

THE LEECHES OF THE DOUGLAS LAKE REGION

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Leeches of the Douglas Lake region

The Hirudinea, or leeches, are predatory or parasitic annelids with terminal suckers serving for attachment and locomotion. They are distributed all over the world, mostly in fresh water though a few are marine and a few are terrestrial. Herodotus in the 5th century B.C. referred to the leech under the name "bdella" which still forms the ending of some scientific names of certain leeches and groups of leeches (Nachtrieb, 1912, p.3). The medicinal leech, Hirudo medicinalis Linnaeus, was known from the time of the Greeks until the middle of the 19th century because of its use for blood-letting. Considerable work was done on the morphology of leeches during the 19th century but they have received relatively little attention recently. Gee (1913, p.199) gave a resume of the literature on leeches up to 1913.

Leeches are usually found under sticks or stones or in the mud on the bottom of lakes, ponds, and streams unless actively in search of food. Of approximately three hundred leeches collected in the Douglas Lake region during June and July, none were found at a depth greater than two feet. The temperature range of the water was between 18°C. and 26°C. Gently moving water in protected coves or at the outlets or inlets of lakes is preferred to still water.

Some leeches are free-living scavengers, others temporary parasites remaining attached to their hosts only long enough to become gorged with blood, while others are confirmed parasites. Nachtrieb (~~Nachtrieb~~, 1912, p.5) says "In many places leeches are abundant enough to be of economic importance. They may be of value in so far as they serve as food for fishes and birds or in so

far as they are scavengers. On the whole, however, the leeches are rather an injurious group. They may kill fishes and other animals, particularly young by bleeding them to death, or, indirectly, by devouring the snails, worms, and larvae which constitute the principal food of some fishes. They are also injurious in so far as they serve as intermediate hosts for various developmental stages of animals that during some period of their lifetime are parasitic on fishes, birds, and other animals. There is still a great deal to be learned about the life histories of many of our leeches, their relations to other animals, particularly their relations to fishes, and their influence on the character of the fauna in particular bodies of water.

'The wounds made on man by the blood-sucking leeches very rarely produce any serious results. Considerable, sometimes, intense, itching of the region immediately around the wound is usually the only noticeable effect. More serious results are probably due to infection.' Moore (~~Moore~~, 1923, p. 12) says that the itching "probably results from the injection into the wound of a natural haemolytic agent in the saliva. If the leech be permitted to complete its meal this substance is largely or entirely withdrawn from the wound, but if the meal be curtailed much of the haemolysin remains and acts as an irritant..... The haemolysin prevents the coagulation of the blood, which is the reason why a leech bite continues to bleed so much longer than an ordinary slight cut."

Relative to leeches as internal parasites in man, horses and cattle, Nachtrieb (~~Nachtrieb~~, 1912, p. 5) says "When, however, the leeches find their way into internal passages, they may produce serious disturbances. The young of the blood-sucking horse leech

taken in by horses and cattle while drinking from ponds or lakes have been known to become attached to the lining of the pharynx and the windpipe and cause more or less serious disturbances. Fortunately the number of species that in this way practically become internal parasites is very small, and the chance of their invading human beings exercising some care is very slight. It may be well to remember, however, that was a small inconspicuous leech not thicker than a horsehair, that was the cause of considerable trouble to Napoleon in Egypt. His soldiers in drinking water directly from the streams, lakes and pools took in small leeches which attached themselves in the back part of the mouth cavity and caused annoying blood spitting and difficulty in breathing." Gee (1913) ^{p. 205} quotes from Masterson (1908) regarding the Hirudinea as parasites of man in Palestine. "Leeches are common in the fountains and pools of Palestine, particularly in the northern parts known to us familiarly as 'Galilee' and further north in the district of Lebanon. In the later summer and autumn months they are so plentiful in places that almost every horse and mule passing through these parts has a bleeding mouth. Under such conditions it is not wonderful that human beings from time to time are attacked.... Many of the springs in the mountains of Galilee and in Lebanon are widely known for the multitude of leeches which lurk in their waters, but a thirsty traveler seldom has the self-control to restrain himself from drinking, and when he does so, particularly at dusk or in the night, he is very likely to suck one in! In the cases, some three dozen or so, which I have had under my own observation, the leech has been attached to the epiglottis, the pharynx, the nasal cavities, or, most common of all, the larynx....

The haemorrhage, though never great in quantity at any one time, may, when prolonged, be very serious or even fatal. I know of two cases where the patient has actually died from this."

External Characters

The large posterior sucker and smaller anterior ones are the most prominent external characters of the leech. When at rest the body is elongated, more or less flattened dorso-ventrally, tapering gradually toward the anterior and more abruptly toward the posterior end of the body. The body is very muscular and can be shortened, changed in shape, or tightly rolled up.

The leech body shows the characteristic metamerism of the annelids having thirty-three to thirty-four somites but does not have the thin septa separating the somites internally. In addition the leech has an external annulation which does not correspond to true metamerism. The limits of the somites may be determined by the arrangement of internal structures especially the nerve ganglia. Figure 1, Plate I illustrates this relationship. The typical number of annuli to a somite of any species is determined by the number in the somites of the middle region of the body. The number may vary in the anterior and posterior somites. The different annuli of a somite may be equal or unequal in size and some may be only partially divided. Nearly all leeches can be placed in two groups, one having three primary annuli and one having five primary annuli in each somite. A system of numbering the annuli to aid in the location of structures and to indicate the relationships of the annuli was adopted by Moore (Nachtrieb, 1912, pp.12-13) and is Figs. 3 and 4, Plate I. Fig. 2, Plate I shows how annuli become

Plate I.

- Fig. 1. The somite and annuli of the Glossiphonidae as determined by Castle and Moore, showing the relation to the nerve ganglia.
- Fig. 2. The derivation of a typical somite of five annuli and a typical somite of six annuli from one of three annuli.
- Fig. 3. This diagram illustrates how annuli become divided into two, four and six annuli and how a somite of four or twelve or fourteen annuli may be derived from a somite of three annuli.
- Fig. 4. The system of notation adopted by Moore to indicate the relationships of the annuli.

Plate I.

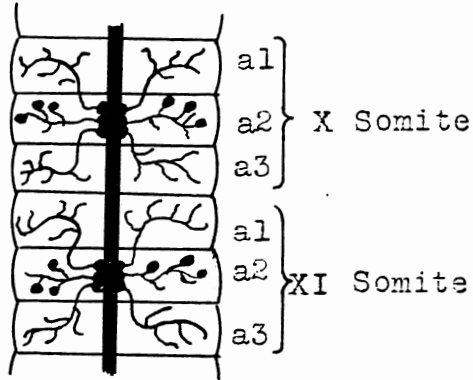


Fig. 1

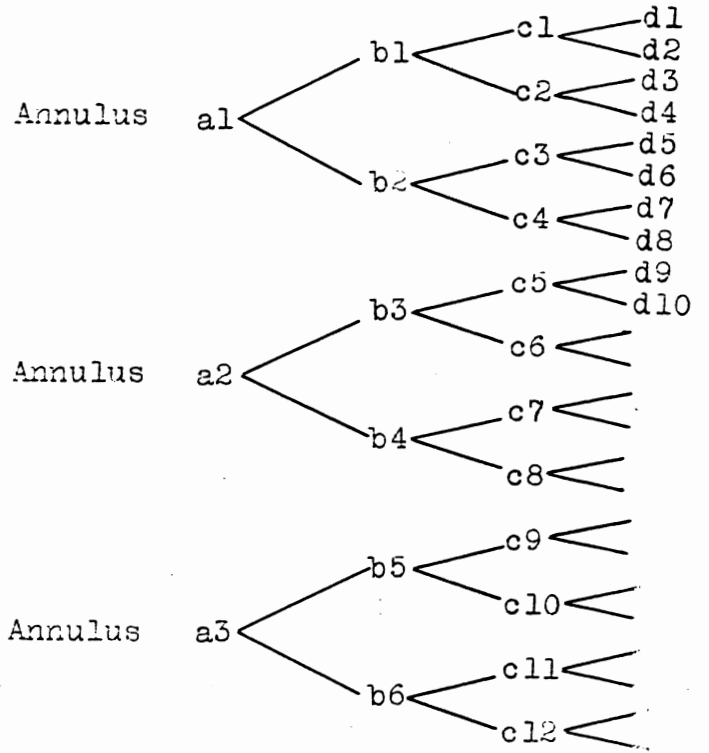


Fig. 4.



Fig. 2.

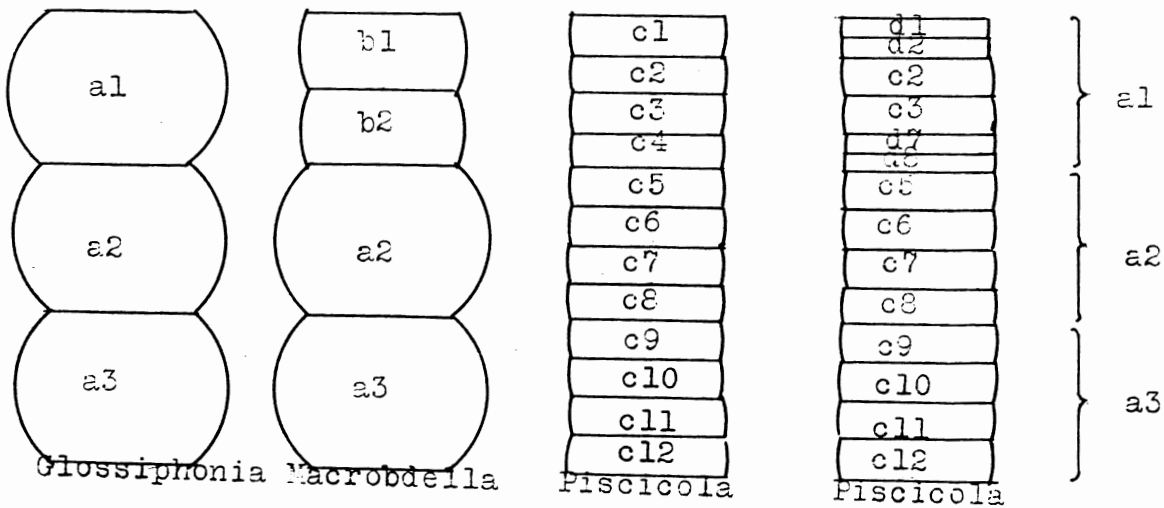


Fig. 3.

