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ARTICLE XII. THE HIRUDINEA OF ILLINOIS.

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ERRATA.

Page 136, line 2, and page 182, line 17 from bottom, for '*95a* read '*95*.

Page 226, line 2, page 263, line 17 from bottom, and page 267, lines 2 and 15, for '*98*, read '*96*.

Page 233, line 15 from bottom, for '*82* read '*82a*.

Page 355, line 2 from bottom, for C. *F.* Hudson read C. *T.* Hudson.

Page 389, foot-note, for Vol. *V.* read Vol. *IV.*

Page 457, line 5, for *Genera* read *Genus*.

ARTICLE XII.—*The Hirudinea of Illinois.* BY J. PERCY MOORE.

This paper is a partial descriptive catalogue of the leech fauna of Illinois. It is founded on collections gathered from time to time during the past twenty-five years by the Illinois State Laboratory under the direction of Prof. S. A. Forbes, of which material by far the most important part, as regards both number of species and individuals and state of preservation, is that taken by Prof. Frank Smith and other members of the staff of the Illinois Biological Station. For the opportunity of studying this material I am indebted to the interest and courtesy of Professors Forbes and Smith. No doubt other species occur in this region; indeed several others have already been recorded from the State.

No general morphological questions are discussed herein, though the specific descriptions include some evidence pointing to several generalizations of fact and theory which will be evident to the reader. The nomenclature of somites and annuli used, is that suggested in two recent papers (Moore '98 and 1900). Some differences (in the enumeration of somites of certain species) between this paper and the earlier one just mentioned are due to the recognition of an additional somite in the preocular lobe, as pointed out by Apathý ('88) and Whitman ('92), and the adoption of the neuromeric standard for the determination of somite limits as maintained by Castle (1900) and Moore (1900). A sharp distinction has not always been made between the different kinds of cutaneous sense organs, unless such distinctions are readily discernible in surface views. Eyes are described as single if they appear so in surface views, even though sections show them to be compound. In the figures the pigment cups alone of the eyes are exhibited, so that in some cases they are indicated in somites different from those which furnish their sensory cells. In fact, with very few exceptions, the descriptions have purposely been restricted to such features as are

visible under a good dissecting lens, though nearly all of the species have been sectioned and the distribution of sensillæ, etc., verified in that way. It has also been thought best to omit full synonymical tables (partly because of the doubt which attaches to some descriptions) and to include just sufficient names to connect the species under consideration with the previous descriptive literature. Blanchard's opinion has been followed with regard to the names of European forms. The order in which the species are considered does not express the writer's view of their relationships. The brief notes on habits are the results of observations made chiefly in the neighborhood of Philadelphia, where most of the species occur.

GLOSSIPHONIDÆ.

PLACOBDELLA BLANCHARD.

Placobdella parasitica (SAY).

Hirudo parasitica Say ('24).

Diagnosis.—Somites I and II are included in the preocular lobe, which may or may not exhibit a furrow separating them; one pair of small pigmented eyes on the large anterior annulus of III; the furrow V *a* 1/*a* 2 is much less distinct than V *a* 2/*a* 3; cutaneous warts and papillæ are numerous but low and often inconspicuous, and the median series is feebly developed; the epididymes and ducti ejaculatorii form a close coil chiefly confined to somite XI.

General Description.—This tortoise leech reaches a large size, occasionally attaining a length in extension of more than four inches. Such huge individuals are, however, rare, and the ordinary examples are seldom more than one half that size. In the resting state the outline is rather broadly oval, the anterior ends being only slightly less broadly rounded than the posterior. The body is depressed, with sharp margins and gently convex dorsum. When fully extended—and the capacity for extension is very great—the

body is widest near the posterior end and very slender anteriorly. Under such circumstances the head may be much wider than the constricted region immediately following it and has a somewhat cordate form.

The dorsal surface is provided with numerous sensory papillæ or cutaneous warts (Pl. XLII., Fig. 4). Except toward the margins, where they are arranged somewhat in two rows, they form a single series across each annulus. On many specimens none of the papillæ are at all conspicuously elevated, and the surface may appear quite smooth; in others each annulus bears from ten to twenty quite large warts which in general correspond in position with the larger warts of *P. rugosa*, but have very different proportions. The median series, so prominent in the latter, is in this species almost obsolete. The largest and most constant are those which overlook the dorso-lateral sensillæ. In all cases they are low, smooth, and rounded, and seldom bear more than a single sense organ; never a rough rosette-like aggregation at the summit.

The shape of the head differs much according to conditions of contraction and extension. Generally in the larger individuals it partakes of the even outline of the body and is broadly rounded anteriorly. In the younger specimens, especially in extension, it is somewhat expanded beyond a neck-like constriction, and the preocular lobe is somewhat sharply pointed. In such, also, the annuli are very clearly differentiated, and in a few cases the preocular lobe, which is generally simple, is distinctly subdivided into two rings (Pl. XLII., Fig. 1).

A single pair of eyes—they are really compound—(Pl. XLII., Fig. 1), frequently united in a common pigment spot, is situated on the posterior part of the second (occasionally the third) distinct annulus. Then follow a short annulus, a very large one, again a distinct short one, which forms the posterior rim of the sucker below, and then two imperfectly separated annuli V (a 1+a 2) which completely unite ventrally to constitute the postoral ring. On the ventral surface of the sucker and lip most of these furrows may be readily

recognized, and under some conditions are very deep. The mouth is relatively small, and placed far forward on a median thickening of the rim of the sucker beneath the preocular lobe.

There is no distinct clitellum, and the gonopores have the usual glossiphonid position of XI/XII for the male and XII *a* 2/*a* 3 for the female. The nephridial openings, of which there are 16 pairs, are situated on low papillæ a little anterior to the middle of the annulus *a* 2 on somites VIII to XXIII.

Compared with *P. rugosa* the posterior sucker is relatively large, its anterior margin reaching to XXII and the posterior largely free. It is circular, flat, and smooth. The anus is large and at XXVII/XXVIII.

Annuli and Somites (Pl. XLII., Fig. 1).—The annulation of this species is especially interesting and suggestive, inasmuch as it presents the strongest kind of confirmation of the comparison recently made (Moore, 1900) between the biannulate somite of *Microbdella* and the triannulate of the glossiphonids. Even in the largest specimens, and more or less obviously in all parts of the body, the annuli *a* 1 and *a* 2 are evidently more closely associated than are *a* 2 and *a* 3. In young examples and toward the extremities of the body, the neuromeric limits of the somites and the more primitive relations of their component annuli become extremely clear. The gradations between the biannulate and the triannulate types are so gentle that the exact number of complete somites cannot be definitely stated; it is impossible to decide just where the biannulate type ends and the triannulate begins. Of course this is more or less true of many leeches, but one can usually rest satisfied with a decision that a particular furrow is to be described as incipient or as complete. Not so, however, with this species. The different values of these furrows have, however, not been brought out in the plate.

I and II are preocular and are rarely separated by a recognizable furrow. In some cases the furrow II/III is very faint. At least one pair of metameric sensillæ are constantly

discernible; the others are obscure and must be sought for in sections.

III is biannulate. The first annulus is large and generally divided by an incipient cross-furrow, posterior to which are the eyes and a full set of metameric sensillæ. The second annulus (*a* 3) is smaller, and loses its individuality at the margins.

IV is also biannulate, the annulus (*a* 1 + *a* 2) being very large, but sometimes scarcely more visibly divided than its preceding homologue. All of the four pairs of sensillæ except the dorso-median are very distinct. This somite forms most of the lateral margins of the sucker, and its posterior ring contracts suddenly and sweeps caudad and mesiad as the narrow posterior ventral rim of the latter.

V. When the head is expanded as described above, this somite forms its posterior limit. The furrow *a* 1/*a* 2 is more evident than in somite IV, but *a* 1 and *a* 2 together may still be regarded as a single large and incompletely divided annulus. In no case does this furrow extend beyond the margins of the body, so that the ventral surface of the annulus is entirely undivided. The dorsal metameric sensillæ occupy the posterior constituent (*a* 2). The small annulus *a* 3 is a trifle more than half the length of the large one, and the furrow *a* 2/*a* 3 is very much deeper and more distinct than *a* 1/*a* 2, though somewhat less so than V/VI; it is also fully developed ventrally.

VI may be provisionally and arbitrarily regarded as complete, but even in this somite the furrow *a* 1/*a* 2 is dorsally much less obvious than *a* 2/*a* 3 and becomes on the ventral side very faint, and in small specimens especially obsolete. These two potential annuli are also smaller and more intimately associated on the ventral than the dorsal surface. Viewed from either above or below the marginal curvatures of *a* 1 and *a* 2 are more homogeneous and the emarginations much less deep and abrupt than between *a* 2 and *a* 3, thus further indicating the closer growth relations of the former two.

Much the same conditions prevail in succeeding somites,

but become gradually less and less obvious as *a* 1 becomes relatively larger and more completely dissociated from *a* 2. At the same time all of the furrows and the emarginations become more uniform; but in some specimens of large size and in a great many of the smaller ones the intersomitic furrows remain more distinct and *a* 1/*a* 2 less distinct for the entire length of the body, and especially is this so on the ventral surface. The external limits of the somites are often quite as distinctly indicated as in *Microbdella.*

On the fully developed somites of the middle region *a* 3 is always the largest annulus (Pl. XLII., Fig. 4), but, except in the posterior somites of large individuals, there is no indication of further subdivision into *b* 5 and *b* 6. Anteriorly, and especially in young individuals, *a* 2 is longer than *a* 1, but in the middle region it is only equal to or slightly less than this. Unlike *P. rugosa* this relative size of the annuli is the same ventrally and dorsally, and the ventral furrows are either exactly continuous with the dorsal or all are slightly and equally in advance of them at the margins.

At the posterior end, somite XXIII is triannulate above; but below the furrow *a* 1/*a* 2 becomes more or less reduced. Dorsally the marginal curvatures and emarginations present the features described for the anterior end, and *a* 3 is slightly shorter than *a* 1.

XXIV. Although the annulus *a* 3 unites with *a* 2 mesially and *a* 1 remains distinct for its entire width, contrary to the relative disposition of these annuli anteriorly, the marginal curvatures and emarginations still associate *a* 2 more closely with its predecessor than with its successor. Marginally, at least, *a* 1 is the largest component. On the ventral side all three annuli unite more or less completely into one.

XXV is very incomplete; *a* 1 and *a* 2 are inseparable and *a* 3 is distinct only marginally. XXVI is still more faintly biannulate at the margins or even entirely uniannulate. XXVII is uniannulate.

Reproductive Organs.—The six pairs of testes lie in the posterior parts of somites XIII to XVIII, extending somewhat into the succeeding somite in each case. The vasa

deferentia are ventrad and laterad of the testes. A slightly enlarged coiled region of the ducts in somite XI corresponds to the epididymes and ducti ejaculatorii, which latter become constricted before opening into the somewhat enlarged prostate cornua. The latter are quite distinct from one another except where they join beneath the nerve cord at the small bursa. There is no true muscular atrium.

Alimentary Canal.—The protrusible pharynx is very slender and when at rest reaches into somite X, where at its base it receives the pair of common ducts of the pharyngeal glands. There are two of these much lobulated glands on each side. The larger one extends by the side of the pharynx from a point opposite to the female pore in XII to the middle of IX. The main duct arises in this lobe at the junction of its anterior and middle thirds. The second gland is smaller. Beginning in a short duct which joins the middle of the principal one, it extends forward, dipping beneath the pharynx, as far as the anterior end of the main gland, where it emerges from beneath the pharynx and continues forward a short distance. Very frequently, but apparently not invariably, a median annectant lobe joins the lateral halves across the ventral face of the pharynx.

The lateral cæca are exceedingly well developed and their numerous lateral divisions reach almost to the margins of the body. Six pairs correspond very nearly to as many somites (XIII to XVIII). Except the first, they are arranged as a series of overlapping chevrons with the angles directed posteriorly. A seventh much larger pair of cæca arises in XIX and continues backward parallel with the intestine to about XXIII. The intestine bears four pairs of long simple cæca which are directed laterad dorsal to the last described.

Color.—Placobdella parasitica is very richly colored. On the dorsal surface the ground color of brown, greenish brown, or olive green is variously spotted, striped, and blotched with bright yellow, which replaces the ground color more or less extensively. Two specimens entirely alike can scarcely be found, so that a description applicable to all cannot easily be framed in a few words. The following, however, probably

includes the most essential features: The preocular region is very light colored, with a bright orange spot, sometimes including the eyes. The light yellow areas are chiefly confined to a median longitudinal stripe, to marginal spots, and to a pair of series of spots or blotches between these two. Sometimes the median band is continuous for the whole length, sometimes its middle part disappears, and sometimes small remnants of it remain at the ends only. It is of very irregular width, alternately expanding widely at intervals of about three somites and contracting between. The marginal spots are generally very regular, of somewhat triangular shape, and extend over the two annuli which lie between the successive neural annuli, the latter being dark colored at the margins. It is only at the ends of the body that they suffer modification. The intermediate series are the most variable. They may be formed of small spots including the dorsolateral sensillæ, and occurring on the neural annuli of every somite or only on every second or third somite; they may extend over *a* 3 as well as *a* 2 or they may become large irregular blotches reduced in number and extending over several somites; they may coalesce more or less into irregular longitudinal stripes which are likely to be constricted on *a* 1; and they may unite in various ways with the marginal spots or with the median band. The ground color may greatly predominate or almost disappear.

Habits.—This very common leech is found most frequently adhering to the plastron or naked parts of the skin of various species of turtles, to which it clings very tenaciously. In the early spring, before and during the period of production of spermatophores and oviposition, they feed eagerly and gorge themselves with blood. Like other species of similar habit they not infrequently kill their host by thus draining its blood. At other seasons they may be kept for months without food. Not infrequently this species is also found on floating wood in ponds and ditches or under stones in streams, where it feeds on small oligochætes, etc.

Placobdella rugosa (Verrill).

Clepsine ornata var. *rugosa* Verrill ('74).

Diagnosis.—Somites I and II distinctly and completely separated, usually strictly uniannulate; the single pair of eyes very close together on the posterior part of the large annulus of III; the furrow V *a* 1/*a* 2 quite as distinct on the dorsal side as V *a* 2/*a* 3; cutaneous papillæ numerous, mostly very large and rough and the median series very conspicuous; reproductive organs essentially as in *P. parasitica*.

General Description.—Although reaching a large size the largest individuals probably do not equal the largest of *P. parasitica*. Generally the length is from one to two inches. When resting this is the broadest and flattest of our leeches, the whole body being excessively depressed and foliaceous. A living individual in this state measures twenty-two millimeters long by fourteen broad. Incapable of the great degree of extension possible to *P. parasitica* it never becomes very slender.

The integuments have a peculiar translucent appearance, quite different from the opacity of *P. parasitica*. The whole dorsal surface of the body is exceedingly rough, in large living examples being clothed with a veritable forest of papillæ from which the eye readily picks out three longitudinal series of more prominent ones, conspicuous not only because of their large size but because of the regularity and constancy of their occurrence. One of these is median, the others about halfway to the margin. Toward the anterior end they become smaller and fewer; at the posterior, the median series ceases and several very prominent papillæ appear in a short series on each side of the median line. Further details are given below under the description of a typical somite.

Under all conditions of contraction or extension the anterior sucker partakes of the regular curvature of the body and never appears as an appreciably expanded disc. In preserved specimens it is deeply concave, with a high but thin posterior margin formed by IV, and thicker lateral margins. Anteriorly the preocular lobe is rather narrow and more or less inrolled

ventrally, where it is continuous with a thick rounded ridge which extends to about the middle of the sucker and ends at a deep curved furrow continuous laterally with III/IV. The mouth is a minute pore placed near the anterior end of the ridge beneath the overhanging preocular lobe. Metameric sensillæ on the preocular region have not been detected in surface view, though they can be demonstrated readily enough in sections. The eyes are essentially as in *P. parasitica.*

No clitellum has been found. The male sex pore is at XI/XII and the female at XII *a* 2/*a* 3, but *a* 3 is enlarged mesially and pushes forward into an emargination in *a* 2, so that the female pore generally lies rather more within the latter. The male orifice is the larger and is surrounded by more or less prominent rugosities. The most anterior nephridial openings which have been detected are on VIII, the last on XXIII.

Although of smaller size than in *P. parasitica* the posterior sucker is rather large and has a longitudinal diameter slightly exceeding the transverse. It extends anteriorly to XXIII. The entire free dorsal surface bears papillæ which are numerous and rough on the posterior exposed part, where four to six radiating rows are larger than the others. Anus XXVII/XXVIII.

Annuli and Somites (Pl. XLII., Fig 2).—I and II constitute the preocular lobe.

