Setae simple (not bifid); prostomium elongated.
Spermathecae one pair in segments 8, 9, and 10 or 11.....Eclipidrilus.
Spermatheca single in 8, with diverticula.....Sutroa.

Genus Lumbriculus, Grube.

Greatly elongated worms with a rounded prostomium; setae bifid. The dorsal and ventral blood vessels are connected in the posterior part of each segment; in each segment, except 8 or 10 anterior segments, there is also a pair of blind lateral branches

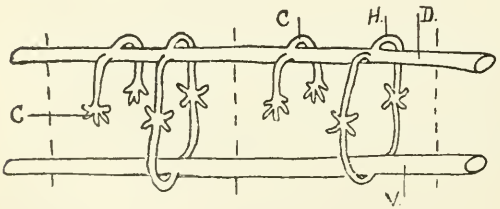

Fig. 12

Fig. 12.—Diagram of blood vessels in two segments of a Lumbriculid. C., Caeca or diverticula which are contractile; D., dorsal vessel; H., transverse or perivisceral loops about the gut; V., ventral vessel.

forming contractile diverticula (Fig. 12). Sperm ducts as in the family generally, with openings on segment 8 to 10; spermathecæ simple, one pair in each of the three or more segments back of the spermiducal pore. Two pairs of ovaries and funnels.

Lumbriculus inconstans Smith.—Length 30-60 mm., and 150-200 segments; color reddish; brain slightly concave anteriorly with deep incision behind; the transverse contractile appendages of the dorsal vessel begin in segment 11 and get larger and more branches posteriorily. Two pairs of testes in 9 and 10; two pairs of ovaries in 11 and 12; sperm sacs open in 10 and extend backward as far as 20; spermathecae 5 pairs (11-15 or 12-16). Havana, Ill.

L. limosus Leidy. Length 2-4 inches, with 170-225 segments; setae long, sigmoid, suddenly narrowed at outer end, and bifid,—two each bundle. Sperm ducts (?) open on 9; the reproductive organs (1) extend as far back as segment 20. Under stones and leaves on the muddy borders of streams. Eastern Penna.

Genus Eclipidrilus, Eisen.

Under this genus may be included for the present three species of worms from widely different parts of the country, which possibly should be placed in separate genera. The setae are in twos and are not bifid; the prostomium is usually somewhat elongated. The sperm ducts are complex, and each is invested with a spiral muscle about its middle, forming a sperm reservoir; it communicates with a protrusible penis. The contractile branches of the dorsal vessel are less well developed than in Lumbriculus.

E. frigidus Eisen. No proboscis; two pairs of testes and sperm funnels in 9 and 10; one pair of sperm sacs extending thru several segments; one pair spermathecae in 11; a pair of protrusible penes in 10; a pair of ovaries in 11 with oviducts opening on 12; one pair of nephridia in each of segments 4-8. California.

E. palustris Smith. Length about 50 mm., and 1 mm. in diameter; segments about 165. Prostomium drawn out into a proboscis. One pair testes in 10; one sperm sac well developed, the other much reduced; two spermathecae in 9, but on the same side of the segment; one penis on 10; one pair of ovaries in 11, oviducts opening 11-12. A pair of nephridia in 7. Florida.

E. asymmetricus Smith. Length about 30 mm.; segments 65; prostomium extended into a proboscis. One pair of testes in 10; single sperm sac extending as far as segment 21; the sperm duct with muscular reservoir extends thru segments 12-14; single male pore in middle line of segment 10; no atrium or spermiducal glands, but with a penis; two spermathecae in 9 with their pores in the middle line, one behind the other; one pair of ovaries in 11. Nephridia absent from the anterior segments, or one pair in 6. Illinois.

Genus Sutroa, Eisen.

Prostomium extended into a proboscis; setae not bifid. Clitellum 7-15; one pair of testes in 10; two pairs of sperm ducts, with very much elongated spermiducal glands, surrounded by the sperm sacs and opening externally on segment 10; a single spermatheca in 8, with many diverticula, simple and branched; ovaries in 11, with oviducal pores on 11-12.