From Nachtrieb (1912)

divided into more than three annuli.

Leeches vary in length from about one eighth of an inch to a foot and a half. Color markings are varied, even within one species. One to five pairs of eyes, showing as conspicuous pigment spots, are found on the anterior somites. Special sense organs called sensillae are found on one of the annuli of most of the somites. The body is always covered with a thin, tough cuticle and more or less mucous. The mouth and anus comprise the openings of the digestive tract. The genital openings will be found in the region of the XI/XII somites from one to five annuli apart. The more anterior one is the opening from the male reproductive organs and is the more conspicuous. The opening of the female reproductive organs is very inconspicuous. The nephridia open to the exterior through pores in the somites in which nephridia are located. These can often be detected by wiping the ventral surface dry and then running it with some smooth tool which forces the content from the nephridia.

Internal Anatomy.¹

The digestive tract is a more or less highly differentiated tube extending from one end of the body to the other. The mouth is on the ventral surface at the anterior end in the center of a more or less well-developed sucker. In the Gnathobdellidae, the mouth is provided with three "jaws" which radiate from a common point with an angle of about thirty degrees between the middle jaw and the outer of the trio. The free edge of each jaw is curved and, in some species, covered with a chitinous band that is notched like a saw. When these jaws are worked back and forth on the skin of the host by the special muscles attached to them, they cut a

¹Adapted from Nachtrieb, 1912, pp. 17-21.

ragged wound in the skin which bleeds much more freely than would a single cut. The mouth opens into the pharynx or esophagus. The Rhynchobdellidae can protrude this organ and it is generally called a proboscis. In true blood-suckers this region has opening into it a large number of unicellular glands called salivary glands. They are located mainly in the two or three somites immediately preceding the male reproductive opening. There may also be a multicellular gland with a duct called the esophageal gland. These glands produce a secretion which prevents the coagulation of the blood sucked from the host. The esophagus opens into the stomach or crop which in the true blood-suckers has from two to fourteen gastric ceca. As a rule there is but one pair of gastric ceca to a somite but in some cases there are two. They are side pockets which serve as reservoirs for the ingested blood. When they are full the leech may leave the host and seek some secluded place until digestion is completed. This process may last for several months, nine in the case of Hirudo medicinalis. Generally there are no gastric ceca in the leeches which do not suck blood. The intestine of true blood-suckers may also have several pairs of intestinal ceca. When the blood enters this region of the digestive tract it rapidly changes color and composition due to the active digestion which takes place in this region. The rectum opens to the exterior through the anus which is located on the dorsal side near the posterior sucker.

The blood vascular system consists of several longitudinal vessels with connecting branches to each somite, vessels to the nephridia and other organs, and so-called sinuses which represent portions of the true body cavity. Portions of this system have contractile walls which, with the aid of the muscular contractions of the body, keep the blood in circulation.

Respiration in most leeches is performed almost wholly through the skin. Two marine forms have gills on certain somites.

The excretory system is composed of nephridia which are similar in structure and function to those of the earthworm. The large bladder-like reservoir near the nephridiopore is enlarged in terrestrial leeches.

In general the nervous system is similar to that of the earthworm.

Leeches are hermaphroditic but the eggs of one individual are fertilized by the spermatozoa of another. The male reproductive organs consist of a series of pairs of testes close to the nephridia in certain somites. The number varies from five to eleven pairs in the different species. The series on each side is connected by a common duct, called the vas deferens, which opens into a muscular tube near somite XI. The terminal portion of the common duct formed by the two vasa deferentia is sometimes called the penis, as it can be protruded through the external pore. The essential female organs consist only of a pair of ovaries which usually lie in somite XI with the female pore from one to five annuli behind the male opening.

In some species fertilization may be accomplished by the attachment of spermatophores, packets of spermatozoa, to any part of the body wall of another leech. The spermatozoa escape through the body wall into the underlying connective tissue and thence work their way to the ova near the uterus where fertilization takes place. In other cases fertilization takes place in the uterus (or in capsules containing ova, spermatozoa, and some albuminous material) by spermatozoa introduced directly through the external opening.

Some leeches lay a few eggs at a time in small capsules which are attached to submerged parts of water plants or stones. Others enclose a few eggs in egg-shaped capsules or cocoons which may be half an inch or more in length. These cocoons are deposited in masses of decaying vegetation. Others carry the eggs and young attached to the ventral surface of the body until the young are old enough to fend for themselves. In these cases the eggs are laid in small spherical clusters, each mass surrounded by a delicate membrane of mucous-like substance secreted by skin glands. A number of such groups of eggs are somewhat loosely hung together and are attached to the ventral surface of the parent, by a substance similar to the membrane around each spherical mass of eggs. When thus burdened with eggs or young the leech stays in some protected place and by undulatory movements of the body keeps the eggs or young well aerated. If the egg masses become dislodged the parent will make efforts to collect them and again attach them.

Methods

Collecting: Leeches may be collected from the under side of stones and wood as well as by dredging the mud at the bottom of shallow ponds. Ward and Whipple (1918, p.600) says, "Sanguivorous species are easily collected by stirring the mud in their haunts with one's bare feet and removing the leeches from the skin as they become attached, or by attracting them with fresh blood placed in the water." Moore (1923, p. 30) suggests the use of baits "of freshly killed and bleeding small animals and of slaughter-house blood placed in a muslin bag, dragged through the water, or simply placed in the water and allowed to diffuse." He also

suggests the use of traps which he describes and diagrams but does not recommend highly. He found freshly killed frogs the most effective bait.

Culture: All writers agree that there is little difficulty in keeping leeches alive and in good condition in the laboratory for months. An aquarium containing water, a little algae or water plant and a stone for hiding provides a satisfactory environment for them. The characteristic food for the species should be provided occasionally but the fact that most leeches normally take one big meal and then do not eat again for several months makes the feeding problem a simple one.

Narcotisation: Various narcotics have been suggested (Lee, 1924, pp. 12-17; Castle, 1900, p.19; Heminway, 1912, p.31; Ward and Whipple, 1918, p. 650) such as menthol or chloreton crystals sprinkled over the water, a 1% hydrochlorate of cocaine, lemon juice, and carbonated water. Of these, carbonated water in the form of ordinary bottled "pop" has proved the most successful, with lemon juice a close second.

Killing and Fixing: Castle (1900, p.19) recommends Perenyi's fluid for gross anatomy as it removes pigment, and Flemming's fluid or corrosive sublimate for preparing sections. For preserving pigment, he suggests the use of a picric acid fluid or formaldehyde. Heminway (1912, p.31) used Gilson's mercurio-nitric mixture on small forms for an hour, then transferred to 80% alcohol and treated with iodine.

Staining: Heminway (1912, p.31) stained in bulk with Mayer's Paracarmine, counterstained with Lyons blue after sectioning, or cleared with cedar oil and examined as a transparent object.

These cleared specimens were later sectioned and stained with Ehrlich-Biondi stain. Castle (1900, p.19) used iron hematoxylin for sections and Mayer's hydrochloric acid carmine (70% alcoholic) for whole preparations, decolorizing in acid alcohol (1% HCl in 70% alcohol) washing in neutral alcohol, and clearing in cedar oil.

Behavior

Gee (1913, pp.208-248) classifies the movements of leeches into the following categories, (1) random movements, (2) looping response, (3) swimming response, (4) undulatory respiratory movements, (5) righting reactions, (6) general responses to stimuli including feeding responses, and (7) breeding reactions.

Regarding random movements, he says (p.209), "Too much stress cannot be placed upon the part played by random movements in the behavior of the leech. Its life is one of repeated trial, and the adaptiveness of its selective actions from among the many varying factors of its environment usually serves to steer the animal effectively out of regions unfavorable to its continued existence, and into proper environmental conditions..... Nor is it necessary for some stimulus to be applied to observe this tendency to random movements. Almost every looping response of the animal in its progress forward is preceded by a series of random movements of the anterior end. So thorough is the exploration of the advance ground, at times, that the body of the animal describes several very wide arcs of a circle before orientation is finally effected. This tendency to 'prove all things, hold fast to that which is good!' is perhaps the most striking single characteristic of the behavior of leeches, and undoubtedly, due to the flexible

nature of the response, serves a most important adaptive purpose in the life of the animal."

The looping reaction resembling the movements of Geometrid larvae or "measuring worms", is, in my experience, more characteristic of the Rhynchobdellidae than of the Gnathobdellidae though it is evidenced by all leeches to varying degrees. The leech with the posterior sucker attached, extends its body to the full extent, attaches the front sucker, releases the posterior one and brings it up almost if not quite in contact with the front sucker. In this way it can travel at a fair rate of speed.

The swimming response, on the other hand, is characteristic of the Gnathobdellidae, many of the Rhynchobdellidae swimming very little if at all. Gee (1913, p.212) describes this reaction as follows, "The reaction consists in a rhythmical undulatory muscular contraction proceeding antero-posteriorly. The body strikes up and down in the water, or the lateral axis of the body may become vertical in position, and the body of the animal be lashed from side to side. A very characteristic feature of this eel-fashion of swimming is the dorsal-ventral flattening of the body." Swimming may be stimulated easily by proding the posterior sucker.

Undulatory respiratory movements resemble swimming movements except that the leech remains attached by its posterior sucker and the body waves outward in the water. This is frequently observed when leeches have remained quiet in an aquarium for some time. The Rhynchobdellidae may accomplish this with both suckers attached so that there is body slack. Then an up-and-down motion produces the aeration. This is a characteristic activity of a leech carrying eggs or young.

The righting process is accomplished with the aid of either the anterior or the posterior sucker though in the Gnathobdellidae it is frequently effected by swimming.

In general leeches are highly sensitive to stimuli. Gee (1913, p. 216) calls attention to the tendency of nephelid leeches to collect in twisted masses in an aquarium which does not have stones and also when the temperature is lowered to about 10°C. Leeches are extremely sensitive to jar, movements or shadows. They are markedly negatively phototactic and positively thigmotactic. Nephelids are positively rheotactic. The tendency of the Rhynchobdellidae to roll up "pill-bug" fashion when disturbed is very characteristic. Gee (1913, p. 219) says that "The food is located by 'trial and error' movements, and is often crawled over and under by leeches without its presence serving to check all of them. When the anterior sucker comes in contact with the soft body of the snail there seems to be a reinforcing stimulus to the contact response, . . . and the animal holds on literally as well as figuratively 'for dear life'". The mouth region seems more sensitive to the presence of food than other regions indicating the possible presence of taste sensory cells in that region.