III is biannulate, with the large anterior ring very faintly divided by an incipient cross-furrow, posterior to which are the closely approximated eyes, two pairs of metameric sensillæ, and one pair of warts which apparently belong to the dorso-lateral series. The second annulus bears a full set of the characteristic papillæ or warts, but they are of very small size.

IV differs from III dorsally in that *a* 1 is more distinctly differentiated from *a* 2 by a furrow which is always distinct marginally but may disappear mesially. The anterior annulus (*a* 1) thus indicated is smaller than *a* 2, and bears no papillæ except in the case of two exceptionally rough individuals from Tinicum Island, near Philadelphia. The *a* 2 constituent bears all of the dorsal sensillæ except the dorso-

median and the supra-marginal, and the more characteristic papillæ belonging to this ring. *A* 3 is about half the length of the larger double annulus, bears its characteristic papillæ, and forms the margin of the posterior rim of the sucker.

V is triannulate dorsally, *a* 2 is slightly wider than *a* 3, and the latter than *a* 1, but all furrows are equally well developed, until at the margin *a* 1/*a* 2 suddenly disappears, leaving two ventral annuli of approximately equal size.

Eighteen somites (VI to XXIII) are completely triannulate. A curious feature of these (Pl. XLII., Fig. 3) is that the relative lengths of the annuli differ dorsally and ventrally; above, *a* 2 is the largest, *a* 3 slightly less, and *a* 1 obviously the smallest; below, *a* 2 is the shortest, and *a* 3 just appreciably shorter than *a* 1. This is readily explained by comparison of the relative positions of the furrows. Along the margins of the body is an exceedingly thin expansion, crenulated in correspondence to the annuli. Set in the emarginations between successive lobes are narrow wedge-shaped pieces which in the contracted leech assume the position of more or less vertical folds uniting the dorsal and ventral furrows. When the leech is extended these pieces of course become horizontal, and the dorsal and ventral furrows assume the following relative positions; *a* 3/*a* 1 is ventrally in advance of its dorsal part, *a* 1/a 2 is ventrally slightly behind, and *a* 2/*a* 3 again ventrally in advance. This lack of alignment characterizes all furrows from about VI/VII to XXIV/XXV.

On the dorsal surface some very faint transverse wrinkles pass between the principal papillæ and are about equally apparent on all of the annuli. Ventrally *a* 1 and *a* 2 may be more or less divided, the portions toward the ends of the somites being the smaller; *a* 2 very rarely shows faint traces of such a division. In this feature and in the rough cutaneous papillæ the species resembles *Hæmenteria officinalis.*

The disposition of the papillæ on a typical complete somite is shown in the figure (Pl. XLII., Fig. 3), and is as follows: On the dorsal surface of each annulus are two rows of small smooth sense papillæ separated by the transverse wrinkles

above mentioned and differing somewhat in size and distance apart. They are generally single but here and there are grouped in twos, threes, or fours. The number in a transverse row counted singly or as groups is from thirty to fifty on the middle region of the body. A few others may be scattered between the rows or even form a third broken row between the larger papillæ, particularly on *a* 3. Along the margins large numbers may be aggregated. The large rough papillæ are prominent wart-like elevations of the integuments, some of which measure more than a millimeter in height in living examples. They appear not to contract under ordinary stimuli, but are sometimes very much less elevated in preserved material. They are generally conical in shape, their summits bearing a ring of from four to twenty smaller sense papillæ arranged around a central larger one. When the number is greater than eight or nine they are likely to form a less regular ring and to extend further down the sides of the wart, while the central one becomes replaced by two or three. A relation between the size of the wart and the number of papillæ in its crown seems to exist. Of the median series (*mp*) that on *a* 2 is the largest and often bears twice as many sense organs as that on *a* 1, which is the smallest. The next series counting laterad (*mdp*) is always represented by a very large wart on *a* 3, by a much smaller, frequently absent, one on *a* 1, and on *a* 2 is replaced by a rather prominent but smooth papilla which supports the dorso-median sensilla (*md*). This cannot be confounded with the rough papillæ. The next important series (*dlp*) is made up of a large one on *a* 2, a smaller one on *a* 3, and a very much smaller one or none on *a* 1. Just external to the large one on *a* 2 is the dorso-lateral sensilla (*dl*), which is somewhat elongated transversely and is litttle elevated above the surface. At the margin are two rows so imperfectly developed that they are probably better described as a single irregular row (*dmp*) sometimes represented by two warts on a single annulus. Warts of smaller size are generally present, but are more irregularly distributed than the fairly constant ones just described. They are most frequent on *a* 1, where one such is likely to be present

between the median and dorso-median rows, two between the latter and the dorso-lateral, and two between this and the marginal. *A* 2 sometimes bears one internal and one external to the dorso-median sensilla. The marginal sensillæ are small.

At the posterior end somite XXIII, though triannulate, shows some peculiarities. The median papilla on *a* 2 is much reduced in size or absent, and on each side of the middle line appears a very large rough wart not represented on any of the anterior somites. In surface views no trace of the dorso-lateral sensillæ can be found, but it is suspected that they have been raised to the top of the large warts just described, where a truncated clear area is sometimes visible. Annulus *a* 3 is somewhat shortened, but in all other respects this somite is typical.

On XXIV the same features appear somewhat exaggerated; the papillæ are as described for XXIII, and annulus *a* 3 is distinctly smaller and mesially joined to *a* 2.

XXV, XXVI, and XXVII show successive steps toward a simpler condition. The first is generally divided into two annuli nearly or quite to the middle; the second, for a greater or less distance from the margin; and the third, just at the margin or not at all. In all of these cases the anterior annulus is the larger and bears a rather large median wart; the peculiar pair of warts of XXIII and XXIV is wanting; and the reduction in size of all other warts leads to the relatively greater prominence of the dorso-lateral series.

Reproductive Organs.—The genital organs differ in no important respect from those of *P. parasitica*. The only difference apparent in a number of dissections is that the prostate cornua of this species are rather longer.

Alimentary Canal.—Only two minor characters in which the digestive tract of this species differs from *P. parasitica* need be mentioned: the pharyngeal glands have no median annectant lobe; and the cæca are less finely and numerously divided.

Color.—The colors of living examples of this species generally impress one as a pepper-and-salt mixture of various

light and dark browns, yellows, and greens, which, owing to the translucency of the integuments, are seldom sharply defined. They appear to be more definite on preserved specimens, and certain metameric features and resemblances to the plan of coloration of *P. parasitica* are recognizable. The light marginal spots are present with the same regularity as in that species. The light median stripe may usually be distinguished at the anterior, and less frequently at the posterior, end. It is constricted or quite interrupted by the dark color of the neural annuli, which encroaches on it, while in the intervals between them the light color extends in narrow bands more or less laterad. In the middle region of the body short longitudinal median brown or brownish green lines alternate with light spots. The former correspond to the constrictions, the latter to the expansions, of the median stripe of *P. parasitica*. Sometimes there is a very distinct continuous narrow median dark brown line. The rest of the dorsal surface is generally variegated browns, with the papillæ light yellow or green and the position of the dorso-lateral sensillæ indicated by rather large and conspicuous light spots.

Habits.—A species of sluggish habit; abundant in running waters, where it is found clinging to the under sides of stones. It also attaches itself to the under side of floating wood in ponds and ditches. Particles of mud cling to the mucous secretion on the body and render it inconspicuous, and the leeches frequently bury themselves partially beneath the sediment at the bottom. They seldom swim, but creep along the surface to which they are attached. If thrown into the water they roll up and sink to the bottom. They carry the eggs or young in early spring, a habit which is common to most members of the family.

Glossiphonia Johnson.

Glossiphonia complanata (Linnæus) Johnson.

Hirudo complanata Linnæus (1758).
Clepsine elegans Verrill ('74).

Diagnosis.—Somites I to IV each uniannulate, II and III often imperfectly separated and IV sometimes faintly subdivided; three separate pairs of pigmented eyes in somites II, III, and IV, the first pair commonly crossed by the furrow II/III; V is biannulate; male pore at XI/XII, female pore at XII *a* 2/*a* 3; dorsal cutaneous papillæ low and inconspicuous, principally in four series, no median series; epididymis folded into a long loop which reaches into somite XVIII or XIX; nine pairs of testes (XIV to XXI).

This is a species well known in Europe, of which figures may be found in Moquin-Tandon ('46, Plate XII.), and diagrams of the annulation and a description in Blanchard ('96), while Verrill describes the colors of American specimens. It abounds in certain localities under stones in running water, is very active but rolls itself into a ball when disturbed, and feeds chiefly on small snails and annelids.

Glossiphonia lineata (Verrill).

Clepsine papillifera, var. *lineata* Verrill ('74).
? *Glossiphonia triserialis* E. Blanchard ('49).
? *Helobdella triserialis* R. Blanchard ('96).

This species is almost certainly *G. triserialis*, and I hesitate to give it that name only because R. Blanchard ('96) has stated that the male pore of his specimens is situated at 23/24 (XI/XII) instead of one annulus further caudad as in the form here described.

Diagnosis.—Somites I and II uniannulate, III and IV biannulate, and V triannulate; the single pair of very large eyes situated in IV; male pore at XII *a* 1/*a* 2, female pore at XII *a* 2/*a* 3; dorsal cutaneous papillæ conspicuous (owing to black color), generally in three (sometimes in five) longitudinal

series, of which the median is the best developed; epididymis forming a loop which reaches into somite XV.

General Description.—A small species seldom over half an inch in length, but capable of moderate extension. In the resting state broad and slightly convex above but not foliaceous, the body being rather thick; when extended, strongly convex.

The anterior sucker is of moderate size and has a rather thick margin into which the annulations extend. It is deeply concave and presents no central elevation. The mouth is large and situated just behind the anterior rim of the sucker, apparently in somite II. Occasionally it is succeeded by a transverse fold. The eyes, of which there is a single pair, are of remarkable size, their diameter being nearly equal to the length of annulus IV ($a\,1+a\,2$) in which they lie. They are simple and correspond to the second pair of *G. complanata*. The genital pores are separated by but a single annulus, the neural annulus of somite XII; they consequently both lie within the limits of that somite.

The posterior sucker is large but relatively little exposed, elliptical in form, and with a thick margin. It reaches forward to XXIII $a\,2$.

Annuli and Somites (Pl. XLII., Fig. 6).—I and II are uniannulate and constitute the undivided anterior lobe.

III is biannulate, the anterior ring being somewhat the larger. No sensillæ are visible in surface views, but sections show that the eyes are derived from this somite.

IV is biannulate, but the anterior annulus is relatively larger and is faintly subdivided; it bears the very conspicuous pair of eyes. At the margin this somite becomes uniannulate and forms the posterior rim of the sucker.

V is triannulate above. $A\,2$ is much longer than $a\,1$, especially mesially, where it appears to be almost subdivided. The furrow $a\,2/a\,3$ is the deepest in this neighborhood and defines the posterior limits of the head very sharply. Ventrally $a\,1$ and $a\,2$ unite while $a\,3$, as usual, remains distinct.

VI is the first of the fully triannulate somites, and all three annuli are distinct ventrally as well as dorsally. In all of the

complete somites *a* 2 is somewhat wider than its fellows, dorsally at least, and is rendered further conspicuous owing to the papillæ which it alone bears, its slightly protuberant margins, and the white spots which characterize it.

The arrangement of the cutaneous papillæ, though variable in detail, is very characteristic of the species among local forms. But three constant and conspicuous series exist (Pl. XLII., Fig. 6); a median (*mp*) and a pair of dorso-laterals (*dlp*) situated nearly half-way to the margins. The median series begins sometimes as far forward as somite VI or VII, but seldom becomes prominent before IX or X, from which it continues to XXVI. This is really not a strictly median series, as the papillæ comparatively seldom lie exactly in the median line but usually a little to the right or the left. Very frequently the single conical papilla is replaced by two which are placed more or less close together, in contact or even united into a bilobed or a transversely elongated one. The whole appearance of the series must lead one to recognize its dual character. All of these papillæ are prominent, sharp-pointed, simple cones, whose black color amid white or pale surroundings renders them doubly conspicuous. They are largest in the middle of the series and diminish toward the ends, that on XXVI being very small and some of the anterior ones minute.

In every important feature the dorso-lateral series is similar to the median. The papillæ begin further back and are seldom conspicuous anterior to XIII, from which point they continue to XXVI or XXVII, the last two or three being small. They are somewhat smaller than the median ones and are more likely to be absent from a somite. Though forming a nearly perfect series anteriorly, they present an even greater tendency toward irregularity and doubling posteriorly.

Occasionally one or two isolated papillæ are found between the median and dorso-lateral series, and remnants of a very imperfect supra-marginal series occur more frequently on several of the posterior somites. Very few and faint papillæ occur on the sucker. The dorsal surface of the body

is everywhere roughened by projecting cutaneous sense organs.

The anterior metameric sensillæ (Pl. XLII., Fig. 6) are very difficult to make out in surface views, but about X or XI they become very conspicuous and continue so to the posterior end. Here they appear as eight dorsal series of clear white spots. The dorso-medians (*md*) are placed on each side of the median papillæ, separated by a distance about two thirds of that which intervenes between them and the dorso-laterals. The latter (*dl*) are just about half-way between the mesion and the margins, or a trifle nearer to the latter, and consequently are external to the dorso-lateral papillæ. The dorso-marginals (*dm*) are well back from the margins, being about as far from the dorso-laterals as are the dorso-medians, except on the incomplete somites, where the former distance is less. The supra-marginals (*sm*) are very minute and on the exact margins as viewed from above, except on the incomplete posterior somites, on which they are somewhat removed from the margins. The ventral sensillæ have not been studied.

Reproductive Organs.—In most respects resembling the species of *Placobdella* the reproductive organs differ from theirs and resemble those of *G. complanata* in one important feature: the enlarged portion of the sperm-duct (epididymis and ductus ejaculatorius), instead of simply coiling up, extends caudad in a long straight loop which lies ventrad to the gastric cæca and reaches at least as far as ganglion XV.

Alimentary Canal.—The proboscis is of relatively much greater diameter than in the two species of *Placobdella* described, and the gastric cæca are of small size and scarcely lobed. There are but six pairs of these cæca, which increase in size caudally, and the first of which (in XIV) is rudimentary or sometimes absent. In all of these respects this species is intermediate between *G. complanata* and *G. stagnalis.*

Color.—The colors are here described from preserved material. They are very simple and effective. Below, a plain ash-color; above, the same color marked by eleven or twelve longitudinal stripes of brown which are further com-

pounded of narrow brown lines, the number of which varies according to the width of the stripe. The longitudinal stripes correspond with the arrangement of the musculature as described for other species by Graf ('99). On many specimens these stripes are more or less interrupted on *a* 2 of each somite by transverse whitish spots which occur almost constantly in two, four, or six longitudinal series, of which the most constant lie just external to the dorso-lateral papillæ, the next on the flanks of the median papillæ, and the third near the margins. The extreme of this arrangement results in a handsome metameric pattern in which *a* 2 becomes conspicuously marked by a row of white spots which on the posterior somites unite to form a band. In such specimens the ground color becomes a pale brown marked by numerous narrow dark brown or almost black lines, of which a pair near the middle line are very conspicuous. The white spots are least developed anteriorly, but become more extensive and closer together posteriorly. Individuals differ greatly as to the exact manner and extent of the complementary development of light and dark elements in the pattern. The entire preocular region is beautifully white, while brown rays on a white ground mark the sucker.

Habits.—In habits *G. lineata* resembles *G. complanata*, with which it is frequently found. Probably this species inhabits colder brooks than any other of our glossiphonids.

Glossiphonia stagnalis (Linnæus).

Hirudo stagnalis Linnæus (1758).
Hirudo bioculata Bergmann (1757).
Clepsine modesta Verrill ('74).

Diagnosis.—Somites I to III included in preocular region; single pair of eyes on anterior annulus of IV, which is obscurely biannulate; V biannulate; VI to XXIV triannulate; XXV and XXVI biannulate, the latter somewhat united to XXVII; genital orifices as in *G. lineata*; a dorsal chitinoid glandular bursa situated at VIII *a* 1/*a* 2; gastric cæca small, simple, variable, never more than six pairs, of which any or all of the first three may be absent; size small and form con-

vex, capable of great extension; no papillæ nor conspicuous markings.

This widely distributed species is figured by Moquin-Tandon ('46, Pl. XIII., Fig. 16–26), and the annulation of the anterior end by Blanchard ('96).* The species is exceedingly abundant everywhere in the shallow waters of rivers, lakes, and ponds, in small streams, pools, and ditches, in fact everywhere where comparatively warm shallow fresh waters are found. It is found clinging to the under sides of stones, and between the ensheathing leaf stalks of aquatic plants, fallen leaves, etc. When disturbed it creeps actively to a place of concealment. The favorite food is small annelids and gastropods, but blood is also taken from injured fish, frogs, etc. The breeding season lasts all through the spring and early summer.

Hemiclepsis Vejdovský.

Hemiclepsis carinata (Verrill).