S. rostrata Eisen. Length 75 mm. Ventral blood vessel forks in 8 and is connected with the dorsal in the prostomium only. Cocoon not pointed at the ends. San Francisco, Cal.

S. alpestris Eisen. Length 40 mm. Ventral vessel forked in 6, and connected with dorsal blood vessel by loops about intestine in each segment. Cocoon globular and pointed at ends. Donner Lake, Cal.

FAMILY TUBIFICIDAE

This large family of slender aquatic (fresh and marine) worms is represented in America by six or more known genera and a considerable number of species. They do not reproduce by fission; but many of the species are very hardy and consequently they are numerous and well distributed. Three kinds of bristles may be found,—capilliform, pectinate, and uncinate; none but the uncinate occur in the ventral bundles. Dorsal and ventral blood vessels are connected in nearly all segments of the body by transverse branches, forming loops around the gut. The testes are in segment 10 and the ovaries in 11; the sperm ducts always have spermiducal glands (Figs. 13, 14, S. G.) near their opening on segment 11; oviducts open 11-12; one pair of spermathecae in 10.

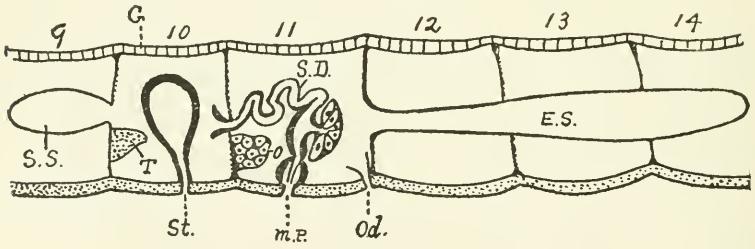

Fig. 13

Fig. 13.—Diagram of sex organs of one of the Tubificidae. Letters as in Fig. 9 and 11.

The points that distinguish the genera are:—the kinds of setae; the number, size, and position of the contractile perivisceral loops or "hearts;" and the character of the glands in connection with the sperm ducts.

Key to the Genera

Tubificids with capilliform setae in dorsal bundles.

Peri-visceral blood vessels gradually increase in size from segment 5 to 10.....Genus Ilyodrilus.

Peri-visceral blood vessels much dilated (heart) in segment 8 (or 9).

Without sensory papillae.....Genus Tubifex.

With sensory papillae around segments.....Genus Embolocephalus.

Tubificids with no capilliform setae in dorsal bundles.
Body not whitish or opaque because of corpuscles about the viscera.
Two pairs dilated hearts.
In 7 and 8; no prostates.....Genus Clitellio.
In 8 and 9; prostates.....Genus Limnodrilus.
Four pairs of hearts (7-11), the 4th enlarged...Genus Telmatodrilus.
Body milky white with corpuscles about viscera; hearts in 7-10.....
.....Genus Rhizodrilus.

GENUS TUBIFEX, LAMARCK.

This genus is apparently one of the best distributed of the fresh water oligochetes. The worms have three types of bristles,—especially in the anterior bundles,—capilliform, uncinate, and pectinate, ventral bundles having only uncinate. The perivisceral vessels of segment 8 decidedly enlarged and contractile. No chitinous penis.

Only one fresh water species is certainly known for America, unless we accept Michaelsen's view that the next species, *Embolocephalus multisetosus* Smith, is a species of Tubifex. Two or three species have been described for brackish or salt water.