Key for the Identification of Hirudinea

Adapted from the Key to the Leeches of Minnesota, Moore (1912) and Key to North American Fresh-water Leeches by Ward and Whipple (1918).

I..Mouth a small pore-like opening in the disk of the anterior sucker, through which a muscular pharyngeal proboscis may be protruded.

A. Complete somites formed of three annuli.

a. Genital orifices separated by a single annulus; eyes one pair, distinct.

b. A dark brown cuticular plate and underlying gland on dorsum of somite VIII. Body capable of great extension; color pale pink, gray or brownish.

Glossiphonia stagnalis p.20

bb. No nuchal gland or plate in the adult.

c. Body very slender, elongated, and little flattened; very transparent due to the nearly complete absence of pigment; no cutaneous papillae.

glossiphonia nepheloidea p.23

cc. Body relatively broad and flat; more or less heavily pigmented with brown arranged in a linear pattern, annulus a2 marked with white spots usually arranged in transverse rows; three longitudinal series of conspicuous black papillae.

Glossiphonia fusca p. 26

aa. Genital orifices separated by one annulus; eyes in several pairs

b. Eyes in three groups of two; body transparent, with little pigment; no papillae; gastric ceca six pairs, nearly or quite unbranched.

Glossiphonia heteroclita p.28

aaa. Genital orifices separated by two annuli; eyes in several pairs.

- b. Three pairs of eyes; gastric ceca six or seven pairs, branched;
a pair of dark longitudinal lines both above and below.

Glossiphonia complanata p. 30

- bb. Four pairs of sub-equal eyes, all simple; gastric ceca nine pairs.

Hemiclepsis occidentalis p.33

- bbb. One pair of compound eyes followed by three or more pairs of much smaller simple eyes; gastric ceca seven pairs.

Placobdella hollensis p.36

- aaaa. Genital orifices separated by two annuli; a single pair of compound eyes; gastric ceca, seven pairs, branched.

- b. Somites I to V much widened to form a distinct head; dorsum marked by three strong papillated keels; gastric ceca much branched.

Placobdella montifera p.39

- bb. Anterior segments not especially widened.

- c. Posterior sucker: very free and supported on a slender peduncle; anus at XXIII/XXIV; gastric ceca little branched; body rather high, very contractile; dorsal papillae wanting.

Placobdella pediculata p. 41

- cc. Posterior sucker not supported on an especially slender peduncle; anus at XXVII/XXVIII; gastric ceca much branched.

- d. Cutaneous papillae smooth and round; body much depressed.

- e. Integuments rather opaque; dorsal papillae few, low and smooth; size large; longitudinal lines on ventral surface

Placobdella parasitica p.44

- ee. Integuments translucent, brightly but not deeply pigmented with green, orange, and white; size medium.

Placobdella picta p.47

dd. Cutaneous papillae prominent and rough and pointed.

- e. Numerous minute papillae around margin of caudal sucker; body moderately depressed; dorsal papillae usually in a median and two paired series, small, acute, pale yellow or brown; a very conspicuous and constant pale band across somite VI; size small.

Placobdella phalera p.47

- ee. No marginal papillae on caudal sucker; body very much depressed; papillae numerous; size large.

Placobdella rugosa p.48

AA. Complete somites composed of more than three annuli.

- a. Complete somites consisting of six unequal annuli; posterior sucker very large and provided with a marginal circle of contractile papillae; eyes one pair contiguous in middle line.
- b. Sucker papillae and glands about 30; median dorsal series of papillae alone developed.

Actinobdella inequiannulata p.53

- bb. Sucker papillae and glands about 50; five series of dorsal papillae.

Actinobdella annectens p.57

- aa. Complete somites consisting of twelve or fourteen approximately equal annuli; body divided into two regions; posterior sucker without marginal papillae; eyes widely separated on posterior part of head.
- b. One pair of eyes, occasionally two; posterior sucker without eye-spots.

Piscicola punctata p.61

- bb. Eyes two pairs; four longitudinal yellow bands; twelve eye-spots on posterior sucker.

Piscicola milneri p.64

II. Mouth large, the sucker appearing as its bounding lips; the pharynx not forming a protrusible proboscis.

A. Eyes five pairs arranged in a regular arch on somites II to VI; genital ducts with complex copulatory apparatus; testes strictly paired, their number moderate; at least one pair of gastric ceca present.

a. Jaws prominent bearing many small teeth arranged in one series; accessory copulatory glands present and opening in pores behind female genital orifice.

b. Teeth about 65 in each jaw; genital pores separated by five annuli; the dorsum marked by median red and marginal black spots, both metameric.

Macrobdella decora p.66

aa. Jaws prominent, bearing a few coarse teeth arranged in paired series; no accessory copulatory glands.

a. Teeth twelve to sixteen pairs on each jaw; the primary annuli VIIa3 and VIIIa1 enlarged, but only partially divided into secondary annuli; color variable but marked more or less thickly with non-metameric black blotches.

Haemopsis marmoratis p.71

bb. Teeth twenty to twenty-five on each jaw; the secondary annuli VIIb5 and b6 and VIIIb1 and b2 completely formed; color nearly uniform, usually with a median dark stripe and a few or no blotches.

Haemopsis lateralis p.74

aaa. Jaws absent or rudimentary; no teeth; no accessory copulatory glands.

b. Male genital orifice at XIb5/b6; the female at XIIc5/b6; color pattern consisting in part of close or distant blotches.

of dark pigment, ventral ground color lighter than dorsal.

Haemopsis grandis p.78

bb. Male and female genital orifices constantly at the middle of XIb6 and XIIb6 respectively; a few distant dorsal blotches or none; no ventral blotches, ventral ground color not paler, usually darker than dorsal, the rufous or orange marginal stripe conspicuous.

Haemopsis plumbeus p.81

AA. Eyes three or four pairs (rarely absent, usually one or two pairs on II and two pairs at the side of the mouth on IV; no jaws, no gastric ceca; genital ducts relatively simple, with small atrium produced into a pair of dorsal cornua and no penis; testes numerous, not paired. Predaceous.

a. Somites strictly five-ringed, none of the annuli obviously enlarged or subdivided; eyes three pairs, the first largest; genital pores separated by two annuli; atrial cornua simply curved; vasa deferentia reaching forward to ganglion XI.

Herpobdella punctata p.85

aa. Annulus b obviously enlarged and subdivided; atrial cornua spirally coiled, vasa deferentia with anterior loops reaching to ganglion XI; eyes four pairs; genital orifices separated by two annuli; colors plain or irregularly blotched.

Nephelopsis obscura p.88

aaa. Atrial cornua not spirally coiled, but short and merely curved.

b. Vasa deferentia with anterior loops reaching to ganglion XI.

c. No pigmented eyes; genital pores separated by two annuli; longitudinally striped. California.

Dina anoculata p.91

cc. Eyes four pairs; genital pores separated by three to three

and one-half annuli; nearly pigmentless.

Dina parva p.93

bb. Vasa deferentia not extending anterior to atrium.

c. Eyes three pairs; genital pores separated by three annuli; atrial cornua very small; pigment nearly absent.

Dina microstoma. p.94

cc. Eyes three or four pairs; genital pores separated by two annuli; atrial cornua prominent; pigment absent or in scattered flecks.

Dina fervida p.97

Descriptions of Families, Genera and Species.

Family Glossiphonidae (from Moore, 1912)

Leeches of medium or small size; generally rather short, broad and much flattened, rarely slender and elongated. No distinct clitellum. Caudal sucker usually large and flat; oral sucker rather small and, except in a few cases, scarcely expanded. Complete somites of middle region usually of three rings, rarely of 2, 5 or 6. Eyes 1-4 pairs, situated in a longitudinal row close to the median line; the first pair often compound, the others simple. Dorsum often studded with cutaneous papillae in addition to metameric sensillae. Mouth a small pore in the oral sucker. Pharynx a slender, protrusible proboscis without jaws or teeth. Salivary glands present. Stomach with from one to ten pairs of lateral, simple or branched ceca. Intestine with four pairs of ceca. Genital orifices separated by one to four rings, the female in somite XII and the male in XII or between XI and XII. Testes sacs usually six, rarely nine pairs; sperm ducts divided into a very slender vas deferens and a large epididymis and ductus ejaculatorius, the latter of which opens into a small median atrium without a penis. Ovisacs a pair of slender convoluted tubes opening together at the female orifice without a vagina. Fertilization by means of horny spermatophores attached to the integument from which the spermatozoa penetrate the tissues to the ovisacs. Eggs and young borne on the ventral surface of the parent. Strictly fresh water. Tortoise and snail leeches, which feed on snails, small worms, etc. or suck the blood of tortoises, frogs or fishes, rarely fixed parasites of the latter. Creepers, mostly poor swimmers.

The following descriptions of Genera and species are taken from Moore(1912) unless otherwise indicated.

Genus *Glossiphonia* Johnston

Moderately depressed or elongated and nearly terete. Eyes 1-3 pairs, all simple. Cutaneous papillae few or none, never strictly median. Pharyngeal salivary glands diffuse; gastric ceca 1-7 pairs, simple or slightly branched. Sperm ducts forming a pair of long, open loops extending through several segments. Chiefly free-living or attached to invertebrates.

Glossiphonia stagnalis (Linn.) Johnston

Hirudo bioculata Bergmann (1757)
Hirudo stagnalis Linnaeus (1758)
Clepsine modesta Verrill (1872)
Helobdella stagnalis Blanchard (1896)

Description - *Glossiphonia stagnalis* is a small leech somewhat what larger and decidedly stouter than *G. nepheloidea*. Large individuals may reach a length of an inch when fully extended and in that state would be fully twice the width of a *G. nepheloidea* of the same length. When contracted to one-half that length, which is about the ordinary resting condition, they would be about three times the width of *G. nepheloidea* and much more flattened, but still decidedly convex above. The head is small but moderately distinct, less elongated and more strongly annulated than in *G. nepheloidea*. The caudal sucker is well developed, strongly directed ventrad, and but little exposed posteriorly; its axis ordinarily at about right angles to the body axis. While only one pair, situated as in *G. nepheloidea*, the eyes are much more conspicuous owing to the greater amount of their pigment. A conspicuous feature is the more or less deep brown chitinous plate and underlying gland situated on the dorsum of VI-Ial and a2.