Clepsine papillifera, var. *carinata* Verrill ('74).

Diagnosis.—Somites I and II rather distinctly biannulate; the single pair of eyes on III; the widely expanded head pedicellate on a wide pedicle formed by VI; annulus *a* 3 of complete somites much larger than *a* 1 or *a* 2 and unequally subdivided at the margins; the dorsum bears three prominent papillated keels; the epididymis and ductus ejaculatorius form a few simple coils in XI and XII.

General Description.—A medium-sized glossiphonid of striking appearance. It seldom reaches a length of more than one and one half inches when partially extended in the act of creeping. The shape of this species is entirely characteristic among known Illinois leeches. In the large size, distinctness, free margin, and pedicellate attachment the head resembles that of the *Ichthyobdellidæ*. The body is more slen-

* By far the best description of this species extant has recently been published by Castle, in Bull. Mus. Comp. Zoöl., XXXVI. (1900), pp. 21-33.

der and less flattened and foliaceous than in other glossiphonids of equal size. It is never very wide and depressed, but on the contrary rather strongly convex dorsally. Capable of great extension and contraction the body may become very slender, especially anteriorly, or short, thick, and elliptical, and very convex above. In both states the head stands out clearly and sharply as a distinct region. This is an excellent character for distinction from the other leeches described in this paper.

Viewed from above the head is very broadly cordate, the bluntly rounded apex being anterior. Below, the very free posterior margin is entire and slightly convex or straight. This margin appears to be formed by the very strong downward and backward development of V, which becomes much enlarged below and whose ventral sensillæ are visible on the lateral parts of the posterior margin of the sucker. Dorsally the surface of the head or sucker is strongly annulated. At the margins the annuli are supplemented by a narrow but distinct undivided rim. The ventral surface is smooth, with sometimes two or three faint transverse furrows. Just inside of the anterior border is the small mouth, apparently in II. The labial sense organs are exceptionally well developed around the entire margin of the sucker.

The posterior limit of the head is clearly defined both above and below by the furrow V/VI. This is followed by two small annuli (which are regarded as a divided VI *a* 1) which form a short neck embraced anteriorly and concealed below by V *a* 3. Ventrally they become still smaller and perhaps united. Posterior to this point the body increases rapidly in width and the posterior part of VI is equal to IV, the widest part of the sucker.

The most striking characteristic of the species, however, is the presence of three prominent carinæ which extend from just behind the head to the posterior sucker. These are formed chiefly of high and closely appressed papillæ, the tips of which produce a sharp erect serrate crest.

There is no true clitellum, and the genital pores have the usual situations at XI/XII and XII *a* 2/*a* 3. Sixteen pairs of

nephridiopores have been determined on somites VIII to XXIII inclusive.

The posterior sucker is exactly circular, with a finely but distinctly denticulated margin. It is, though not of large size, widely exposed behind, and reaches anteriorly to XXIII *a* 1. Its pedicle of attachment is unusually small, permitting great freedom of movement.

Annuli and Somites (Pl. XLII., Fig. 5).—I forms the apex of the head and is divided dorsally into two small rings by a cross-wrinkle.

II is quite distinctly biannulate and bears evident dorso-median and dorso-lateral sensillæ.

III consists of two large annuli, of which the anterior is slightly divided by a faint cross-furrow which is confined to the median region. It bears the eyes, which are separated by a space about equal to their own diameter, and three pairs of sensillæ, one of which is remarkable by reason of its position directly above the eyes. Sections of this species have not been studied.

IV closely approaches the triannulate condition, *a* 1 having very nearly the typical relations. Three or sometimes four pairs of sensillæ are easily discernible.

V. This somite presents several interesting features. It consists of two annuli of about equal size, both enlarged at the margins, where the anterior one is somewhat divided into *a* 1 and *a* 2. Three pairs of sensillæ are present on *a* 2, but the dorso-medians are wanting, while on *a* 3, almost directly behind the dorso-laterals, appear what seem to be an extra pair of these sense organs.

VI is also peculiar in that *a*1 is completely divided on the dorsal side into two small annuli which appear as one ventrally.

VII is fully triannulate and the annuli present the typical proportions. *A*1 is the smallest, *a* 2 intermediate, and *a* 3 the largest. *A*1 and *a* 3 exhibit shallow ventral furrows across their entire width, and the furrow of *a* 3 continues on to the dorsal side, from the margin almost to the dorso-lateral carinæ. It cuts the annulus posterior to the sensillæ. XXII,

the last triannulate somite, lacks this subdivision, but it exists on all other complete somites.

XXIII, in addition to the differences of papillation already mentioned, shows peculiarities in annulus *a* 3, which is the smallest of all and is differentiated from *a* 2 at the margins only.

On XXIV the complete individuality of all three annuli is suppressed, their boundaries being evident only at the margins. On XXV only the marginal notches *a* 2/*a* 3 are indicated.

XXVI and XXVII are uniannulate and contracted to form the supporting pedicle of the sucker.

The arrangement of the papillæ is as follows: The median series (*mp*) begins in small isolated papillæ of about equal size, usually on VI *a* 2 and *a* 3. By about IX they are well established on all three annuli, *a* 3 bearing the largest, *a* 2 the next in size, and *a* 1 a very small one, and this relative size is maintained throughout the series. A few somites caudad they are higher, more prominent, crowded, and elevated on a ridge. Nearing the posterior end the ridge increases in height and the papillæ on *a* 2 and *a* 3 increase in size, but the crowding becomes relieved and the papillæ on *a* 1 smaller or more frequently absent. Both the ridge and its papillæ cease completely and abruptly on XXII *a* 3.

The paired carinæ (*dlp*) are slightly nearer to the margins than to the middle line. In essentials they are precisely similar to the median one, but present the following special features: the carinæ as a whole are slightly less prominent; they require a greater distance in which to become fully established, i. e., the papillæ are not supported on a continuous ridge, nor present on every annulus until about XII or XIII; scattered papillæ of small size are found on *a* 1 and *a* 2 as far forward as VI, but they are very small; in the region of full development the papilla on *a* 2 is by far the largest of this series and generally larger than any of the middle series, and the papilla on *a* 1 is very small and frequently absent, especially in the posterior region. The

last papilla of the series is on XXII *a* 3 and is displaced slightly mesiad.

On somites XXIII to XXVI the carinæ are absent and are replaced by four pairs of large papillæ. These form two short series which if continued forward would pass midway between the median and lateral carinæ. The first pair, situated on the larger annulus of XXIII, is the largest, the next somewhat smaller, while the others diminish rapidly and converge posteriorly. Very minute papillæ may occur on the preanal somite.

All of the papillæ enumerated are of prominent conical form, sharp-pointed, and high. Their summits bear a contractile apex, which in some cases is almost filiform in extension, in others short truncate in contraction. Around the base of this appendage a few smaller points may be clustered.

In addition to those more prominent papillæ which have been described, a more or less complete irregular series of small papillæ forms a dorso-marginal line, external to which a few are scattered along the margin and a still smaller number on the internal side. None of these are ever elevated on a ridge.

The metameric sensillæ have the following positions (Pl. XLII., Fig. 5). The dorso-medians (*md*) are just a little way to the mesial side of the middle of the area between the median and the dorso-lateral carinæ, and are quite easily traced as far forward as II. A curious* circumstance which requires investigation is that a pair appears to lie on the integument directly above the eyes. In the middle body region the papillæ of this series are slightly elevated and they are everywhere the most conspicuous. The dorso-lateral sensillæ (*dl*) are almost as evident on the head as the dorso-median, but much less so on most of the body somites. They are just external to the large papillæ of the dorso-lateral series, but after the suppression of their guardian papillæ, on XXIII, they stand out much more prominently in their isolation. The dorso-marginals (*dm*) become visible on III and continue

*Inasmuch as the eyes seem to be the representatives of the dorso-median sensillæ of somite III and to have undergone no shifting.

distinct to XXV, on which latter they approach very close to the dorso-laterals. By the fusion of the sensillæ of these two series on XXVI and XXVII but three pairs remain. Very minute supra-marginals (*sm*) are also present on most of the annuli. Near the margin of the sucker one or two very regular circles of eight sensillæ are ranged.

Reproductive Organs.—The six pairs of testes are in the anterior ends of somites XIV to XIX, extending somewhat into the preceding somites. The enlarged region of the sperm-duct (epididymis and ductus ejaculatorius) forms a coil or two, and its full length when extended laterally scarcely reaches to the margin of the body at the male pore. The prostate cornua are short and wide. The anterior and dorsal lobe of the ovary, which represents the closed end of the sac, is large and prominently projecting.

Alimentary Canal.—Pharynx slender and very extensible, its glands small. The same number and general arrangement of the gastric cæca as in *P. parasitica* are found in this species, but they are much less subdivided and branched.

Color.—The colors of this species are generally dull and uniform. Very commonly the entire body is a light or darker green or brownish green with a few flecks or lines of deep green and an obscure pale yellow border. Sometimes the pattern is more definite, as in the following case: The entire central region of the dorsum is of a brownish green color which on the neural annuli extends to the margins in the form of narrow sharp-pointed projections, by which a series of large yellow marginal spots are separated from one another and thus barely escape forming a continuous yellow border. Six or seven elongated light yellow spots form a median series and alternate with short dark greenish brown longitudinal lines. Smaller, more or less confluent light yellow spots mark the lateral carinæ. The head is marked by an irregular green-edged dark brown "spread eagle" figure, which leaves a large anterior and a pair of posterior lateral light spots.

Habits.—This species to a great degree lacks the social instincts of most glossiphonids. A far larger number of specimens are found singly than in company. In the neigh-

borhood of Philadelphia they are most frequently found in meadow brooks, adhering to stones, or attached to frogs and, during the spring, to toads. They frequently enter the shells of living mussels, which they probably attack. During the spring at least they are voracious blood-suckers, and along the Delaware River congregate at points where fish are cleaned and the waste thrown into the water.

ICHTHYOBDELLIDÆ.

The collection contains several specimens of a small species of *Piscicola* and another probably of *Piscicolaria*, both parasitic on several species of small fishes. The material is not sufficiently well preserved to permit of determination or description. This family is further represented only by

ACTINOBDELLA gen. nov.

Generic Characters.—The head small, not explanate; the posterior sucker large, hemispherical, with a marginal circle of slender processes; the complete somites with six secondary annuli of unequal size.

Actinobdella inequiannulata sp. nov.

Diagnosis.—A median series of papillæ on annuli *b* 3 and *b* 5; annulus *b* 5 the longest, *b* 4 the shortest, in complete somites; male orifice at XI/XII, the female at XII *b* 4; acetabular papillæ about thirty, provided with adhesive glands.

General Description.—The single specimen representing this species is of small size; the total length is 9.7 mm., the greatest width 1 mm., and the diameter of the posterior sucker about 1.8 mm. The sexual organs are very inconspicuously developed, and it is possible that the species may reach a somewhat larger size.

The form is slender (Pl. XLIII., Fig. 8), with the margins of the body parallel for almost its entire length, but suddenly contracted posteriorly to constitute the narrow pedicle of

the conspicuous sucker, and gently tapering anteriorly to the broadly rounded upper lip. Depressed throughout, with the dorsum convex and venter flat; the margins somewhat sharp.

There is no expanded anterior sucker (Pl. XLIII., Fig. 8) or head as in typical ichthyobdellids, but this end of the body is formed like a glossiphonid or, excepting the character of the mouth, more like a nephelid. The lip is broad and rounded and in this example is turned in ventralward. On the dorsal side it is divided into annuli as described under the caption *Annuli and Somites.* The ventral surface presents a very deep cavity from out of which rises a prominent rounded elevation, near the summit of which the pore-like mouth is situated. The posterior boundary of the sucker is formed by somite V. No pigmented eyes can be detected, but an opaque spot on the third and fourth rings may possibly be eyes, though appearing more like a gland.

No clitellum is developed. The male genital orifice (Pl. XLIII., Fig. 8, ♂) is a minute pore situated in a transversely extended elliptical disc at XI/XII; but on the ventral side the annuli XII *b* 1 and *b* 2 are obsolete and the male disc therefore somewhat overspreads annulus *b* 3. The female pore (♀) is in the form of a small transverse slit in annulus XII *b* 4 and, owing to the great reduction of *b* 1 and *b* 2, appears to be separated from the male opening by only one and one half annuli.

Most remarkable of all of the external features of this leech is the posterior sucker (Pl. XLIII., Fig. 8–10). It is much wider than any part of the body, of hemispherical form, largely free on all sides, and supported by a narrow central pedicle. The ventral surface (Pl. XLIII., Fig. 10) is very deeply cupped, and in the specimen described the rim is somewhat contracted, making the diameter of the opening somewhat less than that of the internal cavity. From the inner face of the sucker, a short distance back from the sharp margin, spring about thirty (exactly thirty in this example) slender finger-like processes, which project more or less freely into the cavity. Owing to their contractile nature they may vary in length and diameter, but when extended

are about .4 to .5 mm. in length and perhaps .1 in diameter. Each one (Pl. XLIII., Fig. 11) contains a central gland duct or perhaps a group of ducts surrounded by a sheath of muscle fibers springing from muscular ridges which pass like radii down the inner face of the sucker. The gland ducts arise from a circle of glands which appear as a ring of whitish spots arranged around the sucker about half-way between the margin and the pedicle, and which raise the outer face into a slightly marked encircling ridge. The anus is inconspicuous and appears to be situated in the usual position posterior to somite XXVII.

Annuli and Somites.—It is obviously unsafe to assign to a species all of the details of annulation exhibited by a single specimen. The arrangement of the annuli in certain regions is so obscure and appears so differently under different conditions of fixation and preservation, and, moreover, is so subject to individual variation, that the typical conditions in many species can be determined only by the careful study of many individuals. What follows, therefore, must be considered as applying in entirety only to the type specimen. The characters of the complete somites and the composition of most of the incomplete somites will in all probability be confirmed by the study of further material.

As the type specimen is interpreted the somites are constituted as follows (Pl. XLIII., Fig. 8, 9):—

I to IV are uniannulate and the furrows which separate the first three annuli are faint. No sensillæ are recognizable.

V, VI, and VII are biannulate, with three pairs of distinct sensillæ on the first annulus of each. In each case the second annulus is somewhat the larger.

VIII is triannulate, and *a* 3 is somewhat larger than its fellows and subdivided by a faint furrow. The sensillæ are on *a* 2.

On IX we find *a* 1 subdivided equally into *b* 1 and *b* 2 by a shallow furrow, *a* 2 more distinctly split into a larger anterior and a smaller posterior ring, of which the former bears the three pairs of sensillæ, and *a* 3 subdivided equally.

X is similar to IX except that *b* 5 is considerably larger

than *b* 6 and the secondary furrows are more nearly equal to the primary.

XI is a typically complete somite and presents characters which are found with some slight individual variations as far back as XXIV inclusive. In all of these the annuli are very clearly indicated both on the dorsal and ventral surfaces. *A* 1 is divided equally into *b* 1 and *b* 2, which are quite short rings unmarked by any papillæ; *a* 2 is very distinctly divided into a long *b* 3, which bears a large median cutaneous papilla and the three pairs of metameric sensillæ, and a *b* 4, of half the size or less, which is the smallest annulus of the somite and bears no papillæ; *a* 3 is cut into *b* 5 and *b* 6, of which the former is the largest annulus of the somite, both in length and breadth, and which bears a large papilla similar to that on *b* 3, while *b* 6 is a simple unadorned ring equal to *b* 1 or *b* 2. Thus each complete somite is divided into six annuli of unequal size, and, leaving out of sight the limits of the somites, this region of the body exhibits a regular alternation of groups of three equal small rings with groups composed of two large rings separated by a very small one. Each of the large rings is marked by three cross ridges which appear to be due to transverse muscle bands, while the narrow rings present only two such ridges, *b* 4 sometimes only one ridge.

The cutaneous papillæ (Pl. XLIII., Fig. 8) are rather conspicuous conical elevations with the long axes of their elliptical bases directed longitudinally. In the middle region they are strictly confined to the annuli indicated, but posteriorly somewhat overlap the succeeding secondary annuli. On other specimens they will probably be found to begin further forward than on the type, as opaque thickenings of the integuments appear in the proper regions of somites X and IX, though there are no elevations.

Of the dorsal sensillæ (Pl. XLIII., Fig. 8) the supramarginals cannot be distinguished, but the dorso-marginals (*dm*), dorso-laterals (*dl*), and dorso-medians (*md*) are obvious, and are very regularly arranged on all somites from V to XXVI. Peripherad of these points they have not been traced.

The distances separating the two dorso-medians and the dorso-laterals from the dorso-marginals are about equal and somewhat less than that between the dorso-medians and dorso-laterals.

XXV exhibits very much less distinct secondary furrows, the annuli all of about equal size, and the somite practically triannulate. This is also the last somite to bear distinct papillæ.