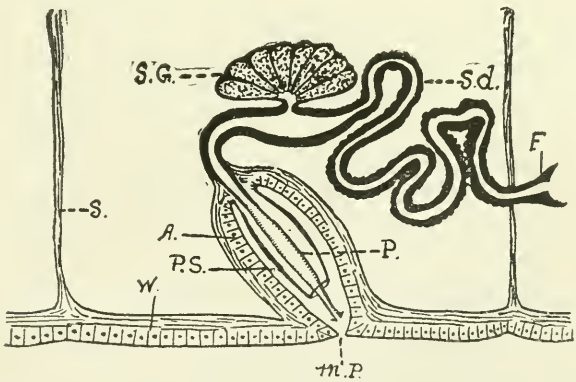

Fig. 14

Fig. 14.—More detailed diagram of the male efferent apparatus in Fig. 13. W., body wall; S., septa; M. P., external male pore; A., wall of "atrium" which contains the penis sheath (P. S.) and the penis (P.) and terminates the sperm duct (Sd.); F., the funnel of the male duct which receives sperm from the segment in front; S. G., spermiducal glands ("prostates"), which may be variously placed in relation to the duct.

T. tubifex (*rivulorum* Lamarck). Length 30-80 mm., with 40-60 segments. Brain concave in front with lateral lobes well de-

veloped; three lobed behind,—the middle lobe being shortest. This worm is fairly common in the rich mud at the bottom of streams in many parts of the country. It buries its anterior end in a tube of mud, and waves the posterior end freely in the water. It is found often in association with Limnodrilus with which it may readily be confused before the examination of the setae.

T. irroratus (Verrill). Length 15-30 mm.; 70-90 segments. Prostomium slender. Capilliform setae with a spiral twist at the end. Vascular system with well developed integumentary plexus; dorsal vessel contractile and supplied with valves at the constrictions. A brackish water species, burrowing deep among the roots of beach grass. Mass.

T. benedeni, d'Udekem. Deep gray or nearly black in color, owing to greenish-gray granules in numerous flattened papillae which cover the cuticle. Capilliform setae often absent. In brackish or salt water between tide marks and out to 7 fathoms. Maine; Conn.; New Brunswick.

T. hamatus Moore. Length 35-40 mm., by 8 mm.; 85-100 segments; 1-4 hooked and bifid setae in each segment.

Genus Ilyodrilus, Eisen.

This is a California genus erected by Eisen and contains 3 species of very local habitat, so far as known. It agrees with Tubifex in the character of its setae and in its general structure. It is differentiated according to Eisen by the character of the efferent male ducts, which are short and broad; no vesicula seminalis.

I. perrieri Eisen. Length 10-12 mm.; width 1 mm. Anterior part of body much larger than posterior. Brain broad as long. Testes in 11, 12, 13 setigerous segment; ovaries in 10; sperm ducts of same length as atrium; penis without chitinous sheath; oviduct with double wall; spermathecae bent, with inner end sacculated and with no accessory glands. Fresno Co., California.

I. sodalis Eisen. Length 25 mm., width 1 mm. Brain much broader than long, with 6 ganglionic lobes on the posterior margin. Testes in setigerous segments 12-22, ovaries 19-22; sperm ducts as long as the atrium and penis combined; no chitinous sheath to penis; oviducts with single wall; spermathecae bent, 2-lobed, supported by a short stem, with a large accessory gland. No differentiated hearts, but the perivisceral vessels from 9 forward slightly contractile. San Francisco, Calif.

I. fragilis Eisen. Length 15 mm., width .25 mm., and anterior part not much enlarged. Brain not as broad as long. Sperm ducts longer than atrium, but not so long as atrium and penis together; penis not chitinous; spermathecae not bent, inner end simple, large and globular; oviduct single-walled and chitinous. Fresno Co., Calif.

Genus Embolocephalus, Randolph.

This genus differs from Tubifex chiefly in the fact that its head is more retractile, and the integument somewhat more heavy and opaque and with non-retractile sensory elevations running in rows around the segments. One pair of hearts in 8. It is questionable whether the species should be separated from Tubifex.

E. multisetosus Smith. Length 20-50 mm.; segments 60-105. The setae are numerous, particularly in the anterior segments. There are two sperm sacs which have been forced into a median

position dorsal to the digestive tract; one extends from 11-14, the other into 9. Havana, Ill.

Genus Limnodrilus, Claparede.