There are no distinct integumental papillae though the surface may be somewhat roughened with scattered sense organs. The meta-

meric sensillae are inconspicuous as in G. nepheloidea.

The annulation is distinct throughout, especially at the caudal end, where the annuli are angulated at the margins. Somites I and II are usually completely united in the short prostomium.; III is uniannulate or occasionally faintly subdivided; IV and V are biannulate, the latter more completely and sometimes showing indications on the dorsum of the furrow a1/a2; VI to XXIV are triannulate, and XXV and XXVI biannulate, the latter occasionally being united with XXVII, which is commonly represented by a pair of wedge-shaped halves nearly sundered by the anus.

The mouth is smaller but otherwise similar in form and position to that of G. nepheloidea. Diffuse salivary glands extend through somites XII to XIV or sometimes farther. Never more than six pairs of gastric caeca are present, but the number is variable and may be reduced to three pairs by the obliteration of the first three. All are simple and unbranched and increase in size from the first to the sixth pair, the last being much the largest and reflexed caudad through three or four somites (XIX to XXII).

The external genital orifices and the reproductive organs generally are essentially like those of G. nepheloidea. The longitudinal muscle cells are arranged diffusely but are strongly developed.

Pale gray, pink, brownish or greenish tints, which are much affected by the contents of the alimentary canal seen through the more or less translucent tissues, are the colors of this species. Young specimens and some adults are almost colorless and translucent, but commonly the tissues of the larger ones are rendered opaque by the presence of numerous reserve and pigment cells.

Habits - Judging by the material which represents it in this collection this nearly cosmopolitan species must be much less abun-

dent in the lakes of Minnesota than in many other sections of this country and especially the northeastern portion from Illinois to Maine. It is found everywhere but abounds especially in warm, shallow waters of streams, pools and ponds and along the shores of lakes and rivers; it is the common pond leech. In all suitable localities it gathers in numbers on the under sides of stones, sticks and fallen leaves or conceals itself between the ensheathing leaf stalks of rushes and other aquatic plants. Less often it attaches itself to bodies of larger leeches, such as Macrobdella and Haemobis, to fresh water snails, mussels, fishes, turtles and more rarely to frogs. It is perhaps transported on the legs of aquatic birds. Like most of the Glossiphoniae it does not swim, but when disturbed creeps with considerable activity to a place of concealment, when, if still further disturbed, it rolls into a ball in the manner of a "pill bug" and falls to the bottom, then quickly unrolls and creeps away into a dark shelter.

Ordinarily its food consists of small annelids, insect larvae, snails, and small bivalves like Pisidium and its allies. Numbers also congregate and feed upon dead bodies of larger animals, such as crustaceans, fishes and frogs; and when occasion offers blood will be drawn from injured fishes, frogs and other vertebrates, including the feet of wading boys. Vast numbers frequent the fishing stations along the Delaware river, attracted no doubt by the quantities of bloody offal thrown into the river at such places. Under such conditions the stomach of every individual will be distended with blood, and, comparing Castle's descriptions of the alimentary canal with my own observations, I am led to suspect that the capacity of the gastric ceca may be increased in individuals which habitually subsist upon such a diet.

On the other hand this little leech is frequently devoured by the large predaceous leeches, sunfish, perch and other small carnivorous fishes. Along the shores of tidal rivers, like the Delaware, various species of snipe and sandpipers, which feed on the flats exposed at low water, pick them from the shingle and gravel.

Breeding begins in early spring and extends into the early summer. During the latter part of April and early May almost every individual bears its burden of eggs or young. In streams and ponds of cold water ovi-position occurs later than in warm waters. In some localities a second brood is raised in late summer. As in most closely related forms the eggs are not attached directly to the body but are contained several together in small mucoid sacs, of which mature individuals bear from eight to twelve or fifteen attached to the posterior ventral surface. When bearing eggs or young the rhythmic oscillating respiratory movements become much more frequent and vigorous than at other times. When disturbed the brood is protected by enveloping it in the margins of the body folded toward the middle line and rolling into a ball.

A more complete description is given by Castle (1900, pp. 21-33) He gives the size, fully extended, 20-25 mm.

Glossiphonia nepheloidea (Graf)

Clepsine nepheloidea Graf (1899)
Glossiphonia elongata Castle (1900)

Description - This species, which may be called the worm leech, is readily distinguished from any other member of its family belonging to this fauna by its slender, elongate, and sub-terete form. Slightly smaller and much narrower than G. stagnalis its great power of extension permits full grown individuals to exceed that species in length. Both the head and caudal sucker are very small and weak, and the axis of the latter nearly coincides with the axis of the

body. A single pair of widely separated eyes show their faintly pigmented cups within the anterior part of somite IV. The skin is smooth and lacks integumental papillae altogether; the nuchal gland and plate are also lacking in the adult.

For the most part the annuli are very distinct, regular, smoothly rounded and simple, but the furrows of the head region are mostly faint and usually require special preparation to make them visible. Somites I and II are united into a single annulus or are separated by a very faint furrow; III, IV, and V are biannulate, the first annulus being the larger in each case; VI to XXIV, inclusive, are triannulate, and XXV, XXVI and XXVII each uniannulate but distinct.

The relatively large mouth is located in somite III. In correlation with the narrowness of the body the stomach is a nearly simple straight tube bearing the last pair of reflexed ceca only, and even these are shorter than in allied species. The salivary glands are small and of the diffuse type.

As is the condition in many of the smaller species of *Glossiphonia* the genital orifices are separated by only one annulus, the male being in the furrow XII a1/a2, the female XII a2/a3. There are six pairs of testes occupying the customary positions, and the vas deferens is folded into a long post-atrial loop, the terminal limb of which is an enlarged sperm sac. The longitudinal musculature is weak and diffuse.

The body of the species, particularly in its anterior part, is remarkable for its transparency and is almost totally devoid of superficial pigment. The walls of the stomach and intestine exhibit more or less of a yellow or pale orange color which is the prevailing tint of the posterior region of the body.

Habits - Glossiphonia nepheloidea is by no means an abundant leech and has been until recently generally overlooked, a result no doubt in large part due to its inconspicuous coloring and seclusive habits rather than its scarcity. Only four specimens, all taken from Lake Pepin by means of a pump, represent the species in the Minnesota collections. Whitman, Graf, and Castle have found it only in ponds in Massachusetts. In my experience it occurs much more numerous in running water among plants, particularly along the muddy flats exposed at low water along the Delaware River, associating with G. stagnalis, G. complanata and sometimes other species.

In appearance and movements it is much more worm-like than any other species of Glossiphonia. Its weak suckers and deficient musculature ill fit it for active creeping and, being incapable of swimming and of a manifestly sluggish disposition, it moves about but little and chiefly in a very unleechlike manner of crawling through the ooze. When exposed in its place of concealment it writhes and twists in a peculiarly helpless fashion, often for a long time not even attempting to attach the suckers and never exhibiting that decision of movement and promptitude to seek concealment which is shown by G. stagnalis. Its means of protection consist largely in a very copious mucous secretion which envelopes the body when irritated.

Although, like G. stagnalis, this leech will feed on snails and worms and even suck blood when the opportunity offers, it is essentially a scavenger and feeds largely on the substance of dead animals and on ooze.

A more complete description is given by Castle (1900, pp. 39-42). He gives the extended length as 25 mm.

Glossiphonia fusca Castle

Clepsine papillifera var. lineata Verr. (1874)
Glossiphonia lineata Moore (1898)

Description - The form is rather short and thick and relatively broader than the other small Glossiphoniae described in this paper. In size it about equals G. stagnalis but lacks the great power of extension of that species. Typically the back bears three longitudinal series of small but prominent sharp conical papillae, an irregular median series, really formed of a pair of closely approximated series reduced to one by fusion or loss of some of the members, and two dorso-lateral ones situated half-way between the middle and the margins. Sometimes two more are added external to the latter, one on each side, but these latter are always very incomplete. There is a single pair of remarkably large eyes situated as in G. stagnalis. No nuchal gland is present.

Somites I and II are uniannulate or completely united; III and IV are biannulate, the larger annulus of the latter partly divided by an incomplete furrow a_1/a_2 ; V is generally triannulate dorsally, but biannulate ventrally. Somites VI to XXIV are fully triannulate, XXV and XXVI biannulate, the latter incompletely in most cases, and XXVII uniannulate. The postanal annulus is very large.

The mouth is situated as in G. stagnalis but is rather larger and the proboscis wider than in that species. There are six pairs of gastric ceca, strictly simple or slightly lobed, and the first is sometimes wanting; the last is reflexed as usual. The salivary glands are diffuse but more extensively developed than in G. stagnalis.

The testes are present in the same number and occupy the same

positions as usual, each lying just anterior to the base of one of the gastric ceca. A long posterior loop of the vas deferens, partly enlarged as a sperm sac, is developed and extends through the ventral sinus to somite XV or beyond.

The colors are plain but very pretty and exhibit a considerable range of variation. The ground is ash or grayish brown, plain below, but on the dorsal side generally marked by numerous narrow longitudinal lines of brown pigment cells which give to that surface a generally brown effect. The entire preocular region is perfectly white, and the neural annuli, for most of the length of the body, are marked with two, four or six white spots arranged in regular longitudinal series and flanking the three or five rows of cutaneous papillae which, owing to their black color, are by contrast very conspicuous. Sometimes the white spots fuse into metameric transverse bars and more rarely they are absent.

Habits - This handsome little leech is much less common than G. stagnalis, though in some localities it occurs in abundance along with that species and G. complanata. It seems to be more partial to colder waters than either of these species and is sometimes found in springs where they do not occur. In ponds it frequently fastens itself to the shells of larger species of Lymnaea and other snails and more rarely to the larger leeches. Less active than G. complanata it feeds less frequently upon active worms and larvae but confines its attacks almost exclusively to the smaller snails.

In placing its eggs in a small number of large capsules this species resembles G. complanata, but it breeds later than that species, continuing far into the summer (as late as Aug. 6th) to carry newly laid eggs.