XXVI is strictly triannulate, with the sensillæ on *a* 2, but lacking any distinct papillæ and secondary furrows. In the figure, XXVII is represented as divided into three narrow rings, but owing to a distortion of this region it is quite impossible to make a satisfactory determination. In some lights and positions there appear to be three rings here, in others two, and two drawings made at different times and independently illustrate the two interpretations.

The color has faded to a uniform gray. Nothing of the internal organization could be learned by studying the specimen, either stained or unstained, in various clearing media, and consequently this description leaves much to be desired. The position of the ganglia and lateral nerves was determined by a partial dissection of the mid-ventral region of two somites.

HIRUDINIDÆ.

MACROBDELLA VERRILL.

Macrobdella decora (SAY) VERRILL.

Hirudo decora Say ('24).
Hirudo decora Leidy ('68).

Diagnosis.—Copulatory glands opening by four pores arranged in a quadrate figure on XIII *b* 6 and XIV *b* 1 and *b* 2; male pore at XI/XII or XII *b* 1, female, at XII/XIII or XIII *b* 1; somite XXVI has annuli (*a* 1 + *a* 2) + *a* 3; annuli VII *a* 3 and VIII *a* 1 relatively large and partly subdivided dorsally; atrium short and spherical; alimentary canal with extensively developed cæca; denticles small, about 65 on each jaw, and monostichodont; color pattern metameric.

General Description.—This fine leech is so well known and has been so fully described by Say ('24), Leidy ('68), Verrill ('74), and Brooks ('82), that only a few notes on certain features need to be added.

The anterior sucker is provided with a rather wide unsegmented and very mobile border which materially increases its capacity for expansion. Anteriorly a distinct median emargination corresponds with a deep ventral sulcus, which divides the upper lip and is flanked by a pair of scarcely less deep sulci. When strongly contracted the upper lip is folded and turned into the buccal chamber, where it is almost entirely concealed by the lateral lobes formed by the margins of somite IV.

A well-marked clitellum is seldom present. In one example it is firm and thick and extends over eighteen annuli, from the posterior half of X *b* 5 to XIV *b* 2. In the fully retracted state the male pore appears as a rather large opening on the furrow XI/XII, into which the surrounding rugosites are converged and inflected, forming a small sinus perhaps comparable with the pit of *Philobdella*. These inflected parts may be everted, in which event they form a prominent conical organ having deeply fluted sides and the small male aperture at the apex. As protrusion of the parts takes place annulus XII *b* 1 becomes relatively longer at the middle and comes to support almost the entire base of the papilla, so that the male pore now lies well within the boundaries of this annulus. I have never seen any other penial organ protruded.

When fully developed each of the four copulatory gland pores lies in the center of a prominent rugous area, the four being arranged in the form of a square. The anterior pair extends half over annulus XIII *b* 6 and equally over XIV *b* 1, and the posterior pair holds a similar relation to XIV *b* 1 and *b* 2. The pores consequently open on the line of the furrows separating these annuli.

Annulation.—The external annulation differs but slightly from the closely allied species *M. sestertia*, figured by Whitman ('86). The principal differences (characters stated as they occur in *M. decora*) are as follows: 1. The annulus IV (*a* 1 +

a 2)—that bearing the third pair of eyes—is distinctly longer than IV *a* 3, and in some examples the furrow *a* 1/*a* 2 is more or less distinctly discernible. 2. The annuli VII *a* 3 and VIII *a* 1 are relatively very much longer, and on the dorsal side the secondary annuli and furrows are distinctly developed. 3. XXVI *a* 1 is always marginally and sometimes completely separated on the dorsal side from *a* 2. 4. The relative lengths of the annuli of complete somites differ in the two species. In *M. sestertia* the neural annulus (*a* 2) is figured as of equal or greater size than the secondary annuli, while in *M. decora* it is typically shorter than any of these in the same somite.

Reproductive Organs.—Testes (Pl. XLIV., Fig. 23, *t*)—ten pairs, situated at XIII/XIV to XXII/XXIII inclusive. The vasa deferentia (*vd*) are glandular, and follow sinuous courses. In somite XI they become narrow and lose their glandular coating. Opposite to ganglion XI they turn abruptly into the compact, massive, much convoluted epididymes (*ep*). From the posterior end of each of the latter a wide somewhat folded and coiled ductus ejaculatorius (*de*) leads to the terminal organ. Just before plunging into the outer glandular and muscular wall of the latter the ducti become constricted, and then form a pair of slightly enlarged sacs which proceed upward side by side to open together into the end of the male invagination (Pl. XLIV., Fig. 22). This terminal male organ (Pl. XLIV., Fig. 23); which is evidently intermediate in its structure and character between the atrium of *Hæmopis* and the genital pit of *Philobdella*, is, when entire, spherical in shape; but when its external coat of muscle fibres and prostate glands (*pg*) is stripped off, the lining sac is found to be somewhat pyriform (*ati*).

The ovaries (Pl. XLIV., Fig. 23, *ov*) are large and globular, situated just behind ganglion XII, and ventral to the nerve cord. Short paired oviducts (*od*) unite in a common oviduct (*odc*) without any evident gland at the point of junction. The vagina (*va*) is short, of irregular diameter, and bent on itself.

The copulatory glands (Pl. XLIV., Fig. 23, *cgl*), the external

openings of which have been described, form a conspicuous mass occupying the posterior half of XIII and the entire region of the floor of XIV included between the vasa deferentia.

Alimentary Canal.—The jaws differ greatly from those of *Philobdella* and resemble those of *Hirudo*; they are more than twice as long as high and each bears about sixty-five fine monostichodont teeth. The remainder of the canal is very like that of *Diplobdella*. Each somite from X to XVIII inclusive is provided with two pairs of cæca which are very spacious from XIII caudad. The large posterior pair, which arise from the stomach in XIX, reach backward clear into XXIV or XXV.

Habits.—*Macrobdella* is probably strictly aquatic and is a true blood-sucker. It attacks man, cattle, turtles, frogs, fishes, etc., which enter its domain, and is frequently found gorged with blood. However, this is not its exclusive food. In the spring great numbers of frogs' eggs are devoured. In the neighborhood of Philadelphia these are sucked from the masses of jelly after the gelatinous envelopes have been cut by the leech's teeth. Large numbers of tubificid worms have also been found in the cæca. Whitman ('86) gives an account of the sensory reactions of this species.

PHILOBDELLA Verrill.

Philobdella gracile sp. nov.

Philobdella floridana Moore ('98), not Verrill ('74).

Diagnosis.—Copulatory gland pores in two nearly counterpart groups related respectively to the male and female genital orifices; male pore at XII *b* 2/*a* 2, in mature examples opening into a conspicuous deep pit, female pore at XIII *b* 1; alimentary canal of *Hæmopis* type, the denticles about 35, partly distichodont; annulation essentially as in *Hæmopis marmoratis*; color partly non-metameric blotches.

General Description.—The largest extended specimen has the following measurements:—

	mm.
Total length,	84.
Length to male pore,	19.
Greatest width (about XX),	7.8
Width at male pore,	7.
Width at anus,	3.
Depth at XX,	2.5
Depth at male pore,	2.8
Depth at anus,	1.5
Diameter of posterior sucker,	4.3

This is a very pretty leech of moderate size and slender graceful form. The preserved specimens are depressed throughout, except just posterior to the mouth, the ventral surface is flat, the dorsal gently convex, with an evident tendency to rise to a rounded median ridge. In some examples the middle two thirds, or so, of the body remains of nearly uniform width; in others the outline tapers gently and regularly from the place of greatest width forward to the mouth.

Probably the body of the living leech has a texture about like *Hæmopis lateralis*, as the muscles and botryoidal tissue display a similar relative degree of development. Except for a few wrinkles and the very slightly elevated sensillæ the surface is quite smooth.

All of the annuli are clearly marked by smooth even furrows, but owing to the absence of any well-marked transverse ridges they are not angulated and the margins of the body do not appear denticulate. Most of the annuli, however, do show a faint incipient transverse furrow, dividing them into approximately equal halves, the posterior one of which may be marked by a very faint raised line.

As in *Hirudo*, but unlike *Hæmopis*, there is a distinct very narrow unsegmented margin or border to the anterior sucker (Pl. XLIV., Fig. 13), which is separated on the ventral side by a shallow trench from the actual mouth rim. The mouth and sucker are small. A median sulcus divides the ventral

surface of the upper lip deeply into two halves, but fades out posteriorly; at least one fainter sulcus appears on each side. Somites I–IV constitute the lip and sucker, and the united annuli of V form the postoral annulus.

The five pairs of eyes (Pl. XLIV., Fig. 12, 19) present the arrangement usual in the family, except that the second and third pairs are closely approximated, owing to the position of the latter very close to the anterior border of somite IV. The fourth pair also is somewhat in advance of the line of sensillæ.

No specimens have been seen in which the clitellum is sufficiently developed to permit of the determination of its form and extent.

As Verrill ('74) long ago pointed out, the external genital region (Pl. XLIV., Fig. 16) is very remarkable; in some respects, indeed, unique among known leeches. This is true not only of the elaborate adhesive arrangements, which are probably important aids to successful copulation, but also of the location of the genital apertures. The features of this region have been described by Moore ('98) from examples collected in Louisiana, but are now figured for the first time. The figure is a composite of the three specimens which this collection contains and which differ from one another in certain particulars.

Comparison of the previous account with this figure will bring to notice some disparity in minor details, due to the fact that almost every specimen presents some individual peculiarities. It is very probable that this results not more from individual variability than from the temporary, seasonal, and developmental character of the structures concerned.

In specimens sexually inactive the male pore appears near the anterior margin of XII *a* 2; the female pore, on XIII *b* 1. They are surrounded by a more or less wrinkled area in which appear a variable number of copulatory gland pores more or less conspicuously developed. Omitting consideration of intermediate states the active condition is represented in Pl. XLIV., Fig. 16. The surface immediately surrounding and succeeding the male pore is inflected as a deep pit

(♂), on the anterior face of which the male pore is carried and concealed by the slightly overhanging* margin. Thus is formed, probably through the contraction of the dorso-ventral muscles, a sort of genital sinus inclining dorsad and cephalad deeply into the body and opening by a wide mouth on to the surface of annuli XII *a* 2 and *b* 5.

The neighborhood of the female pore is reciprocally elevated as a sugar-loaf shaped papilla, inclining caudad and ventrad and consequently well adapted to occupy the male pit, in which event the female pore (♀), situated at its apex, would come into contiguity with the male pore near the bottom of the pit.

The copulatory gland pores (*cgp*) are much more conspicuous than in the individuals first described, but are subject to much variation. Typically they are arranged as follows: In the male system (♂ *cgp*) a pair (concealed in the figure) is placed symmetrically beside the male pore; a second pair, and sometimes an additional median one, is situated just in front of the anterior border of the pit; on the furrow XII *a* 2/*b* 5, just external to the pit, is a third pair; a fourth pair is found just abreast of the last but on the lateral walls of the pit within its mouth; and, finally, a median pore appears on the sloping posterior face of the pit cephalad of the third and fourth pairs.

An almost exact reversed counterpart of the male system is found in the female system of adhesive organs (♀ *cgp*). It is described in the order in which the pores are supposed to correspond with those of the male system as respectively enumerated. The first pair occupies the sides of the female papilla close to the genital orifice; the second is found on annulus XIII *b* 2, caudad and laterad of the papilla and sometimes accompanied by a median one; the third and fourth pairs of the male system are represented by a single pair in the female system, which is just caudad of the male pit on annulus XII *b* 6. A median pore situated just posterior to these completes the parallelism.

*The ventral surface being turned uppermost.

Besides those mentioned, two or three additional pairs are located far from the middle line on annuli XIII *b* 2, *a* 2, and *b* 5.

Each of these pores is the crescentic or slit-like external orifice of a little subcutaneous bursa, usually filled with a more or less hardened substance which may raise the integuments into a small papilla and is probably the secretion of a mass of glands (*cgl*) occupying the whole of the middle region of somites XII and XIII and covering the walls of the male pit internally.

Seventeen pairs of nephridiopores (Pl. XLIV., Fig. 13, 14) are situated on small papillæ near the posterior margins of annuli VII *a* 1 to XXIV *b* 2 inclusive. The posterior are entad, the anterior ectad, of the ventro-lateral sensillæ.

Annuli and Somites (Pl. XLIV, Fig. 12–15, 18, 19).—Except in a few minor respects the incomplete somites possess the same number of rings as in *Macrobdella* and *Hæmopis marmoratis*.

Fifteen somites (IX to XXIII inclusive) are complete and quinqueannulate, *b* 1+*b* 2+*a* 2+*b* 5+*b* 6. In each of these, except IX, *a* 2 is just perceptibly shorter than the others and is less likely than they to show the depressed transverse line, though the raised line just behind the sensillæ is quite as distinct.

The sensillæ are very regular in arrangement but very small. They appear as white circular spots, and, in the best preserved examples, are distinctly but very slightly elevated above the surface. They encircle the exact middle of the annulus. The dorso-medians (*md*) are very close together, scarcely an annulus length apart. About twice this distance separates these from the dorso-laterals (*dl*); from the dorso-laterals to the dorso-marginals (*dm*) and also from the latter to the supra-marginals (*sm*) the distances are slightly greater than that first mentioned. Owing to the flatness of the ventral surface the relative positions of the sensillæ as shown in Figures 13 and 14 represent accurately the distances which separate them.

There are eight incomplete somites at the anterior end.

I is incompletely separated from II and bears but one pair of metameric sensillæ. II is a narrow imperfectly differentiated annulus bearing the first pair of eyes and, externally to these, three pairs of sensillæ. III is also uniannulate, and the second pair of eyes which it bears represents the dorso-lateral sensillæ, the other three pairs being unmodified.

IV is biannulate $(a1 + a2) + a3$. The first ring is wider than the second, and its composition is indicated by an interrupted furrow which passes across the third pair of eyes but anterior to the other sensillæ. V differs from IV only in its somewhat greater length and its relation to the mouth.

VI and VII are each triannulate; the latter is considerably the larger, but in each the annulus $a3$ is dorsally about two fifths of the entire length of its somite and in VII shows a slight furrow all around. The furrow VI $a1/a2$ disappears ventrally.

VIII is quadriannulate; $a1$ is longer than $a2$ and faintly subdivided all around, but is not equal to VII $a3$; $b5$ and $b6$ are fully developed and about equal to $a2$.

In IX the relative size of the annuli is $b1 = b2 < a2 < b5 = b6$; in X, $b1 = b2 = a2 < b5 = b6$; and in XI and succeeding somites $b1 = b2 = b5 = b6 > a2$. The posterior annuli of XII and the anterior of XIII are somewhat contracted in length.

In XXIII, $b5$ and $b6$ are relatively slightly shorter, while in XXIV they are no longer distinct, the separating furrow being very shallow, so that this is counted as a quadriannulate somite. $B1$ and $b2$ are longer than $a2$.

XXV is a contracted quadriannulate somite in which the following relative proportion exists in the lengths of the annuli of the specimens examined: $b1 = a3 > a2 = b2$.

XXVI presents the following variations: In the specimen drawn it is a single large annulus, particularly long at the sides, where a faint emargination and slight dorsal depression indicate an incipient division at about the middle. The sensillæ are fully developed and lie well toward the posterior margin of the ring. Another example from the same lot has this somite very distinctly and completely divided on the dorsal side into two annuli, of which the anterior is almost

twice the length of the posterior, except at the margins, where they are more nearly equal. The sensillæ are very distinct and are all placed very close to the anterior margin of the second annulus which, therefore, in spite of its smaller size, is regarded as (*a* 2+*a* 3).

XXVII is irregular and more or less divided into two rings, especially at the margins. The anus cuts into the posterior margin of the somite, which at that point is irregularly lobed. The sensillæ are close to the furrows by the side of the anus and the dorso-medians are widely separated. XXVIII is somewhat distinct from the sucker and bounds the anus posteriorly.

Reproductive Organs.—Two examples were dissected, and the small size of the organs renders it probable that they were taken at a time when these were not in full activity. The internal organs of generation (Pl. XLIV., Fig. 17) are very simple.

But seven pairs of small testes (*t*) were found at the anterior ends of somites XIV to XX. The very slender vasa deferentia (*vd*) reach to ganglion XI, where they bend back on themselves and become almost immediately much enlarged and thrown into several folds (*ep*, *de*). This region appears to correspond to both the epididymes and ducti ejaculatorii of *Hæmopis*. The two ducts immediately open together into a small thin-walled bursa, and the bursa communicates with the pit as above described. There is no muscular atrium and no penis. Numerous muscular fibers pass between the ventral integuments in the neighborhood of the pit and the dorsal integuments. Ganglion XII is crowded caudad from its normal position to the posterior end of its somite.