This is apparently a widely distributed genus in America, including one species reported from many localities, and several species described by Eisen from California. It appears that this would be a genus peculiarly well worth study in the different parts of this country. Eisen describes also a kindred genus (Camptodrilus) from California, with 4 species, which Michaelsen includes with Limnodrilus.

Limnodrilus is characterized as follows:—Aquatic worms with uncinate setae only. Contractile hearts in 8, or 8 and 9. The transverse blood vessels give off branches that penetrate the body wall in the posterior segments. Penis with distinct chitinous sheath and several times as long as broad; spermiducal glands in connection with the atrium of the sperm ducts.

The following, of which the first is the common species, may be noted:

L. claparedianus Ratzel. Length 40-70 mm., with about 150 segments; brain squarish with cleft behind, and antero-lateral lobes; pharynx extends to the fifth segment; chitinous penis 8-10 times as long as broad (length about 1 mm.). Illinois, California, Missouri, Pennsylvania.

L. ornatus Eisen. Length 30 mm., width 0.6 mm. Brain broader behind; with shallow cleft behind. Chitinous penis about 5 times as long as broad. Spermathecae flask-shaped, sometimes constricted near middle; oviduct single, sac-like, longer than penis sheath. California.

L. steigerwaldi Eisen. Length 80 mm., width .75-1 mm. Brain wider in front, concave behind, with several large lobes projecting forward. Penis about 8 times long as wide, largest at lower end; spermathecae narrow, pear-shaped. California.

L. monticola Eisen. Length 30 mm., 0.5 width. Brain as in *L. ornatus,* but more squarish. Penis cylindrical, about 8 times as long as broad, outer end widened and truncated. Spermathecae cylindrical, sometimes with slight constriction; oviduct double. California.

L. alpestris Eisen. Length 25 mm., width 0.5 mm. Brain wide behind and three-lobed; penis 8-10 times as long as broad, lower end pointed, with sheath trumpet-shaped at extremity. Spermathecae constricted in the middle and coiled at upper end. California.

L. sylvani Eisen. Length 50-180 mm. and breadth 1-2 mm.; mature brain wider than long, sometimes tri-lobed behind; penis 3 or 4 times as long as broad and ½ as long as its sheath; spermathecae are constricted in middle portion and sac-like at the ends; oviducts double walled. California.

L. igneus Eisen. Length 30 mm., width .75 mm.; color fiery red; brain broader in front and deeply cleft in front and behind; penis at least 10 times as long as broad, the

lower end of the sheath being expanded and plate like; spermathecae wide and bi-lobed at inner end; oviduct single walled and sac-like. California.

Genus Telmatodrilus, Eisen.

A California genus agreeing with Limnodrilus in having only uncinate setae and in the general character of the sexual ducts. It differs chiefly in the possession of numerous (8-10) spermiducal (prostate) glands, and the only slightly contractile peri-visceral blood vessels of segments 7-11.

T. vejdovskii Eisen. Length 35-50 mm., and width 1-2 mm. Setae 8-15 in each bundle. Esophagus long and narrow, expanding into the intestine in segment 11; the latter is covered with a coating of pigmented cell from 15 backward. Nephridia with vesicular peritoneal cells. Ventral blood vessel forks in 5. Brain somewhat triangular. Lives in marshy meadows with tail protruding above the surface of the mud in shallow waters, particularly at night. Fresno and Tulare Counties, Cal.

Genus Rhizodrilus, Smith.

This genus described from Havana, Illinois, is represented by one species, and is liable to be found in other places in the Mississippi system. It differs from Tubifex in that it is without capilliform setae, and the contractile hearts are more numerous (segments 7-10).

R. lacteus Smith. The species varies in length from 75-100 mm.; segments 215-365; slender. Nearly white and opaque owing to the presence of numerous small corpuscles in the coelomic fluid. Brain slightly concave on the anterior face, with two posterior lobes. The sperm sacs extend to 15 or 16, opening, as is usual with the family, on 11. Found among roots of submerged plants. Illinois.

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