The original description given by Castle (1900, pp.34-39) is more detailed. He gives the extended size as 20 mm.

Moore (1901) says of the coloring "Below, a plain ash-color; above, the same color marked by eleven or twelve longitudinal stripes of brown which are further compounded 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". Moore (1906, p. 158) says "G. fusca is the most variable of our Glossiphoniae, and the extremes are so unlike that were they alone in hand no hesitation would be felt in arranging them in two or three distinct species, and it is possible that further study may lead to the recognition of two." He divides them into the typical 'fusca' type and the 'lineata' type.

Glossiphonia heteroclita Linnaeus

Description from Castle (1900, pp.42-45)

Hirudo heteroclita Linnaeus (1761)

Hirudo hyalina Muller (1774)

Clembine hyalina Moquin-Tandon (1826)

Description - This small and transparent leech is found both in Europe and in North America. Compared with G. stagnalis and G. fusca it has a proportionally shorter and broader body; in its movements, it is less active. It is found in ponds and sluggish streams, such as G. stagnalis frequents.. Largest individuals extended are 13 mm. in length. The body is in general very clear and transparent, like that of a jelly-fish, but shows great individual variation in the matter of pigmentation. It always has more or less of a golden-yellow tint caused by the presence in the deeper parts of the body, of large, rounded cells each containing a single yellow oil-drop, which is blackened when treated with osmic acid. There are usually

present irregularly rounded, oval, or even somewhat branched cells, which contain pigment granules either orange, dark-brown, or black in color. These cells are found near the dorsal surface of the animal, and often produce a conspicuous color pattern by their abundance in certain regions. The pigmented areas are, first, a median dorsal, longitudinal band extending from about the seventh somite back to the anus. In the anterior ring of each somite it often broadens out into a trapezoidal form. Secondly, in about the same regions of the body, the anterior ring of each somite may be marked by a transverse, pigmented line, most conspicuous a short distance from the margin of the body, from which point it extends inward toward the trapezoidal, broad part of the median vitta, but rarely joins it.

The surface of the body is rather smooth, being only slightly rougher than that of G. stagnalis. Somites I and II are commonly uniannulate but somite II is sometimes divided by a transverse furrow. Somite II, within the anterior part of which lies the mouth, is ordinarily biannulate, as are also somites IV and XXV. Somites V-XXIV are triannulate. Somites XXVI and XXVII usually appear divided at the margin only into a broader anterior and a narrower posterior part.

Eyes, usually six, the anterior pair small and generally, though not always, close together in ring 5; occasionally the pigment of one or both eyes may be lacking. The eyes seem to belong to somites III, IV, and V. (Ward and Whipple (1918, p.652) state that the eyes form a triangular figure but Ryerson (1915, p.168) says that they are arranged in two parallel lines.)

Male and female genital ducts open between the first and second rings in somite XII by a common pore. Testes, six pairs placed in-

tersegmentally in somites XII/XIV-XVIII/XIX. The terminal part of the vas deferens is unusually stout and thick and runs forward to the middle ring of somite XI before turning sharply backward toward the genital pore.

The eggs, which in the vicinity of Cambridge are laid in May or June are whitish in color and are attached singly, not in groups as in other species, to the under side of the body. The eggs are of about the same size as those of G. stagnalis. The number varies greatly with the size of the individual, the observed extremes being eleven and sixty-five. Each egg is enclosed in a separate delicate sac which serves to attach it to the under side of the body.

The mouth is in the anterior part of somite III. The proboscis is long and the esophagus correspondingly short. The salivary glands are large and usually distributed through somites XI-XVII. The crop bears six pairs of strongly developed lateral diverticula. Some or all of the first five pairs may be bilobed distally, and each of the sixth pair, which are very long and extend back into somite XXIII, bears about five secondary, lateral diverticula, which come off metamerically in somites XIX-XXIII. The stomach with its four pairs of lateral diverticula, lies within somites XIX-XXII. The intestine extends back to the anus just behind somite XXVII.

Glossiphonia complanata (Linnaeus) Johnston.

Hirudo complanata Linnaeus (1758)
Clepsine patelliformis Mich. (1872)
Clepsine elegans Verrill (1874)

Description- Although not much exceeding the species previously described in length when extended this leech is considerably larger and more bulky than any of them. The body is rather broad and flat with thicker margins, though G. fusca approaches it in this respect, and like that species it is incapable of great extension. In this

connection it is interesting to note that both of these species have remarkably well developed longitudinal muscles. The head is not distinctly widened and the posterior sucker is small but powerful and less strongly directed ventrad than in the large species of Placobdella. There are at least four series of low, rounded but rather large cutaneous papillae on which the dorso-median and dorso-lateral sensillae are borne. There is no median series. Numerous small sense organs roughen the integument, which is rather opaque. A character which is quite unique among the Glossiphonidae herein described is the presence of three distinct pairs of eyes situated on somites II, III, and IV respectively. They are close together near the middle line and the pigment cups of the first are sometimes in contact, while the second are farthest apart and the largest in size. There is no nuchal gland.

Somites I and II are uniannulate, sometimes indistinctly separated; III is uniannulate or indistinctly biannulate; IV is biannulate divided by a faint furrow into a large anterior and a smaller posterior annulus. The next somite (V) is biannulate or more usually triannulate by the separation of a1 by a shallow furrow from a2. Somites VI to XXVII inclusive are fully triannulate; XXV is biannulate and XXVI and XXVII usually uniannulate, the former frequently exhibiting some marginal division.

The mouth is of relatively large size and placed at the boundary of the second and third somites. Like the closely related species the salivary glands are diffuse. Six or seven pairs of simple or slightly branched gastric ceca are present, the last reflected but relatively shorter than in the blood-sucking species of Placobdella. The longitudinal muscles of this species are remarkably powerful.

Unlike other species of Glossiphonia the genital orifices of this

species are separated by two annuli, the male being situated at XI/XII, the female XIIa2/a3. The vasa deferentia have the customary long posterior loops and enlarged sperm sacs. A remarkable feature and one that is peculiar to this and a few closely allied species is the presence of nine or ten pairs of testes in place of the six pairs usually present. The additional pairs are added at the caudal end of the series in somites XX to XXIII.

A more or less obvious narrowly striped pattern results from the more superficial pigments showing through the rather opaque integuments along the lines of the longitudinal muscles. The general effect is a somewhat heavy green or brown ground color marked dorsally and ventrally by a pair of very conspicuous brown lines which above begin just behind the eyes while below they are slightly farther apart. The dorsal lines are broken into a series of short dashes by small metameric white or sulphur yellow spots corresponding with the dorso-medial papillae on the neural annuli. Four or five additional series of similar spots occur on the neural annuli, making six or seven in all. Of these the median series is the least constant, the others including the four constant papillae, to which two marginal series must be added.

Habits - The snail leech, as this species is named in England, abounds in certain localities in the shallows of rivers and large ponds, where it is found concealed beneath stones. It is remarkable among the small glossiphonids for its great muscular strength, which enables it to overcome its prey and to adhere to stones with great tenacity. While more tardy in seeking to escape when disturbed than its usual associate, G. stagnalis, it is more active in its movements when once aroused. It is more prone than most species to roll into a ball and may remain quiescent in this condition

for a considerable period.

Although occasionally found attached to turtles the snail leech has not been observed to suck blood, but so far as my observations extend feeds exclusively in its natural habitat on small snails, worms etc., which its strength enable it to quickly overcome.

As usual the eggs are carried on the ventral side of the body and their large number, as well as the great length of the breeding season, render this one of the most satisfactory species for embryological study. It is one of the earliest as well as one of the latest of the *Glossiphonias* to bear eggs, which are contained in a small number of unusually large capsules.

It is described in more detail by Castle (1900, pp.46-50) under the name *G. elegans*.

Genus Hemiclepsis Vejdovsky

Form variable, usually rather wide and moderately depressed; tissues soft and almost oedemous, translucent. Suckers as in *Glossiphonia*. Eyes usually four pairs, in longitudinal series near the median line. Cutaneous papillae few and low. Pharyngeal salivary glands diffuse; gastric ceca nine or ten pairs, branched. Genital pores as in *Glossiphonia*, but sometimes farther apart. Chiefly free-living.

Hemiclepsis occidentalis (Verrill)

Clepsine occidentalis Verrill (1874) ?

Protoclepsis occidentalis Verrill (1874)

Description - This rare and very interesting leech is represented in the Minnesota collection only by a batch of young, evidently removed from the parent which carried them, and is consequently described from specimens received from other localities, though the

anterior end of one of these is represented in the figure. The leech is of moderate size, about one and one-half inches being the limit of extension. In life it is of a rather slender form, broadly rounded anteriorly where there is no definitely expanded head, moderately depressed but rather thick at the margins posteriorly and with a very large sucker. A noteworthy feature which separates this from every other species described in this paper is the peculiar transparency and gelatinous consistency of the body.

There are four pairs of large conspicuous eyes, which cannot be mistaken for the much smaller ones of Placobdella hollensis. They are situated on the somites II to V respectively; the first pair is the smallest and very close together or even in actual contact, the others are successively more distant and the third pair is the largest. The first and second are directed forward and outward, the third and fourth backwards and outward.

The upper lip is very mobile and in preserved examples is almost invariably curved into the cavity of the sucker. The small mouth is far forward in somite II. Genital orifices occur at the positions so frequent in the Glossiphonidae, the male at XI/XII, the female at XIIa2/a3. In one specimen the male bursa is everted in the form of a short conical penis, this being the only species of the family described in this paper in which such an organ is present.

Besides the numerous scattered sense organs which roughen the skin there are three pairs of low dome-shaped papillae on each neural annulus except at the anterior end of the body. Apparently these bear the dorso-median, dorso-lateral and dorso-marginal sensillae, the first of which are separated by about one-fourth of the width of the body.

With the exception of the somites X, XI, and XII, on which they

cannot be detected nephridiopores occur on a2 of every somite from VIII to XXV. Very little is known of the internal anatomy of this species but quite enough to establish its position as a member of the genus. The proboscis is very short and is succeeded immediately by a very short esophagus and a long stomach which bears nine pairs of branched ceca, two of which are anterior to the reproductive orifices and the last reflected in the usual manner. The muscular system is very peculiar in the wide intervals which exist between the bundles of muscle fibers.