The female organs (Pl. XLIV., Fig. 17, 21) are of the *Hirudo* type. In the specimens examined they are symmetrically related to the body axis. The ovaries (*ov*) are sausage-shaped and each is folded on itself. Separate slender oviducts (*ov*) lead to an unpaired organ, into the large end of which they open. There is no evident external distinction between glandula albuginea, oviductus communis, and vagina, but the three together are combined in a slender claviform

organ, which is doubled on itself forward and opens by a duct on the external papilla.

Alimentary Canal.—Except for the jaws the alimentary canal is most like that of *Hæmopis*. It is straight and simple, with one pair of large posterior cæca and numerous small pockets, usually two pairs per somite along the middle region. The jaws, however, are of a very different form, resembling those of *Diplobdella*. They are very high and prominent, the height being greater than the length. The denticles are small, sharp, and in part at least ranged in paired series (Pl. XLIV., Fig. 20). It is quite possible to draw them apart with needles and to display the groove which divides the two rows.

Color.—The colors are described from alcoholic specimens which are evidently somewhat faded and otherwise altered. Light brownish drab above, yellowish below. A distinct continuous narrow yellow line marks the dorsimesion, becoming very faint anteriorly while posteriorly it is more or less broken by intrusion of the ground color. A pair of rather broader but less distinct yellow lines mark the margins. Between the dorso-marginal and dorso-lateral sensillæ on each side is a row of small irregular deep brown spots, generally well separated but at intervals becoming aggregated and more or less confluent. A very few faint and suffused brown spots are scattered over the dorsal surface. Ventrally the only markings are some rather larger reddish brown spots which are chiefly aggregated along the margins and become in places confluent.

Habits.—That this leech feeds in part at least on weaker creatures is shown by the presence of remains of earthworms (*Allolobophora*) in the canal. One of Verrill's specimens of *P. floridana* was captured in the act of swallowing a small lumbricoid worm. The structure of the alimentary canal would also indicate a diet of this character varied by an occasional meal of blood.

HÆMOPIS SAVIGNY.

Hæmopis marmoratis (SAY).

Hirudo marmorata Say ('24).
Aulastomum lacustre Leidy ('68).

Diagnosis.—Annuli VII *b* 5 and *b* 6 and VIII *b* 1 and *b* 2 indicated on the enlarged primary annuli but not fully developed; ♂ pore on 32 (XI *b* 6) or 31/32 (XI *b* 5/*b* 6), ♀ pore on 37 (XII *b* 6) or 36/37 (XII *b* 5/*b* 6); atrium and vagina reaching into somite XVII; ovaries just behind ganglion XIV.

General Description.—This species reaches a greater size than is attained by any of the Illinois examples, the largest of which measures:—

	mm.
Total length,	104.
Length to ♂ pore,	22.
Greatest width, (XVII),	15.5
Width at ♂ pore,	12.
" " anus,	7.7
Depth at XVII,	6.5
" " ♂ pore,	3.8
" " anus,	2.5
Diameter of posterior sucker,	6.5

Owing to the great development of botryoidal tissue the body is exceedingly soft and consequently varies greatly in shape, when alive, according to the various states of rest and activity, in preserved specimens, as a result of the different methods adopted for fixation and preservation. When actively swimming, and especially when the stomach is empty, the body is elongated and flattened but never very slender. (This is nearly the condition of the example measured.) The width is generally greatest at about the middle of the body, but differs very little between the clitellum and the last complete somite. In preserved specimens the clitellum is frequently the widest part of the body. Anterior to the clitellum the body tapers rapidly to the broadly rounded

prostomium and is less flattened. When exploring, but not swimming, the form is much less depressed and more terete, and may become much more extended and slender. The resting attitudes are varied and interesting. The body may be contracted to an ovoidal form, the upper lip is usually inflected, and the anterior end of the body variously inrolled or folded on the ventral surface.

Living specimens held in the fingers are so soft and hang so limp that they appear more like pieces of dead tissue than living animals. This peculiarity also enables them to squeeze into the most narrow clefts and thus often to escape from confinement. None of the cutaneous sense organs are elevated upon papillæ, so that the surface appears perfectly smooth.

Both living and well-preserved specimens are strongly annulated (Pl. XLV., Fig. 24), and in the latter each annulus is raised into a transverse ridge situated about one third of the length of the annulus from its posterior border. As a result the margins of the body usually appear rather decidedly serrate. In some specimens such elevated ridges extend around the entire circumference of the body.

The anterior sucker (Pl. XLVI., Fig. 34) is mobile and comparatively large, but without any definitely expanded disc. The mouth is large. The upper lip is broad and bluntly rounded, crenulate on the margin, but almost perfectly smooth and undivided ventrally. Several rows of labial sense organs are situated around its margin and on the preocular and oral annuli. Dorsally the furrows which divide it into annuli may be very faint, but are usually discernible for a portion of its width (Pl. XLVI., Fig. 33).

Of the five pairs of eyes (Pl. XLVI., Fig. 33) the first three pairs are conspicuous and arranged in a regular arc on the 2d, 3d, and 4th annuli; while the fourth and fifth pairs are more widely separated on the 6th and 9th annuli respectively, and are increasingly smaller and deeper and, as a consequence, more obscure. Their optical axes are variously directed; the first pair forward and slightly outward, the second decidedly outwards and forwards, the third directly outwards, the fourth outwards and backwards, and the fifth backwards and some-

what outwards; thus, together, they cover an arc of perhaps 160°.

Annulus 6—V (*a* 1+*a* 2)—unites with 7 (V *a* 3) ventrally to form the broad postoral ring; but the immediate oral ring or lower lip is a rim, more or less narrow and more or less distinct from 6, which is contributed by 5 (IV *a* 3). At the sides the mouth is bounded by the 4th and 5th annuli, which coalesce laterally (Pl. XLVI., Fig. 33).

In mature examples the clitellum (Pl. XLV., Fig. 24) is very distinct and equally well developed dorsally and ventrally. It is smooth, thick, and firm, and at its posterior end as wide or wider than the succeeding annuli. Posteriorly it is straight, anteriorly concave; and it extends over fifteen annuli (X *b* 5–XIII *a* 2 inclusive).

The Illinois specimens exhibit no variation in the position of the genital pores, which are, invariably, the male in XI *b* 6 and the female in XII *b* 6. The male orifice is situated close to the anterior border of its annulus, which enlarges mesially and encroaches slightly on the preceding annulus. Occasionally the region immediately surrounding the orifice is elevated as a low broad papilla. The size of the actual opening, as well as its form, differs according to the state of retraction or protrusion of the penis and related parts. The female pore is rounded or slit-like, is smaller than the male, and, like that, is usually close to the anterior border of its annulus though more liable to shift as far as half its width caudad. The annulus is enlarged and its anterior furrow becomes obsolete in its middle part.

The relatively small posterior sucker is circular, broadly attached, thick posteriorly, and projects by about one third of its diameter beyond the body, its anterior margin reaching to XXV *a* 2. Just anterior to it is the large anus with its much wrinkled margin cutting into XXVII. Prolapsus of the rectum frequently occurs in individuals which contract excessively as a result of irritation.

There are 17 pairs of nephridiopores situated just anterior to the posterior margins of the *b* 2 region of somites VIII to XXIV inclusive (Pl. XLVI., Fig. 34). Each is in a faint

depression bounded anteriorly by a slight forward displacement of the transverse ridge. The anterior pores are exactly in line with or very slightly mesiad of the ventro-lateral sensillæ, while the posterior lie well inside of this line.

Annuli and Somites (Pl. XLVI., Fig. 33, 34).—Somite I can seldom be distinguished as a distinct ring, but in well-preserved preparations a pair of dorso-median sensillæ may always be found anterior to and a little mesiad of the first pair of eyes. Sometimes the furrow may be discerned at and near the middle line, but it is always very faint and incomplete. This region bears numerous labial sense organs, which are arranged in about eight transverse rows; but, except in one case in which two were found, only the one pair of segmental sensillæ can be distinguished.

Somite II consists of a single narrow annulus imperfectly distinguished from the preceding and succeeding annuli. The posterior furrow sometimes extends quite to the lateral margins of the lips, but is usually very faint and imperfect. This somite bears the first pair of eyes, together with dorso-median, dorso-lateral, and dorso-marginal sensillæ, the latter being very difficult to distinguish from the labial sense organs.

III is also uniannulate but is more distinct, though here again the furrows are frequently incomplete. The dorso-median sensillæ are small but distinct, while the lateral and marginal pairs are quite evident. A few goblet-shaped sense organs form a broken transverse series.

IV is biannulate, the two annuli uniting at the margins to form the lateral boundaries of the mouth. The anterior annulus is somewhat the wider and bears the eyes and the full set of sensillæ toward its posterior part. It is consequently regarded as potentially constituted of the two primary annuli *a* 1 and *a* 2. Each annulus bears one row of goblet-shaped organs.

V is a more fully elaborated biannulate somite. The anterior annulus is decidedly the larger, and exhibits on the dorsal side two transverse series of goblet-shaped organs which are ventrally united into one. A full set of metameric

sensillæ is present on the posterior portion of the dorsal surface, but the ventral ones have escaped notice, if present. The second, smaller annulus (*a* 3) has one series of goblet-shaped organs.

On VI a partial furrow indicates the line of division between the constituents *a* 1 and *a* 2 of the much enlarged anterior annulus. The extent of this furrow is variable. It extends from the dorsal mid-line, where it is deepest, laterad sometimes as far as the dorso-marginal or even to the supra-marginal sensillæ, but may reach as far as the eyes only. All of the sensillæ, both ventral and dorsal, are well developed and, including the 5th pair of eyes, are on the *a* 2 constituent. Annulus *a* 3 is the last on which a complete row of goblet-organs is distinguishable.

VII is triannulate, *a* 1 being slightly shorter than *a* 2 and *a* 3 much longer, the latter constituting about two fifths of the total length of the somite. Occasionally in large specimens a very evident furrow divides this annulus into two equal halves on the dorsal surface, and at least a shallow furrow is always present. The sensillæ are normal and on *a* 2.

VIII is quadriannulate. *A* 1 is slightly wider than VII *a* 3, and like the latter shows a partial division into the secondary annuli. *A* 2 bears the sensillæ and *a* 3 is completely divided into *b* 5 and *b* 6, each of which equals *a* 2 in size.

The series of complete quinqueannulate somites begins with IX and ends with XXIII, making 15 in all. The five annuli of each of these are of equal length. The sensillæ are small but very conspicuous on properly prepared material; but the exact size of the sensory areas is difficult to figure, as they appear as circular white spots in small unpigmented areas the limits of which are rather vaguely defined. All of the sensillæ are much subject to variation, even the dorso-medians and dorso-laterals being frequently subdivided, changed in position, or entirely wanting. But the two marginal series are especially prone to subdivision; and they are very commonly represented by a chain of contiguous smaller sensory areas, not infrequently made up of four or five members.

Somite XXIV is quadriannulate, but it is the posterior end (a 3) which is least developed, instead of the anterior end (a 1) as in the quadriannulate somite VIII. In some examples the large posterior annulus (a 3) is marked by a slight furrow, which is more frequent on the ventral surface.

XXV. Because of its variations this normally triannulate somite is one of the most interesting. A1 is always longer than XXIV a 3. In four specimens it exhibits no trace of a subdivision dorsally or ventrally; in six there is more or less evidence of a ventral furrow; four examples, while lacking any trace of a furrow, show two distinct integumental ridges at the margins of this annulus; two others have both the marginal ridges and the furrow; and in one individual of large size the furrow extends even half way around the dorsal side. The remaining annuli a 2 and a 3 are of equal size and present no noteworthy features.

XXVI is uniannulate above, and the sensillæ, with the exception of the dorso-median, which are at about the middle of its length, are situated close to the posterior border. On the ventral side a partial annulus is developed in many cases posterior to the line of sensillæ.

XXVII. For the reason just stated the short preanal annulus is regarded as XXVII a 1, while a 2 and a 3 are united in a single sensilliferous annulus which is cut into by the anus. The furrow a 1/a 2 is sometimes incomplete mesially.

The dorsal surface of the sucker is marked by a variable number of concentric furrows crossed and connected by irregular wrinkles. The sensillæ are difficult to distinguish, but generally about three belonging to each of the dorsal series are present.

Reproductive Organs.—The dissection represented in the figure (Pl. XLV., Fig. 26) was made upon a well-extended mature specimen of medium size. In this the nerve cord passes to the right side of both the genital orifices, and the unpaired portions of the genital ducts lie to its left. The dissection of a number of specimens of this species from several localities shows that while this relation between the

nerve cord and the genital apparatus usually obtains, it is not constant and diagnostic of the species. Cases have been found in which the nerve cord passes to the left of the genital exits or to the right of one and the left of the other, or in which the atrium or vagina crosses the nerve cord dorsally and lies partly on each side of it.

Ten pairs of testes (*t* 1, *t* 3), belonging to somites XIV to XXIII inclusive, appear to be constant. Each occupies the first two annuli of its somite and the posterior annulus, or even two annuli, of the preceding somite. They are largest in the middle of the series, and become smaller toward both ends. The twenty short vasa efferentia are similar in structure and appearance to the paired vasa deferentia into which they empty. Each of the latter (*vd*) is a rather conspicuous glandular tube of yellowish color which takes a more or less sinuous course just entad of the line of nephridial vesicles. When about opposite to the male pore it turns sharply caudad, having become narrower and of firmer, less glandular, texture, and soon passes into a much convoluted region, the epididymis (*ep*). The latter is neither compact nor massive, and in the posterior part of XIII opens into the sperm sac (*ss*), a fusiform enlargement with which the ductus ejaculatorius (*de*) begins. Throughout its greater part the latter is a delicate tube which extends forward to a point opposite to the male pore and then again bends on itself sharply caudad to open into the fundus of the atrium or penial sheath (*at*) at the anterior limit of somite XV. Throughout its entire length the ductus ejaculatorius has firm glistening muscular walls. Generally the right ductus passes beneath the nerve cord at its anterior turning point behind ganglion XI, but occasionally it is the left which makes this crossing.

The atrium or penis sheath (*at*) is very long and slender. Beginning at the anterior end of somite XV it reaches caudad to ganglion XVII, bends sharply on itself, and passes directly cephalad to the male orifice. In the specimen figured, which measures 92 mm. in total length, the atrium has a length of 40 mm., the ratio between the short and long limbs being as

1 to 2.3. The organ is of firm consistency and very muscular. In shape it is terete with the closed end slightly enlarged and provided with an ensheathing layer of prostate glands (*gp*). The protruded penis is a long filiform organ reaching a length of at least 30 mm., though this condition is not exhibited by any of the Illinois examples.

The female organs are equally and correspondingly specialized. A pair of ovaries (*ov*) lie on the 2d pair of testes dorsal to the nerve cord and in the posterior end of XIV. Very short oviducts pass from them to a common meeting place, where they are enveloped by the large glandula albuginea (*ga*), from which the common oviduct emerges. This narrow firm-walled tube (*odc*) leads to a large pyriform ovisac (*os*), which it joins a short distance from the extremity of the narrow end. The vagina (*va*) begins near the large end of the ovisac at the posterior end of somite XVI. It is long, slender, and terete, about 2–3 times the diameter of the common oviduct, of an appearance similar to the latter, and with muscular walls. The coil and whorls into which it is thrown are sufficient to give it, when straightened out, a total length equal to the penis sheath.

Alimentary Canal.—The lip is separated by a slight circular sulcus and fold from the three jaws. Each of the latter is the anterior termination of a pharyngeal fold which here becomes slightly more prominent and curves peripherally into a little pocket into which the jaw may be retracted, so that the whole tooth-bearing ridge may be concealed. The jaws are low and rounded, not at all compressed on the free edge and very little prominent. They bear a double file of large coarse teeth (Pl. XLII., Fig. 7) arranged in from 12 to 16 pairs. The individual denticles have bilobed bases and sharp, slightly hooked, apices, those of each pair meeting in a common ridge above the groove which separates their bases. From each side of the pharyngeal folds, which continue the jaws caudad, somewhat lower folds arise, and in the intervals between these three triad systems additional single or double folds may arise. Thus the pharynx is thrown into from nine to twelve, or even more, longitudinal

ridges extending throughout its entire length. The pharynx reaches into somite X.

A long narrow straight stomach reaches to XIX, where a pair of large lateral cæca arise and pass caudad to XXII or XXIII. Along the course of the stomach are numerous small lateral cæca, as many as two or three pairs per somite; and just posterior to the origin of the large posterior pair are two or three pairs of quite large, short, globular cæca which extend laterad dorsal to the principal cæca.

Color.—Many color varieties of this species occur, some of which have been indicated by Verrill ('74); but only the blotched kinds are represented in the Illinois collection. During life the ground color in such is generally some shade of olive-green or greenish brown, blotched with irregular intermixed spots of lighter grays and darker browns and black. The former kind are likely to predominate on the ventral side, from which the darker pigments may be altogether absent. The darker markings may be scattered and distant or so close as to become confluent and give to the animal an almost black color. Most of the Illinois examples are only moderately blotched. Preservation always causes the loss of the green pigments. No metameric features have been detected in the pigmentation of this species, nor is there any evident close relation between the disposition of the pigment and the arrangement of the muscles.