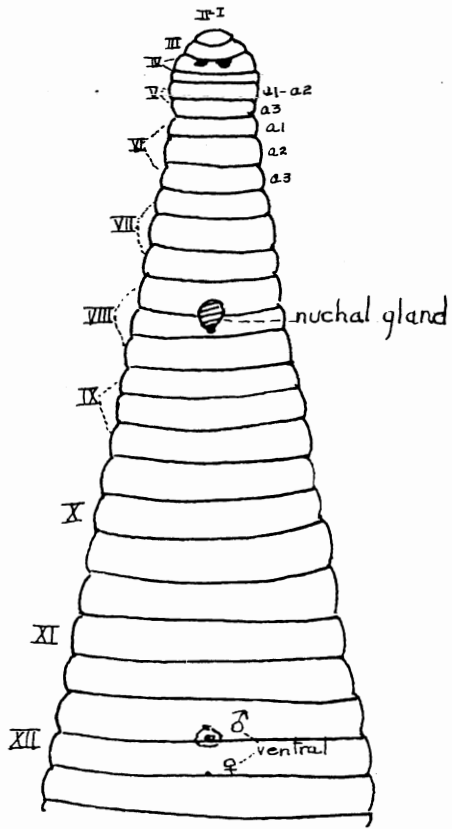
The color of preserved specimens is a translucent grayish green, the dorsum being rather thickly spotted with cream yellow, the largest spots corresponding with the six series of papillae described above.

In the adult somite I is distinct but small preocular lobe, II nearly and IV fully biannulate. A very interesting feature is that V is shorter and much less elaborate than IV. Somite VI approaches the triannulate type very closely and VII to XXIV inclusive are completely triannulate; their annuli and furrows are all equal. Finally XXV is biannulate, XXVI biannulate or uniannulate and XXVII uniannulate.

Habits - An eastern species of Hemiclepsis has been observed in the living state and it is probable that the habits of the form described will not depart much from this. The most striking peculiarity is its remarkable activity. No other members of the family creep with anything approaching its speed. In creeping the caudal sucker is brought forward into actual contact with the oral sucker and the movement is repeated with great rapidity. So far as has been observed the species is entirely sanguivorous, the blood of frogs being taken while worms and snails are refused. The European H. tessell-

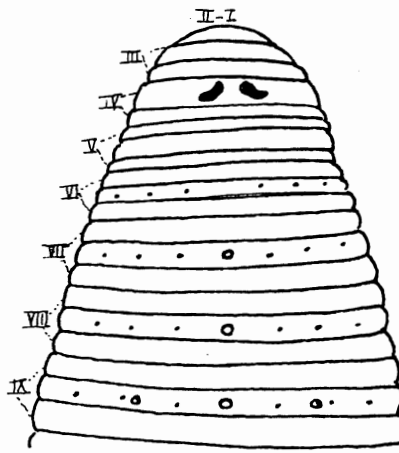
Plate II

- Figure 1. Anterior somites I to XII inclusive show-
annulation, location eyes and nuchal
gland, and indicating position of geni-
tal pores on ventral side. G. stagnalis.
- Figure 2 Anterior seven somites of Glossiphonia
nepheloidea showing location of eyes.
- Figure 3 Anterior nine somites of Glossiphonia
fusca showing position of eyes and dorsal
sensillae and papillae.
- Figure 4 Anterior six somites of Glossiphonia
heteroclita showing position of eyes.
- Figure 5 Anterior eight somites of Glossiphonia
complanata showing position of eyes and
dorsal stripes.
- Figure 6 Anterior seven somites of Hemiclepsis
occidentalis showing partial furrows and
position of eyes.
- Figures 1,2,3,5 and 6 taken from Moore(1912). Fig-
ure 4 taken from Castle (1900)



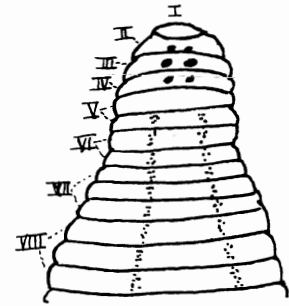
G. stagnalis

Fig. 1



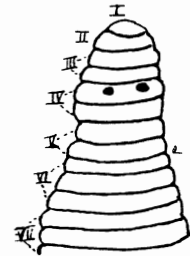
G. fusca

Fig. 3



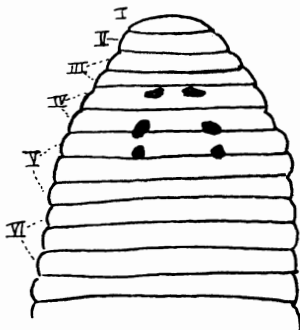
G. comolanata

Fig. 5



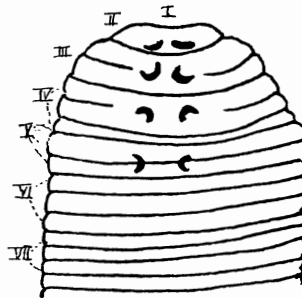
G. nepheloidea

Fig. 2



G. heteroclita

Fig. 4.



H. occidentalis

Fig. 6.

Species of Glossiphonia and Hemiclepsia.

Anterior Ends showing Eye Arrangement.

lata is known to attack water fowl and to be transported while attached to their legs or within the nasal chamber which it occasionally enters. Fertilization takes place by means of spermatophores attached to the skin, but egg laying has not been observed.

Genus Placobdella R. Blanchard.

Body widened and moderately or excessively depressed. Suckers variable, the caudal sometimes with minute marginal serrations. Eyes usually one pair, compound, on somite III, rarely followed by several pairs of imperfect simple eyes. Cutaneous papillae variable, but usually numerous and some median. Pharyngeal salivary glands large and compact; gastric ceca seven pairs, very large and much branched in the flatter species. Sperm ducts without loops, compacted and much convoluted. Parasitic on turtles, fishes and batrachians, or free-living

Placobdella hollensis (Whitman)

Glossina hollensis Whitman (1892)

Description - This very distinct species is very similar to P. parasitica but is a very much smaller leech, a length of from one to one and one-half inches being about the usual size, though individuals reaching two inches in extension have been observed. The most obvious external characteristic is found in the eyes. As in other species of Placobdella a pair of contiguous compound eyes exists in somite III with their bases resting in a conspicuous pigment mass and their principal visual component directed forward. But unlike the other species described this pair is succeeded by an indefinite number of pairs of much smaller eye-like organs which Whitman has shown to be the modified dorso-median sensillae, which possess a diminishing number of visual cells in each successive pair toward the caudal end, and gradually pass into the ordinary sensillae. Super-

ficially each appears as a small clear or whitish area anterior to which more or less black pigment is accumulated in the form of an irregular cup. The first pair (on IV) is decidedly prominent and those on V and VI are also quite conspicuous and eye-like. At first sight, therefore, this might be described as an eight-eyed leech, with the first pair of eyes directed forward, the remaining three, which are smaller and simple, backward. More careful examination shows that the same features exist in a lessening degree in several additional pairs of the dorso-median and some of the dorso-lateral sensillae as well, making it quite impossible to determine just where the visual possibilities of the sensillae cease. All of the sensillae are very distinct, rendering this a very favorable object for study on this subject.

The back is more or less roughened with small sense organs and a few larger round smooth papillae. The latter correspond to the largest papillae of P. rugosa and are most prominent posteriorly. In the Minnesota specimens they begin on the neural annulus of VIII and by somite X present the following typical arrangement: The neural annulus bears a median one and a pair just mediad of the dorso-lateral sensillae. A3 bears a pair directly in line with the dorso-median sensillae and also a smaller median one.

This species exhibits the same gradual development of the biannulate and triannulate somite as P. parasitica and consequently presents the same difficulties in the application of a formal descriptive terminology. Somites I and II may be considered uniannulate, III, IV and V as biannulate, VI as transitional and VII to XXIV or XXV as triannulate; XXVI and XXVII exhibit partial subdivision only at the margins. The complete somites of the middle region of the body show the same tendency of the sub-division of a1 and a3 into secondary annuli

that is exhibited by P. rugosa. In the internal anatomy a considerable number of minute differences between this species and P. parasitica have been observed, but the general and obvious structure of the alimentary canal and reproductive organs of the two species is essentially alike.

The colors as described from living eastern representatives of the species are rather characteristic. The dorsum is generally a light olive green variegated with brown, pale yellow, and colorless areas. The head end lacks pigment almost entirely except what is concentrated about the eyes and the transverse bands on the neural annuli. This light area extends caudad for some distance as a median vitta between the pairs of small eyes. On the neural annuli it is usually interrupted by the transverse bands of interocular pigment between which it is flanked by dark cloudings which more posteriorly takes the form of a pair of dark longitudinal bands just mediad of the dorso-median sensillae. At about somite X and thence caudad, the median vitta and its dark flanking bands are transformed into a chain-like pattern consisting of alternate dark bars and elliptical rings with light centers, the former extending over about two somites and the latter one somite, there being about five of each. Posteriorly and elongated light median area represents several of the rings coalesced.

The larger cutaneous papillae are of a light yellow or cream color and those of the most median neural series interrupt the dark bands described above. A similar yellow color occurs along the margins, alternating in blocks with the green ground color. In many specimens narrow bands of dark pigment extend across the entire dorsum of the anterior neural annuli and less frequently all or nearly all of the sensillae are flanked on the medial side by brown or black pigment. The ventral surface is nearly plain.

Habits - This very interesting leech bears the same relation to the smaller fresh water tortoises that P. parasitica does to the snapping turtles and the other larger species. Not every tortoise is parasitized but as rule several leeches are found associated together on each one so affected. The species also frequently occurs on the under side of floating wood in ponds inhabited by tortoises. In its movements it is more active than other species of Placobdella and swims with much greater facility than any other, not excepting P. montifera. The spermatophores and breeding habits are very similar to those of P. parasitica and P. rugosa.

Placobdella montifera Moore

Clepsine papillifera var. carinata Verrill (1874)
Heminclepsis carinata Moore (1901)

Description - The size is moderate never approaching the maximum of P. parasitica and P. rugosa. In addition to the widely expanded discoid head, which is quite characteristic, the form is more slender and less flattened and foliaceous than usual in the genus. The posterior sucker is large, circular, and rather freely pedicillate and minutely denticulated about the margins. The oral sucker also possesses unusual mobility, has a prominent free margin all around and a narrow unsegmented border. The capacity for extension and contraction exceeds that of either P. parasitica or P. rugosa. The dorsum bears three rows of very large conical papillae situated on the second and third annuli of each somite for the greater part of body as far as somite XXI. These are borne on the crests of three prominent nearly continuous ridges. On somites XXII and XXVI the three tuberculated keels cease and are replaced by a pair of large paramedian papillae on each somite.

The anterior somites are better developed than in the closely

related species, no doubt in correlation to the formation of the distinct head, into which the first five enter. The first two are each faintly biannulate, III distinctly biannulate, with a1 obscurely separated as a small anterior ring, behind which is situated the pair of small eyes. There are seventeen completely triannulate somites (VI to XXII inclusive). In the neck-like constriction between the head and body is a peculiar double annulus which is interpreted as Val. In the complete somites the three annuli increase in length caudad and a3 is partly cut into two by marginal furrows. Somites XXIII and XXIV are triannulate at the margins only, the third annulus of each being the least developed, and the furrow XXIVa1/a2 deficient mesially. The two following somites (XXV and XXVI) are further simplified in the direction indicated in XXIII and XXIV. They are incompletely biannulate with only traces of a2/a3; XXVII is uniannulate. Three well marked post-anal annuli form the narrow portion of the sucker pedicle.

The mouth is small in somite II; the proboscis is long and slender and the esophagus of about equal length. There are the usual seven pairs of capacious gastric ceca divided into numerous lobes which reach almost to the margins of the body; the first sends a long anterior lobe forward into somite XI and the last reaches from XIX to XXIII. The salivary glands are compact and rather small.

While conforming in every important feature to the general plan characterizing the other members of this genus, the reproductive organs are somewhat peculiar in the shorter and more loosely folded sperm sacs.

The color is generally a dull greenish gray or pale olive brown with an interrupted dark green or brown median dorsal line, a series of obscure light yellow marginal spots or a marginal yellow border, more or less interrupted on the neural annuli, and spots of the same

color , often including green flecks on the papillae. A deeply pigmented green and brown spot marks the otherwise pale colored head. The ventral surface is plain.

Habits - This very interesting keeled leech exhibits little of that gregariousness which is common to most other members of the family. It is met with far more frequently singly than in company. As a parasite it devotes itself especially to frogs and, when they frequent the water during breeding season, to toads.

It also habitually enters the shells of living mussels, though it is not known definitely that it feeds upon their soft tissues. Meadow brooks and swamps adjacent to the shores of lakes and ponds are its favorite haunts, where it lives among water plants and beneath stones as well as upon the bodies of frogs. Nothing is known of the breeding habits beyond the bare facts that spermatophores are deposited in early spring and that the young are carried.

The name montifera is suggestive of the resemblance of the carinae to conventional mountain ranges.

Placobdella pediculata Heminway

Description - Like P. parasitica and P. rugosa this species reaches a large size, though no specimens quite equaling the largest of these been seen. Judged by the poor state of preservation of the few adults that I have examined it is in life soft-bodied and more than usually contractile. All of these specimens are gorged with blood and in this state are thick and hard in the region of the body occupied by the gastric ceca. All are strongly contracted and have the very characteristic pyriform outline and strongly convex dorsum, but the most striking peculiarity is the abrupt contraction and attenuation of the posterior segments to form a narrow pedicle supporting the caudal sucker, which consequently, stands out freely exposed behind the wide

posterior part of the body in a most characteristic manner. Hemirway has made the interesting discovery that this condition arises in the course of individual development and does not exist in young leeches one centimeter long, which consequently differ less obviously than do the adults from related members of the genus. The oral sucker, so far as can be determined in its contracted state with the lip in-rolled, has the same structure as in P. parasitica.

The skin is perfectly smooth without a trace of cutaneous papillae; and only a few obscure segmental sensillae and Bayer's scattered sense organs, the latter chiefly near the margins of the body, are detected. Undoubtedly suitably preserved material would exhibit the sensillae typically distributed and essentially as they occur in related species. Eyes are very difficult to detect in surface views of preserved adults but small pigment masses occur at III/IV in the same position as in P. parasitica and distinct eyes appear in the young. However it has not been determined whether the eyes are simple or aggregated.

In spite of the obscurity due to great and often unequal contraction of the annuli a careful analysis of the external morphology shows that, except for the caudal peduncle and an apparently greater simplicity of the corresponding anterior segments of P. pediculata, the structure is essentially as in P. parasitica. In respect to the annulation the condition existing in young leeches must be accepted with some caution as the somites become increasingly complex with growth and age. The annulation of somites I to IV of adults is unknown but in the young where I and II are uniannulate and III and IV biannulate. Somite V is biannulate dorsally but ventrally the furrow fades away toward the median line; VI is triannulate at the margins but furrow a1/a2 is incomplete above and even more so below. Somites VII to XIII or XXIV are triannulate but the furrow a1/a2 is incomplete med-

ially on the venter of both VII and VIII and on most of the succeeding somites is less marked than either a2/a3 or the intersegmental furrows. On anterior somites, and, to a less degree on the posterior a3 is slightly longer than a1 or a2. The annulation of the post-anal somites, constituting the caudal peduncle, is irregular and somewhat puzzling in the adult, but here also most of the somites, while very short, appear each to be made up of three small annuli of varying size and incompletely defined limits. The posterior sucker is large, circular and directed strongly ventrad.

The mouth is very small and is situated far forward near the anterior rim of the sucker in somite II. As in related species the proboscis is slender, the esophageal glands compact and the stomach provided with seven pairs of large ceca reaching nearly to the margins of the body. The ceca are less deeply divided and simpler than those in P. parasitica, each of the first six pairs presently only two or three rather short lobes. The intestine reaches to the posterior part of somite XXIV or even beyond and then bends abruptly forward toward the dorsum as an extremely narrow rectum to the anus situated at XXIII/XXIV. The forward curvature of the rectum and the anterior position of the anus are unique features in the family.

The reproductive organs are essentially similar to those of P. parasitica. The male and female external orifices are situated respectively at XI/XII and XII a2/a3. Six pairs of testes are between the bases of the gastric ceca. The large sperm sac and ejaculatory duct of the vas deferens form a compact snarl in somite XII in the immediate neighborhood of the atrium.

Habits -Heminway gives the following account of what is known concerning the interesting habits of this leech:

Placobdella pediculata appears to be a true fish parasite, having been found only in the gill chamber of the freshwater sheephead

(Aplodinotus grunniens), the posterior sucker of the leech being deeply imbedded in the side of the isthmus or shoulder. In the case of young leeches which have not been long attached, the depression caused by the posterior sucker is comparatively shallow, being a mere external depression in the inflamed tissues of the fish. As the attachment continues the inflamed tissues of the host grow up like a collar and close in around the leech's body in front of the sucker. This closing in of the inflamed collar presses upon the body of the leech, narrows it to a slender peduncle in front of the sucker and incidentally crowds the sucker down into the tissues of the fish, so that in time, this depression may reach into the underlying muscles of the host to a depth of half an inch or more and have an opening of about a quarter of an inch or less in diameter. The bottom of the depression has a larger diameter.

These leeches are capable of becoming greatly contracted and when one is disturbed it draws back until it appears as a mere brownish pyriform knob which entirely covers the place of attachment.

Practically nothing is known of this leech separate from its host, but it seems possible that a part of its existence may be spent elsewhere. During September, 1903, I examined several thousand specimens of the sheepshead from Lake Pepin and found only three isolated leeches, each about one centimeter long. ... As full grown specimens, deeply embedded, were found in the same locality during August of 1899, at least some of the adults must remain with their hosts during the summer and probably throughout the year.

Placobdella parasitica (Say) Moore

Hirudo parasitica Say (1824)

Glossiphonia parasitica Castle (1900)

Description - Of all of our numerous species of glossiphonids

this attains the largest dimensions. Ordinarily examples are about two inches in length when extended, the giants upwards of four inches in the same condition. The form is broad, very flat and foliaceous-- especially when food is absent from the ceca. In extension the head is somewhat expanded, but in contraction partakes of the general ovate pyriform outline of the body. The posterior sucker is large size and considerably exposed behind the body, the plane of its adhesive surface being parallel with the ventral surface of the body. Cutaneous papillae are numerous but inconspicuous, low and smooth; sometimes they are obsolete. The most constant are disposed in three longitudinal series on the neural annuli and two longitudinal series on the post-neural annuli. Those of the median series are not enlarged but on the contrary are usually smaller than those of the paired series.

The annuli and the somite limits are well defined, the furrows exhibiting certain constant differences in depth. Somites I and II are united in the reduced prostomium lobe, which may, but usually does not present a faint cross furrow; III and IV are triannulate, the anterior annulus in each case being much the larger. Somite V is triannulate dorsally but the furrow a_1/a_2 is faint and becomes obsolete on the ventral side. There is a very gradual deepening of the furrow a_1/a_2 on the succeeding somites, but VI to XXIII or sometimes XXIV may be considered to be full triannulate, as this furrow, as not so deep as the others, is complete. The first annulus is always more closely united with the second than is the third. The furrows correspond closely on the dorsal and ventral surfaces. Somite XXIV is usually simpler owing to the incompleteness of the furrow a_2/a_3 toward the mid dorsal region. XXV is biannulate at the margins only, the furrows disappearing mesiad; XXVI and XXVII are normally uniannulate.

The small pore-like mouth is in II. The salivary glands are compact and with a median lobe. As usual in this genus there are seven pairs of large spreading gastric ceca, in this species extensively developed and reaching almost to the margins of the body as fine lobes more numerous than in any other Minnesota species. The last pair is the largest and reflexed as far as somite XXII.

Male and female orifices are located in the furrows XI/XII and XII a2/a3 respectively. The testes are six pairs, the sperm sacs long but closely and complexly folded in somites XI and XII by the sides of the atrium.

The coloration is very rich and striking but extremely variable. The ground color of the dorsum is dull green, olive green or brown, marked with bright yellow which may replace the ground color very extensively. Usually the yellow is confined to the following regions: a continuous or interrupted longitudinal median band which widens and narrows alternately at intervals of about three somites, regular marginal spots covering the intervals between the successive neural annuli, and large irregular blotches constituting an intermediate series which often become confluent with one another or with the marginal spots or both. The ventral surface is longitudinally striped with light and dark the whole having a peculiar bluish or purplish reflection. Dorsal integuments rather opaque.