Habits.—In the neighborhood of Philadelphia this so-called horse-leech lives in the mud by the sides of pools, ditches, and streams. At times it leaves the water in search of earthworms, which constitute part of its food. Various kinds of aquatic insects and their larvæ, aquatic oligochætes, gastropods, and lamellibranchs are eagerly eaten, and large quantities of mud containing organic matter are swallowed. When the opportunity arises this leech will take blood, attaching itself to drinking cattle or to the legs of boys wading in its haunts.

Hæmopis lateralis (Say).

Hirudo lateralis Say ('24).
Macrobdella valdiviana Philippi ('72).
Semiscolex terrestris Forbes ('90).

Diagnosis.—VII *b* 5 and *b* 6 and VIII *b* 1 and *b* 2 are fully developed, so that VII is quadriannulate and VIII quinque-annulate. The male pore is on annulus 34 (XI *b* 6), the female on 39 (XII *b* 6); the vagina and atrium extend to the anterior part of XIV; the ovaries lie between the female pore and ganglion XII.

General Description.—Many of the characters of this large leech have been described by Forbes ('90). It reaches a size much larger than *H. marmoratis*, some examples of the terrestrial variety from Illinois measuring as contracted alcoholic specimens nearly 8 in. in length and $\frac{7}{8}$ in. wide. The smallest specimen in the collection measures 38 mm., the largest 190 mm., in length. A medium-sized individual from which the drawings were made, measures:—

	mm.
Total length,	103.
Length to ♂ pore,	21.
Width at ♂ pore,	10.5
Greatest width (just anterior to 17th nephridiopore),	13.5
Width at anus, about	5.
Diameter of posterior sucker,	6.
Depth at ♂ pore, about	4.
Depth at last nephridiopore,	5.5
Depth at anus,	2.5

Living aquatic examples which I have watched assume the attitudes and shapes described for *H. marmoratis*, but *H. lateralis* is much more slender and capable of much greater elongation. The greatest width is further back (about XXIII), from which point the body tapers gently forward. Compared with *H. marmoratis* the ventral surface seems flatter, the dorsal more abruptly, but still gently, arched, and the anterior region more terete. As in that species the surface of the body is perfectly smooth, without

any papillæ, but unlike that species the metameric sensillæ are exceedingly difficult to detect, and I am not yet satisfied that they have been correctly identified in surface views. A better developed muscular system gives the body of this species a somewhat firmer consistency.

The annuli (Pl. XLVI., Fig. 28–32) are remarkably distinct, which results chiefly from the presence on each of a strong welt or ridge which encircles it and causes the margins to stand out like so many serræ. Just anterior to the ridge a faint furrow appears on many of the secondary annuli.

The upper lip (Pl. XLVI., Fig. 29, 32) is rather slender and pointed and its ventral surface divided by a slight median and several lateral longitudinal grooves. The mouth and sucker are relatively smaller than in the horse-leech. A slight constriction is usually evident between the fourth and fifth pairs of eyes. The eyes (Fig. 28) are arranged as in *H. marmoratis*.

Very few examples exhibit a well developed clitellum, but when present it has a form and extent similar to that of *H. marmoratis*. Although the male and female pores are situated on the annuli homologous to those bearing them in *H. marmoratis*, two more annuli intervene between them and the anterior end than in that species. This results from the presence of an additional annulus in each of somites VII and VIII. The orifices are also situated further caudad on their respective annuli (though seldom beyond the middle) than in that species.

The usual seventeen pairs of nephridiopores (Pl. XLVI., Fig. 29) are situated on the annulus *b* 2 of somites VIII to XXIV inclusive. As in *H. marmoratis* they open just posterior to the transverse ridges, which at each pore are pushed forward as short spout-like projections which may serve to direct the flow of the excreted fluid. The distance separating the two pores of a pair is almost exactly half the width of the body at that point.

Annuli and Somites.—Owing to its distinctness the annulation (Pl. XLVI., Fig. 28–32) is very easy to work out, but on account of the difficulty or impossibility of detecting the

metameric sensillæ in surface views the metamerism is less readily determined. Comparison with *H. marmoratis* brings to light some interesting points of distinction between the two species. No differences of any consequence are noticeable in the first five somites.

In VI, *a* 3 is relatively much longer, and occasionally a faint subdivision appears on its dorsal surface.

VII presents a similar condition in *a* 1, while *a* 3 is represented by the fully developed secondary annuli *b* 5 and *b* 6, which are completely separated both dorsally and ventrally, making this somite quadriannulate, with the formula *a* 1+*a* 2+*b* 5+*b* 6, or (*b* 1+*b* 2)+*a* 2+*b* 5+*b* 6.

VIII is quinqueannulate, owing to the complete separation of *b* 1 and *b* 2. This species presents, therefore, one more complete somite—having the formula *b* 1+*b* 2+*a* 2+*b* 5+*b* 6—than does *H. marmoratis*.

In most of the complete somites, usually from about X to XXI, a characteristic relative size of the component annuli is maintained. *A* 2 is always the shortest, *b* 1 and *b* 2 are equal and slightly longer, and *b* 5 and *b* 6 are equal and still longer. The faint depressed line which is mentioned above as crossing most of the annuli is rarely discernible on *a* 2, while on the secondary annuli it is usually quite evident.

In XXIV, which is the last complete somite, the relative size of the annuli anterior and posterior to the neural annulus (*a* 2) is reversed, *b* 1 and *b* 2 being larger than *b* 5 and *b* 6.

XXV is triannulate, *a* 3 being distinctly smaller than *a* 1 or *a* 2, especially on the ventral side, where it becomes somewhat approximated to *a* 2 and the dividing furrow less deep.

XXVI is biannulate, the first annulus being dorsally as long as the second at the margins, or even longer, but relatively smaller mesially. By displacing the sucker the second ring is seen to include on each side a remnant of a very narrow posterior ring, which in one specimen is well developed both dorsally and ventrally. As the supposed sensillæ are found on the anterior part of the second ring this is regarded as representing *a* 2 and *a* 3.

XXVII is biannulate and includes the anus.

Fortunately, in the posterior region of some aquatic individuals from Ohio the sensillæ are comparatively distinct, so that the determination of the values of the annuli and of the limits of the somites is accomplished with greater ease and confidence than would otherwise be possible.

Reproductive Organs.—The reproductive organs also have been described by Forbes, to whose account a few notes may be added. The nerve cord may pass to the right of the genital exits, as described by Forbes, or to the left, as here figured. In two out of three dissections the latter condition prevailed; but the number is of course insufficient to determine which is the more usual.

The figure (Pl. XLV., Fig. 27) will serve to show the marked contrast in several respects between these organs in *H. lateralis* and *H. marmoratis*, in most of which the former approaches nearer to the *H. sanguisuga* of Europe. The sperm-sacs (*ss*) and epididymes (*ep*) of *H. lateralis* are confined to the distance between ganglia XI and XII, and the latter are massive and compact and closely molded around the sperm-sacs. The atrium (*at*) of this species is much shorter, its posterior turn being at ganglion XIV; the relative lengths of the short to the long limb is as 1 to 1.7. The penis is not protruded in any of the Illinois specimens, but in the aquatic variety from Ohio is essentially similar to that of *H. marmoratis*.

Unlike the latter species the ovaries (*ov*) of this are situated far in advance of the second pair of testes. Sometimes, at least, they lie beneath the nerve cord and between the female exit and ganglion XII. Similarly to the atrium, the vagina is relatively short and never extends posterior to ganglion XIV.

Alimentary Canal.—Counting the rudimentary denticles which complete the series posteriorly the number on each jaw is from 20 to 25 pairs (Pl. XLV., Fig. 25), arranged, as in *H. marmoratis*, in two contiguous series. They are of more irregular shape than in that species and of smaller size, but their greater number causes them to occupy an approximately equal distance on the jaws.

Color.—Forbes ('90) has described the colors from living

specimens of the terrestrial variety. On living aquatic examples from Ohio the dorsal black stripe may be conspicuous, but is more frequently faint and obscure, broken into small spots, or totally wanting.

Habits.—The habits of this species have been briefly described by Say ('24) and Forbes ('90).

HERPOBDELLIDÆ.

*Erpobdella Blainville.

Erpobdella punctata (Leidy).

Nephelis punctata Leidy ('70).
Nephelis lateralis Bristol (in part) ('98).

It has been found impossible to certainly identify this with any of Verrill's species. There is little doubt that *Nephelis lateralis* Verrill and *Nephelis quadristriata* Verrill are founded on two distinct species which are common in New England and both of which are quite distinct from Leidy's species; but *N. quadristriata* Verrill (not Grube) may be in part synonymous with *E. punctata.*

Diagnosis.—Complete somites quinqueannulate, *b* 6 sometimes slightly larger than the other annuli but not typically divided in the middle by a cross-furrow; pigmented eyes three pairs, the first situated on II, the second and third on IV; genital orifices, male at XII *b* 2/*a* 2, female at XII *b* 5/*b* 6; atrium deeply cleft, the prostate cornua prominent, and the anterior loops of the vasa deferentia reaching to ganglion XI.

General Description.—Bristol ('98) has given an excellent description of the external characters, the annulation, and the neural metamerism of this species, most of which need not be repeated, especially as the external features distinguishing species of this family are mostly slight and obscure. The number and arrangement of the external annuli may be

*Blainville's original spelling is here followed. Blanchard has changed this to *Herpobdella*, and separated the family from the *Hirudinidæ*.

almost exactly the same in several species, which are nevertheless readily distinguished by other and very obvious characters, and especially by the terminal portion of the male genital ducts.

Erpobdella punctata reaches a large size and has a more robust form than any other of our common nephelids. In preserved specimens the dorsal surface is rougher and the posterior lateral margins thinner than in most other species. The body is very muscular and has a firm feel.

For the purpose of comparison with the species of *Dina* which are described below some features of the complete somites may be mentioned. Of these there are seventeen, VIII to XXIV inclusive. All of the five annuli are of nearly equal size, but *b* 6 is frequently slightly enlarged. This is, however, never very obvious, and the annulus is never marked by a transverse furrow except in strongly contracted specimens in which all of the annuli are equally affected. *a* 2 is noteworthy as being rougher than the secondary annuli, and its papillæ are frequently larger and more numerous, extend further marginally, and are more subject to concrescence into a transverse ridge. When fully extended all of the annuli are free from cross-furrows or wrinkles, but when contracted irregular and interrupted transverse furrows may appear on all of the annuli. These may occur anterior to the papillæ only, or both anterior and posterior, in which latter case the annulus is more or less completely divided into three parts, of which the middle bears the principal papillæ. Such transient subdivisions must not be mistaken for the true tertiary annuli which appear in *Dina*, etc.

Reproductive Organs.—The external male organ when fully extruded has the form of a low circular disc occupying nearly the entire median width of two annuli. It consists of a marginal rim fitting closely around a transverse elliptical central cushion of about twice the height of the rim. The terminal openings of the sperm-ducts appear well separated on the sides of the cushion.

The testes extend through six and one half somites

(posterior part of XVIII to the anterior part of XXIV). In one specimen in which they were counted the number varied from fifty to sixty on each side of each somite. They are small pyriform or globoid bodies grouped about the vas deferens, into which they empty, in most cases by separate ducts. The vas deferens (Pl. XLVII., Fig. 35, *vd*) is an extremely fine, straight tube reaching to ganglion XVIII. At this point the duct suddenly enlarges into a very conspicuous epididymis or sperm-sac (*ss*). This much convoluted tube continues through several somites but gradually diminishes in diameter. By somite XV it has become only one half or one third of its greatest size, and in XIV the convolutions become more open and soon the duct is merely wavy. This region is the ductus ejaculatorius (*de*), which passes forward in a long loop to ganglion XI, at which point it turns sharply mesiad and caudad and returns to the terminal organ. Regarding all of the latter as the atrium, it consists of two more or less elongated curved conical horns (*p*) directed longitudinally. At their bases they rest on a pair of swollen pedestals covered with a layer of prostate glands, which also extend somewhat on to the bases of the cornua themselves. This basal region, the two halves of which embrace the nerve cord between them, may be separated quite to the basal integuments, where each half communicates by a separate orifice with a small bursa. The median part of the atrium appears to be represented by these two basal halves of the cornua.

The ovaries (Pl. XLVII., Fig. 35, *ov*) are a pair of long slender sacs, each doubled on itself, with both ends in somite XII, and the loop reaching far back along the median line, ventral to the alimentary canal, to the neighborhood of ganglion XVII. From somite XIV to somite XVII the two ovarian sacs lie side by side; just anterior to ganglion XIV they diverge, the closed end of each arching upwards around the pharynx; and they end close together, near the median line. The external ends of each, on the other hand, retain their ventral position and join beneath the nerve cord at the common external opening (♀).

Habits.—The favorite food of this species is small aquatic oligochætes. Bristol ('98) and Leidy ('70) have given some account of its habits.

Dina R. Blanchard.

Dina fervida (Verrill).

Nephelis fervida Verrill ('74).

Nephelis fervida is supposed to have been described from individuals of this species having eight eyes, a variation which frequently occurs. The species here described is abundant in the Lake region from which Verrill's types were taken, and has the size, form, and color of that species.

Diagnosis.—Complet esomites quinqueannulate, *b* 6 being distinctly enlarged and divided by a cross-furrow into two equal halves; pigmented eyes normally three pairs, the first situated on III; genital orifices at XII *b* 2/*a* 2 and XII *b* 5/*b* 6; median chamber of atrium of medium size and not deeply cleft, the prostate cornua prominent, and the vasa deferentia not reaching anterior to their ends in somite XII.

General Description.—A single small specimen represents this species in the Illinois collections, and the following notes are derived from numerous examples in my own collection received from Ohio and Michigan and from the well-preserved series taken by Professor Reighard during his recent exploration of Lake Erie.

None of the large number of specimens examined reaches a length of much more than two inches. The body is depressed posteriorly; the mouth is relatively large and the lip blunt. The posterior sucker is relatively larger than in most small nephelids, with its anterior margin more broadly free and reaching as far forward as XXV *a* 2. The body is not of particularly firm consistency. The clitellum extends over fifteen annuli, X *b* 5 to XIII *a* 2.

The annulation and metamerism are essentially as in *E. punctata*, except that the first pair of eyes is placed on the third instead of the second annulus, and that in the com-

plete somites *b* 6 is subdivided. In addition to these there are some incipient differences, but they are too minute to be used in this connection. The larger size and subdivision of the annulus *b* 6 is a very obvious and constant character. It is true that many of the other annuli at times show faint cross-furrows, but these lack the constancy, depth, and completeness of the diagnostic one.

Reproductive Organs.—The testes are larger and fewer than in *E. punctata*. In one specimen they average thirty-two to each side of each somite. As in that species, they extend from the posterior part of XVIII to XXIV. The vasa deferentia (*vd*), sperm-sacs (*ss*), and the greater part of the ducti ejaculatorii (*de*, Pl. XLVII., Fig. 36) exhibit no important differences; but the anterior ends of the latter stop short at the anterior limit of somite XII, where they join the apical ends of the prostate cornua. When the copulatory organ is fully retracted the ducti form no loops whatever anterior to these cornua; but when it is protruded the latter are drawn somewhat caudad, leaving a short sweep of the ductus anterior to it on each side. The prostate cornua (*p*), though prominent, are shorter than in *E. punctata* and diverge more widely laterally. A third important difference is found in the presence of a well-developed median atrial chamber (*at*). This is quite undivided in the median line, where the nerve cord, instead of sinking between two separated lobes, is raised some distance above the body floor. The prostate glands cover the dorsal portion of this chamber as well as the bases of the prostate cornua.

The protruded male copulatory organ differs in some details from that of *E. punctata*. It is relatively larger and especially higher. It is supported on a broad pedicle which projects freely through the male pore. Around the entire edge of the disc is a groove which divides it into a proximal and distal circular ridge. The latter bears a delicate ring-like flange which probably corresponds to the muscular border here present in *E. punctata*. The central cushion is subcircular, and instead of two widely separated openings has

a single large crescentic one, into the deep ends of which the prostate cornua open.

The female organs present no important differential characters, although the ovaries (*ov*) of all of the specimens dissected reached to ganglion XVIII.

Color.—Living specimens, according to Verrill's description and a water-color sketch sent me by Professor Reighard, are pale red with some darker cloudings.

Preserved specimens may be separated into two groups according to the amount of pigment present. One group, which includes the smaller and a portion of the larger ones, lacks pigment entirely; the other, which includes most of the larger examples, has the dorsal surface marked with more or less numerous minute black flecks which differ greatly in number and somewhat in arrangement. Many specimens have so little pigment as to appear light-colored, with a faint dark band on either side of a median clear band; in others the dark bands are very broad; and still others appear quite dark, the pigment specks being very numerous and close and extending continuously over the median region. In all cases the margins, including the region of the lateral vessels, are unpigmented; and in no case does the pigment assume any other form than that of minute flecks more or less closely placed.

Dina microstoma sp. nov.

Diagnosis.—Complete somites quinqueannulate, *b* 6 enlarged and subdivided; first pair of eyes in III; male orifice at XII *b* 2/*a* 2, female orifice at XII/XIII; median chamber of atrium relatively large and without median groove; prostate cornua inconspicuous, shorter than diameter of median chamber; vasa deferentia lacking anterior loop and ending abruptly at the atrium.

General Description.—This is a generally slender species. Well-preserved specimens are nearly terete and in extension linear. An average specimen measures:—

	mm.
Total length,	42.
Length to male pore,	10.
Width at male pore,	3.4
Greatest width (middle),	4.2
Width at anus,	3.5
Depth at male pore,	about 1.5
Depth at middle,	about 2.
Depth at anus,	1.2
Diameter of posterior sucker,	2.5

The width is greatest at about the middle of the body but varies little in the entire postclitellal region. The margins of the body are rounded except just about the anal region, where lateral flanges begin at about XXIII and become more and more prominent until they terminate in a pair of thin expansions which embrace the base of the sucker. A curious feature which appears in a great many specimens is a short contracted region just behind the clitellum, where the body becomes perfectly terete and bellies ventralward. From the genital region forward the body tapers quite rapidly to a point just posterior to the mouth and then rapidly contracts into the narrow lip. As in nephelids generally, the entire body is covered with small sensory papillæ arranged in zones on every annulus.

The mouth is small, even in specimens which have been killed in a much relaxed condition. In most specimens the upper lip is extended, slender, and prominent, and is often most sharply distinguished from the succeeding annuli by a deep furrow which passes behind the postoral ring. Dorsally it is smooth, divided into distinct but very narrow rings, and provided around the margins very richly and above sparingly with labial sense organs.

There are three pairs of eyes, of which the first are the largest and are situated on somite III, instead of on II as in most nephelids. Sometimes one or each of these is represented by two. The second and third pairs are on IV, the dorsalmost slightly in advance.

The male gonopore is situated as usual at XII *b* 2/*a* 2, the female at XII/XIII, three annuli consequently intervening. The former is a large and conspicuous opening usually surrounded by a thin integumental disc which spreads over about one half of the contiguous annuli. The female pore is small and usually concealed. A strongly developed clitellum is generally present. It is thick both dorsally and ventrally, sharply defined, and extends over fifteen annuli, from X *b* 5 to XIII *b* 2. The nephridiopores are as usual.

Even for a nephelid the posterior sucker is weak and small. It is very broadly attached, with scarcely any free margin anteriorly, where it reaches only as far forward as XXVI. Eight low radiating ridges or lines of papillæ disposed in pairs mark its upper surface. Anus large, with a much wrinkled margin, XXVI/XXVII.

Annuli and Somites.—The external features of metamerism in this species differ but little from those of *E. punctata*, but as Bristol has adopted another standard of enumeration in his description of that species it seems best to give a brief account of the present species.

I is the wide anterior region of the lip.

II is a narrow preocular annulus bearing one row of sensory papillæ.

III is a single wide annulus faintly subdivided and bearing a complete row of sense organs posteriorly and an incomplete row anteriorly. The large pair of eyes are on its extreme anterior part and are separated by a distance of about three times their width.

IV is biannulate, the first ring being distinctly subdivided and separated from the second dorsally but united to it ventrally. In many cases its posterior furrow is very deep and limits the head region as noted above. The second group of eyes is borne by this somite, the ventral pair being on the furrow *a* 2/*a* 3, the dorsal just in advance of it.

V is also biannulate, the first annulus bearing two rows of sense organs and being somewhat wider than the second.

VI is triannulate. *A* 1 and *a* 3 are each slightly wider than

a 2, bear two rows of sense organs, and are faintly divided marginally.

VII is quadriannulate, the fourth annulus being double; but as none of the other annuli show any indication of further division the formula is regarded as *b* 1+*b* 2+*a* 2+(*b* 5+*b* 6).

VIII to XXIII inclusive are complete somites. In these the relative widths of the annuli and the subdivision of *b* 6 are not such constant and obvious features as in *Dina fervida*, but careful measurements of a large number of cases show the approximate equality of the first four annuli, while *b* 6 proves to be about twenty per cent. larger. In many of the best-preserved specimens this relative proportion appears with great constancy and regularity, but in others is more or less obscured. In well-extended specimens a dividing furrow cuts *b* 6 approximately into two equal sub-rings, but in contracted examples this is also obscured by the development of transient wrinkles as described for *E. punctata*. Of the more distinct sensory papillæ there are on each ring from fourteen to eighteen above and about an equal number of smaller ones below. These are arranged in an irregular transverse row along which smaller sense organs are scattered. Frequently a median longitudinal dorsal tract is entirely free from them, and they always become more evident marginally. On *a* 2 the papillæ are usually more prominent, especially so, as Bristol has observed, on some of the posterior somites. On *b* 6 two rows of papillæ appear. These are especially distinct at the margins of large individuals.

XXIV is sometimes complete, and is always quinque-annulate so far as observed. In most cases it differs from the complete somites only in the relatively smaller size of *b* 6 and the tendency, sometimes quite evident, for *b* 5 and *b* 6 to unite on the ventral side.

XXV is usually quadriannulate, sometimes only tri-annulate, but it has been found impossible to find any inherent clue to the exact values of the annuli. Analogy with other species would point to the first form as being composed of *b* 1+*b* 2+*a* 2+*a* 3; the second, of *a* 1+*a* 2+*a* 3.

XXVI is biannulate, the wide anterior annulus showing

two rows of papillæ. The anus cuts the second, which bears but very few papillæ. XXVII is postanal and biannulate.

Reproductive Organs.—The numerous small testes are found in somites XVIII to XXIII, but their number was not determined. The vasa deferentia, sperm-sacs, and ducti ejaculatorii are sufficiently indicated in the figure (Pl. XLVII., Fig. 37). The latter end abruptly, without any preatrial loop whatever, at the prostate horns, into the ends of which they empty.

The atrium is a very characteristic one and differs from that of any other species of American nephelid which I have examined. It may be remarked in passing that the efferent male apparatus of this species and *Dina fervida* have many characters in common which distinguish them from *D. mexicana* Dugès, which Blanchard regards as being co-specific with the type of the genus. The median chamber (*at*) is a thick-walled sac of relatively large size. It stands up prominently from the body floor, raising the nerve cord with it and barely marked by a median groove. Its transverse diameter is much greater than the antero-posterior and about equal to its height, but in immature specimens the organ is spherical.

The prostate cornua (*p*) are small,—when straightened, less than the shortest diameter of the median chamber,—and their attachments are far apart on the dorsal surface of this chamber, with which they remain in close contact as they curve strongly ventrad on each side. At their lowest point at the sides they become continuous with the ducti ejaculatorii as above described.

The ovaries (*ov*) present no peculiar features, and their form and relations are sufficiently indicated in the figure.

Color.—Not one of many examples of both young and old shows any pigment. This would indicate that during life they are red, the color of the blood showing through the integuments.

Small tubificid worms have been found in the stomachs of those examined.

Note on Discodrilidæ.—The collection sent me includes three bottles of *Discodrilidæ* comprising altogether about sixty specimens of *Bdellodrilus philadelphicus* (Leidy) Moore. This species was originally described by Leidy under the name of *Astacobdella philadelphica* in the Proceedings of the Philadelphia Academy of Sciences for 1851, page 209. Some additional notes on it may be found in two papers by Moore in the "Journal of Morphology," Vol. X., page 498, and Vol. XIII., page 327 et seq. The Illinois specimens were taken from the exterior of *Cambarus diogenes* and *C. blandingii.*

University of Pennsylvania, August, 1900.

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EXPLANATION OF PLATES.

The somites and ganglia are indicated by Roman numerals I to XXVII; and the annuli of individual somites by letters (*a*, *b*, etc.) which indicate the successive generations by which they multiply from the triannulate type, the indices (1, 2, etc.) being their theoretical number in an antero-posterior series.

With the exception of a few modifications which are explained in the text the lettering is uniform for all of the figures.

The metameric sensillæ: *md*, dorso-median; *dl*, dorso-lateral; *dm*, dorso-marginal; *sm*, supra-marginal; *sbm*, sub-marginal; *vl*, ventro-lateral; *vm*, ventro-median.

The cutaneous papillæ: *mp*, median; *mdp*, dorso-median; *dlp*, dorso-lateral; *dmp*, dorso-marginal; *smp*, supra-marginal.

General: *a*, anus; *at*, median atrium or penis sheath: *atf*, internal elevation resulting from male pit (false atrium), covered by a layer of copulatory and prostate glands; *ati*, lumenal coat and sac of atrium; *c*, clitellum; *cgl*, copulatory glands; *cgp*, copulatory gland pores, ♂ of male and ♀ of female system; *de*, ductus ejaculatorius (variously modified and not always strictly homologous as indicated in the several figures); *ep*, epididymis (remark under *de* applies to this also); *g*, cutaneous glands; *g* XI to XVIII, ganglia of the ventral chain, numbered to agree with their somites; *gp*, (or *pg*), prostate glands and prostate region of penial sheath; *ga*, glandula albuginea; *np* 1 to 17, nephridial openings of pairs indicated by the numerals; *od*, oviduct; *odc*, common oviduct; *of*, closed end of ovarian sac; *os*, ovisac (uterus); *ov*, ovary or ovarian sac; *ov'* (in Fig. 27), position of ovary; *p*, prostate cornua of atrium; *pg* (or *gp*), prostate glands and prostate region of penial sheath; *ss*, sperm-sac; *t* 1, 2, etc., testes, numbered by pairs from before backwards; *va*, vagina; *vd*, vas deferens; ♂, male genital orifice or its position; ♀, female genital orifice or its position.

Unless otherwise stated all of the figures are made from specimens in the Illinois collection and have been copied to scale as nearly as possible after the originals, which were drawn upon camera tracings. Diagrams are indicated.

Plate XLII.

Fig. 1. *Placobdella parasitica.* Dorsal view showing the metamerism and annulation of the twelve anterior somites; the cutaneous papillæ are not indicated. The color pattern is shown, the stippled parts being the brown or olive background and the plain areas the yellow spots and band. × 5.

Fig. 2. *Placobdella rugosa.* Similar representation of the anterior ten somites (except X *a* 3). The principal cutaneous papillæ are shown. From a specimen taken near Philadelphia. × 5.

Fig. 3. *Placobdella rugosa.* Details of papillation, etc., of the right half of the dorsal surface of somite XIX of a large example. The lines to the right indicate the relative positions of the ventral furrows. × 5.

Fig. 4. *Placobdella parasitica.* A similar view of onehalf of somite XIX, but of a much smaller specimen. × 5.

Fig. 5. *Hemiclepsis carinata.* The principal features of the external morphology of the dorsum of somites I to XII. Drawn mostly after a specimen from Venice, Ohio, and very slightly diagrammatic. × 4.5.

Fig. 6. *Glossiphonia lineata.* A slightly diagrammatic figure showing the external morphology of the dorsum of somites I to X. The annulation is originally derived from young; the sensillæ and papillæ added as determined in adults. The young, × 30.

Fig. 7. *Hæmopis marmoratis.* Surface view of denticles from median jaw. × 112.

Plate XLIII.

Actinobdella inequiannulata.

Fig. 8. The dorsal external morphology of the entire leech (somites XIII to XXI) omitted. Somewhat diagrammatic in that the furrows are made to appear more regular than in the original. × 35.

Fig. 9. Side view of the posterior end, showing the sucker with some of its papillæ projecting. × 35.

Fig. 10. Outline of the sucker from below, with the circle of papillæ somewhat diagrammatically shown. × 35.

Fig. 11. A small portion of the sucker rim showing the muscular ribs and four of the papillæ. The glandular ducts of the latter are stippled. × 130.

Plate XLIV.

Philobdella gracile.

Fig. 12, 13. Dorsal and ventral views respectively of the anterior nine somites, showing the chief features of external morphology. × 5.

Fig. 14, 15. Ventral and dorsal views respectively of the posterior end of the body; the dark spots are outlined. × 5.

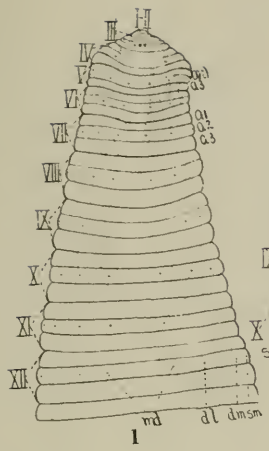
Fig. 16. The ventral surface of somites XII and XIII showing the various features of the region of the genital orifices. A combination drawing from several specimens. × 5.

Fig. 17. Reproductive organs dissected and partly displayed. × 4.

Fig. 18, 19. Posterior and anterior ends respectively from the left side. × 5.

Fig. 20. Surface view of a posterior portion of the tooth series of the median jaw with the outline of the jaw partly shown. × 56.

Fig. 21. Female reproductive organs dissected and viewed from the right side. From the same dissection as figure 12. × 4.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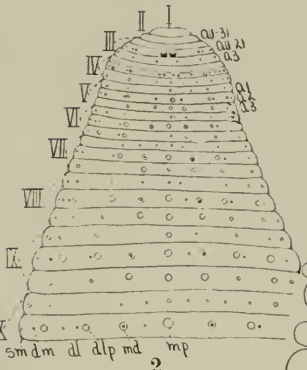
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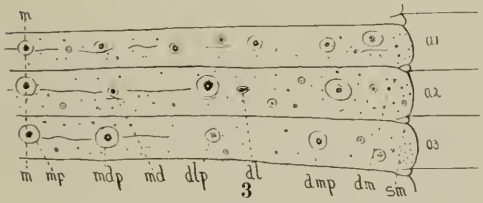
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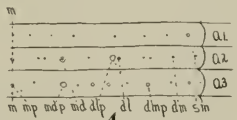
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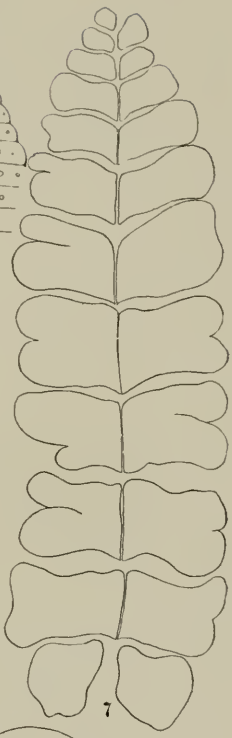

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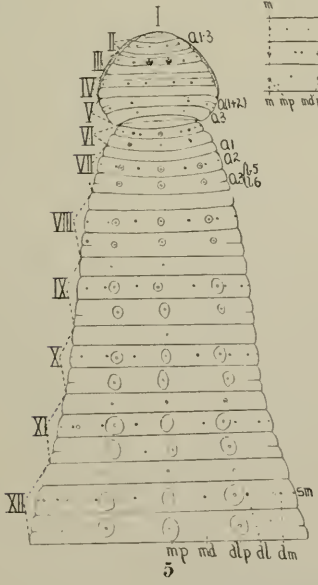
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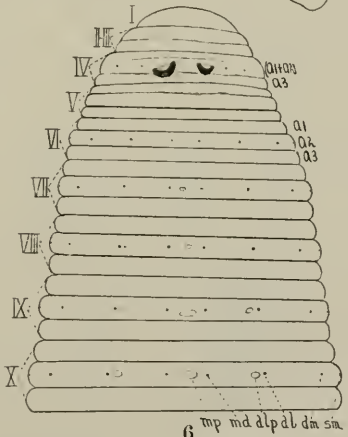
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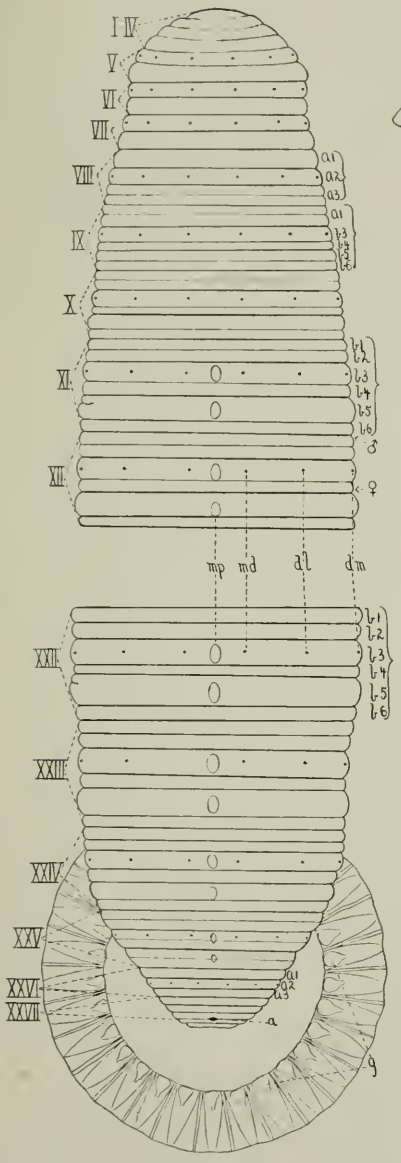
Plate XLIII.



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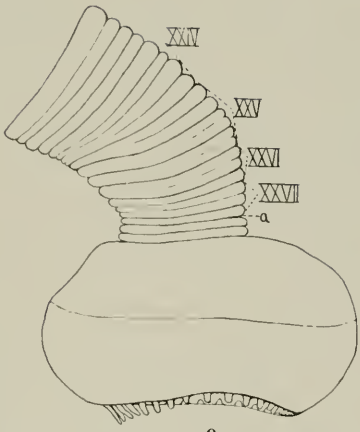

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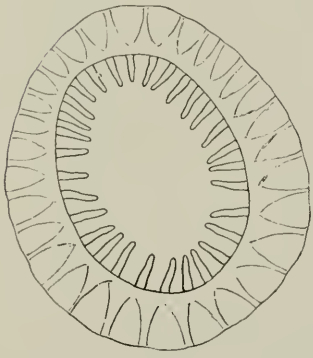

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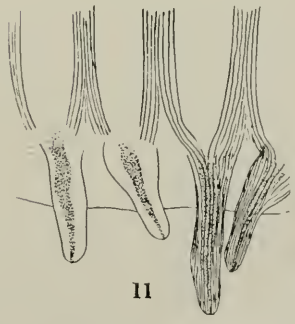

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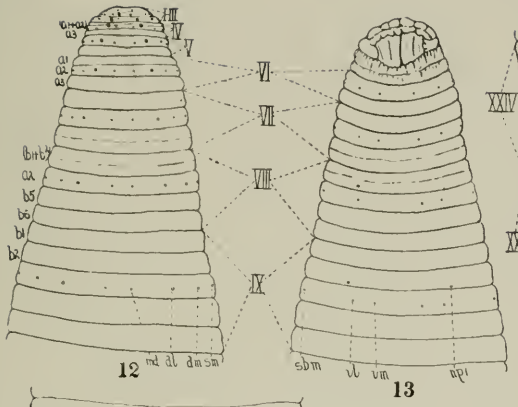
Actinobdella inequiannulata.



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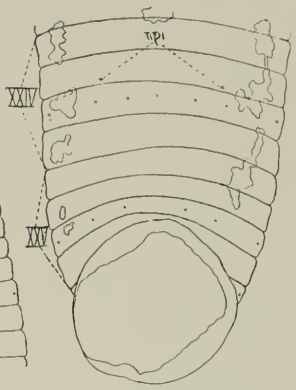

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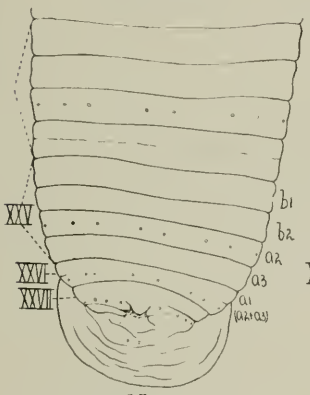

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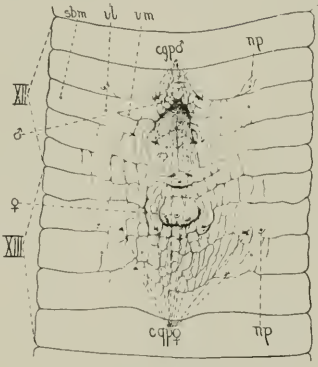

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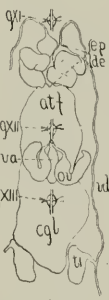

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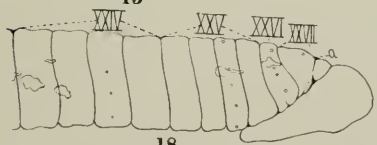

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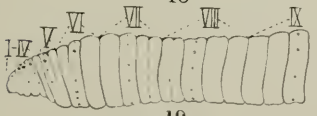

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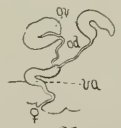

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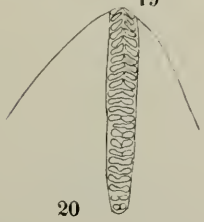

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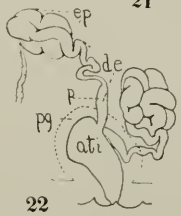

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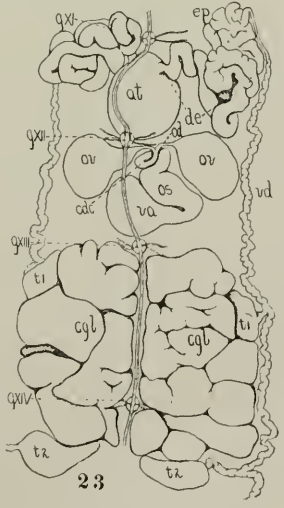

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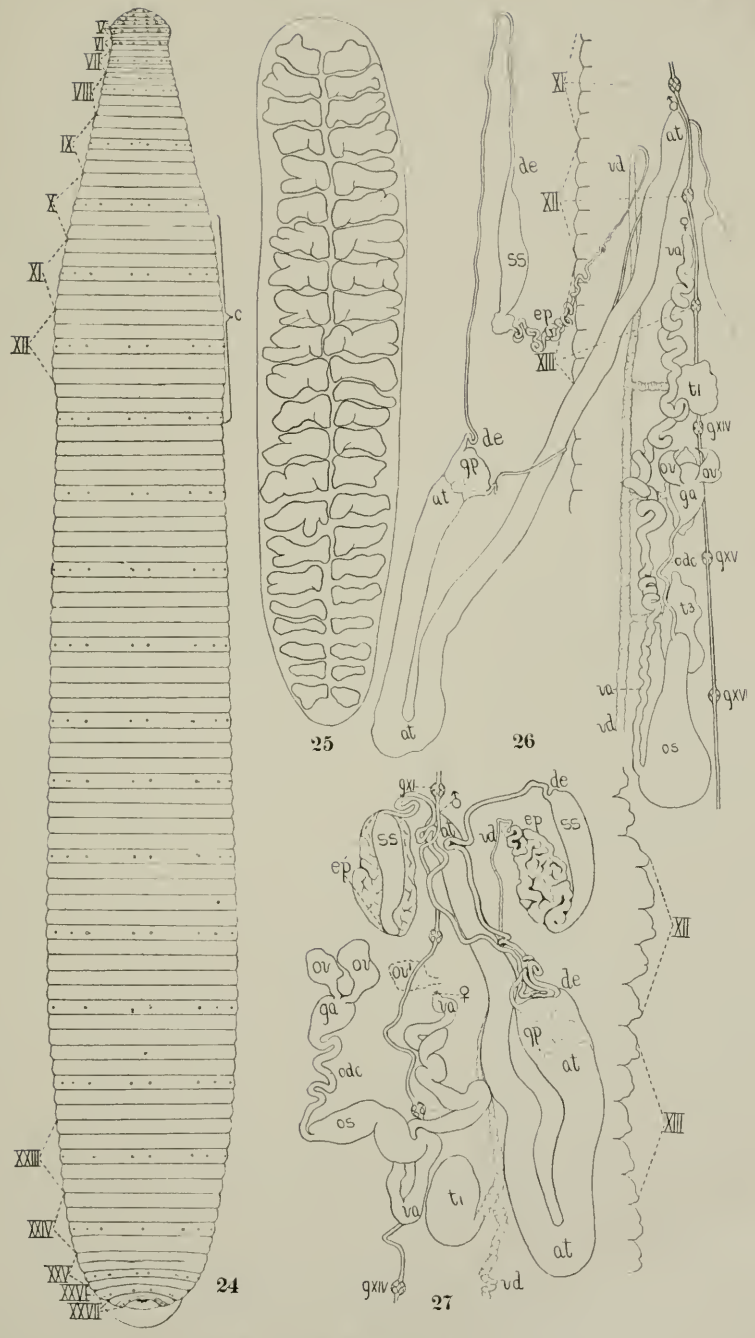
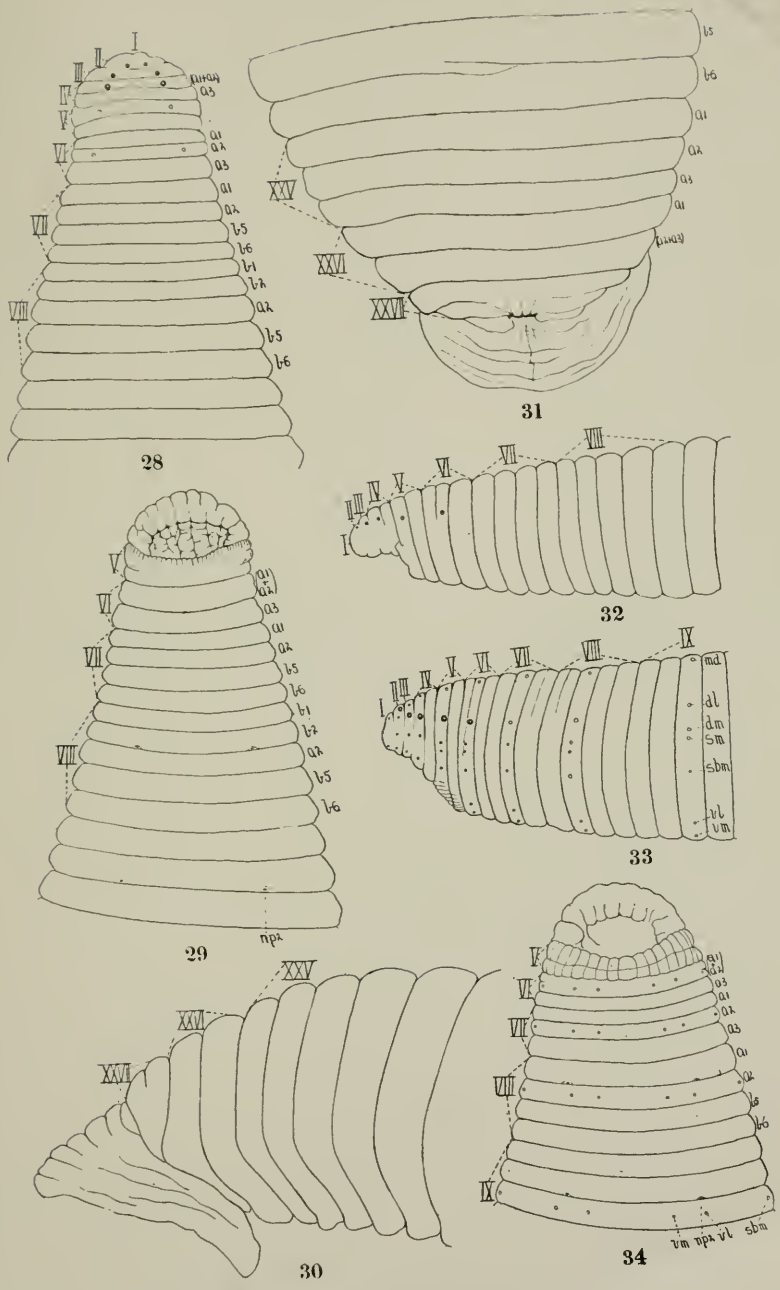
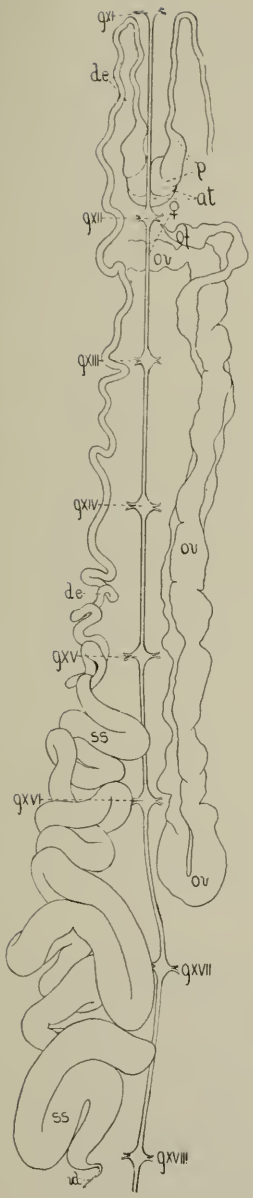
PHILOBDELLA GRACILE, MACROBDELLA DECORA.



HÆMOPIS MARMORATIS, H. LATERALIS.

Plate XLVI.





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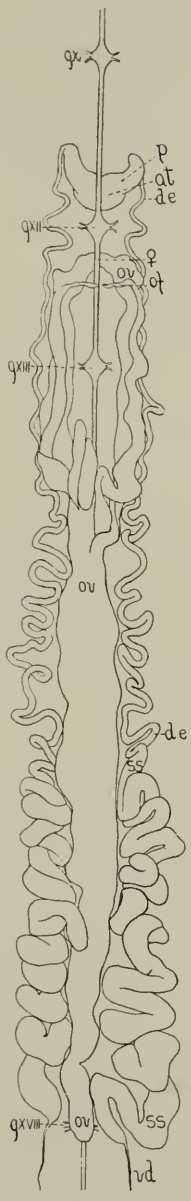

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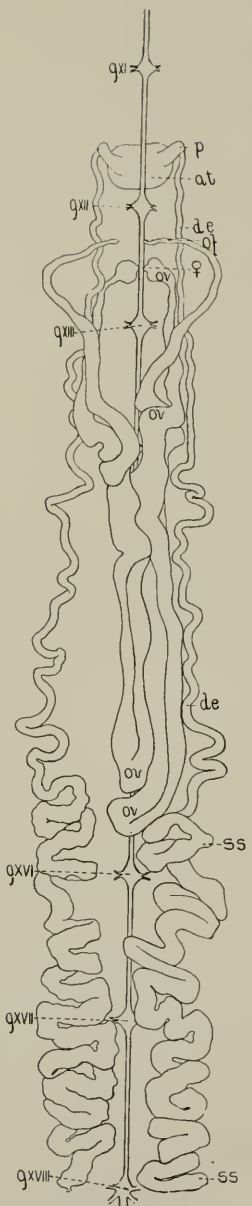

37

Macrobdella decora.

Fig. 22. The male organs dissected and viewed from the right side. The left sperm-duct has its natural position, the right has been displaced upwards. The dotted line indicates the form of the atrium before the removal of a layer of muscles and prostate glands. × 4.

Fig. 23. The greater part of the reproductive organs dissected and viewed from above. From a specimen from the Fulton Lakes, New York. × 4.

Plate XLV.

Fig. 24. *Hæmopis marmoratis.* Diagram of the entire dorsal annulation, showing also the sensillæ, eyes, etc. × 2.

Fig. 25. *Hæmopis lateralis.* Surface view of denticles of median jaw. × 112.

Fig. 26. *Hæmopis marmoratis.* Reproductive organs dissected and partly displayed in dorsal view. The female organs are shown nearly in situ; the atrium with the left ductus ejaculatorius and epididymis has been displaced far to the left and only a portion of the right ductus is shown; three testes of the left side are included. × 3.5.

Fig. 27. *Hæmopis lateralis.* Reproductive organs dissected and displayed as in figure 26. The ovaries and oviducts are displaced to the left, but the proper position of the left ovary is indicated in outline (*ov'*). The atrium is withdrawn somewhat to the right and the epididymes and ducti ejaculatorii of both sides are shown, as well as the anterior end of the right vas deferens and the first testis. × 3.5.

Plate XLVI.

Fig 28, 29, 32. *Hæmopis lateralis.* Dorsal, ventral, and left lateral views respectively of the anterior eight (+) somites. × 5.

Fig. 30, 31. *Hæmopis lateralis.* Right lateral and dorsal views respectively of the posterior end. × 5.

Fig. 33, 34. *Hæmopis marmoratis.* Respectively left lateral and ventral views of somites I to VIII and part of IX.

Plate XLVII.

The three figures of this plate represent similar dorsal views of dissections which were selected because of the equality in size and apparent equality of sexual activity of the individuals. In each case almost exactly the same extent of body is represented, as indicated by the numbered ganglia, and the somites containing the testes are omitted. All, × 7.5.

Fig. 35. *Erpobdella punctata.* The left ovary and the right sperm-duct have been removed.

Fig. 36. *Dina ferrida.*

Fig. 37. *Dina microstoma.*