Habits - Living chiefly as a parasite upon snapping turtles whose blood it feeds on voraciously, the geographical range of this species is largely determined by that of its principal host. As the snapping turtle is an important article of commerce this leech is very well known and is reported from all parts of the United States. Its habits are too familiar to require description though it is not so widely known that the species also lives a free life particularly when carrying eggs or young and feeds on aquatic worms, etc.

Placobdella picta (Verrill)

Description from (Ryerson (1915, p. 171)

Clepsine picta Verrill (1872)

In the collection there is only one specimen answering to the description of this species. This specimen measures 29x5 mm. and is broad and flat in shape. The dorsum is marked by numerous longitudinal lines of deep green. Verrill describes this species as having a marginal series of yellow spots on the tips of the first and third annuli of the somite. In the preserved specimen the presence of these spots cannot be observed with certainty and the notes give no information on this point. The color of the ventral surface is a flecked green. In the living specimen numerous papillae were observed on the dorsum.

There are diffuse salivary glands present and the esophageal glands are long and similar in form to those of P. rugosa or P. parasitica. The esophagus is almost straight, not looped as in the other species of this genus. The seminal duct forms a long loop connecting with the testicles anteriorly, much as in the species of Glossiphonia.

The single specimen of this species collected was found on the lower side of a clam shell on a sandy bottom.

Placobdella phalera, Graf.

Description from Ryerson (1915, p. 170), Moore (1906, p. 160)

Seven specimens showing the markings characteristic of this species were collected. In size varying from 10 to 13 mm. and from 2 to 6 mm. in width. Body broad and flattened, tapering to a rather slender anterior end. Color brown with a striking greenish tinge. From the anterior end backward to about the seventh annulus, the dorsal surface is a yellow and a yellow band passes around the body in the region of the eleventh or twelfth annuli. Along the margin of the body are yel-

low spots on the tips of the first and third annuli of the somite. In some specimens there is a median dark brown line interrupted in some cases by yellow patches. There are, usually, three series of papillae, but, on one specimen, five were observed.

As shown by dissection, there is a long looped esophagus with a short pair of esophageal glands connected with it. The diffuse salivary glands attached at the base of the proboscis, are large in size and stretch outward and backward, not forward as in other species. In one specimen the stalk of the posterior sucker was found to be quite long. In another specimen small bodies which appeared to be spermatophores were found attached to the body.

The specimens collected were taken from dredgings at a depth of from one to six feet and from the lower sides of stones or clam shells on a sandy shore.

Moore says " Several specimens of a small leech which is rather doubtfully referred here to conform closely with Graf's account of the arrangement of pigment, reserve cells, and other features of P. phalera. Two of the most striking characters of the species are the strongly developed band of reserve cells, appearing on the surface as a white or pale yellow stripe, which extends entirely across the neck at somite VI, and the serrated margin of the posterior sucker, which has a circle of small papillae as in Actinobdella annectens, but lacks the definite aggregated glands."

Placobdella rugosa (Verrill) Moore

Clepsine ornata var. rugosa Verrill (1874)
Glossiphonia parasitica var. rugosa Castle (1900)

Description - Placobdella rugosa is a large leech, nearly or quite equalling P. parasitica, although the great majority of examples met with average considerably smaller than that species.

In form it is even more depressed, starving individuals being scarcely thicker than a card, very broad and leaf-like. The head is essentially similar to P. parasitica but as this leech does not extend itself as fully as that it is seldom seen in the distinctly expanded state. The caudal sucker is large and elliptical rather than circular, the antero-posterior diameter being slightly greater than the transverse. An important characteristic is the presence of numerous large rough cutaneous papillae on the dorsum. The principal ones are constant in arrangement but the number of the smaller ones is quite variable. Most characteristic and conspicuous are five on each neural annulus, median, supra-marginal and intermediate in position and forming five longitudinal series as far caudad as somite XXIII, posterior to which the median papillae become greatly reduced in size and overshadowed by paramedian papillae in line with the dorso-median sensillae. On all the papillae are all relatively small while a3 bears some of large size inferior only to the largest on a2. The integument is translucent.

Somites I and II are uniannulate and always distinctly separated; III is biannulate with a faint furrow usually discernible across the larger anterior annulus, on the posterior division of which are seen the small compound eyes, often included in a common pigment mass. Somite IV is triannulate dorsally but a1/a2 is less distinct than the other furrows; V is triannulate dorsally but a1/a2 is less distinct than the other furrows; V is triannulate dorsally, biannulate ventrally. The fully triannulate somites are VI to XXIII inclusive, and this species shows in a much less convincing way the transitional steps between biannulate and triannulate somites. In all of the complete somites a noteworthy feature is the lack of alignment between the dorsal and ventral furrows, as a result of which

a2 is the longest annulus dorsally but the shortest ventrally. Of the posterior simpler somites, XXIV is triannulate dorsally with a3 of very much smaller relative size and incompletely separated from a2 on the ventral side, XXV and XXVI are wholly or partially biannulate and XXVII uniannulate.

The alimentary canal is nearly as in P. parasitica but the compact salivary glands have no median lobe and the divisions of the gastric caeca, although long, are less numerous. The reproductive organs are essentially similar in the two species, with the sperm sac, epididymus and ductus ejaculatorius compactly folded in somites XI and XII.

Owing to the numerous papillae and the translucency of the skin the colors are a somewhat confused mixture of light and dark browns, yellows and greens, based upon a fundamental pattern similar to P. parasitica and consisting of a variegated brown ground with light intermetameric marginal spots, a median dorsal light stripe interrupted by short dark brown or brownish green longitudinal lines, which sometimes unite into a continuous dark line, and numerous small light yellow or green spots corresponding to the papillae and sensillae. The ventral surface is plain gray or light brown without longitudinal stripes.

Habits - Placobdella rugosa, the rough leech, is a frequent inhabitant of streams and ponds, where it may be found clinging to the under side of stones and floating wood, especially during the late spring and early summer. At other seasons they are sometimes found upon aquatic turtles upon whose blood they in part subsist. Leeches of this species are sluggish and when exposed in their resting places press the flat body closely to the stone or log, whose colors they so closely simulate, and trust to this protective resemblance to escape detection, rather creep actively away in the manner of other species

of allied leeches. The close resemblance to the surroundings is much enhanced by the fact that particles of mud adhere to the mucous and rough papillae. Furthermore the leeches may partially bury themselves in the bottom sediments. They seldom swim and when thrown into the water roll up and sink passively to the bottom, upon reaching which, they creep to a place of concealment in a most deliberate fashion.

So far as has been actually observed no other food than blood is actually taken though it seems probable that the juices and even the solid parts of small aquatic invertebrates may serve the same purpose, as is certainly the case in closest ally of this species.

The large chitinoid spermatophores may be observed as frequently and easily as those of P. parasitica which they closely resemble in form and mode of fixation. The eggs are very numerous and are fixed lightly to the ventral surface of the body covered by a delicate mucoid membrane. During the period of incubation the parent leech attaches itself firmly and is very loath to leave its resting place. If, under such circumstances, force be used the leech holds tenaciously by both suckers to its support and curls the margins of the body in such a manner as to enclose the eggs or young. As the result of a struggle to remove the brooding leech the eggs are generally detached and are then sometimes found to be adherent to the stone or glass of the aquarium against which they have been pressed. When forcibly removed from the eggs the leech will usually seek and return to them.

Plate III

Figure 1 Anterior ten somites of Placobdella hollensis showing the location of the eyes, the sensillae and papillae.

Figure 2 Anterior thirteen somites of P. montifera showing the head, location of the eyes, sensillae and papillae.

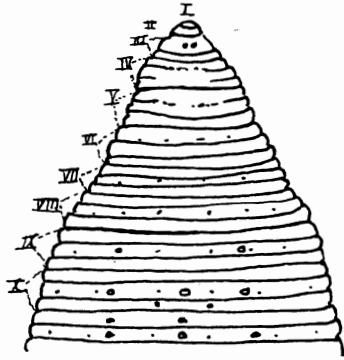
Figure 3 Anterior twelve somites of P. pediculata showing absence of eyes and other markings.

Figure 4 Anterior twelve somites of P. parasitica showing position of eyes.

Figure 5 Anterior ten somites of P. rugosa showing position of eyes, sensillae and papillae.

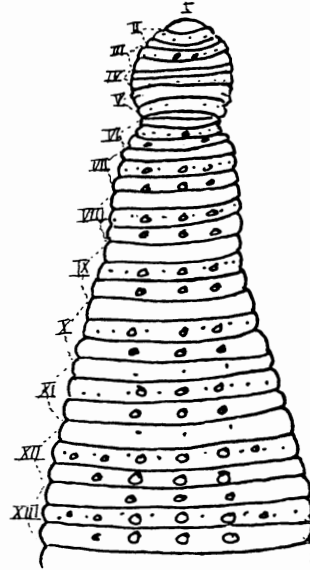
Figures taken from Moore (1912)

Plate III



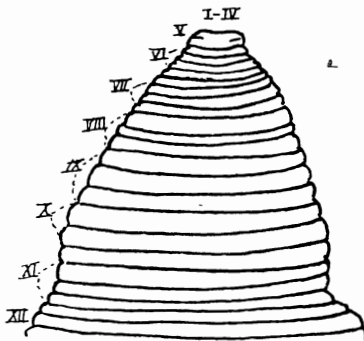
P. hollensis

Fig. 1



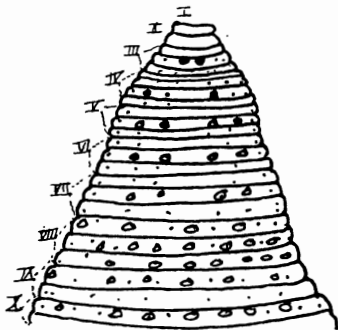
P. montifera

Fig. 2



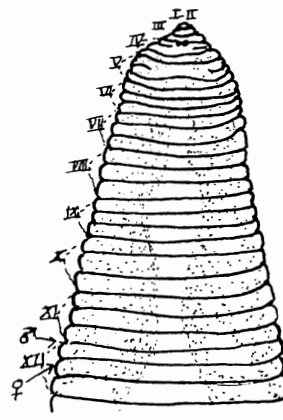
P. pediculata

Fig. 3



P. rugosa

Fig. 5



P. parasitica

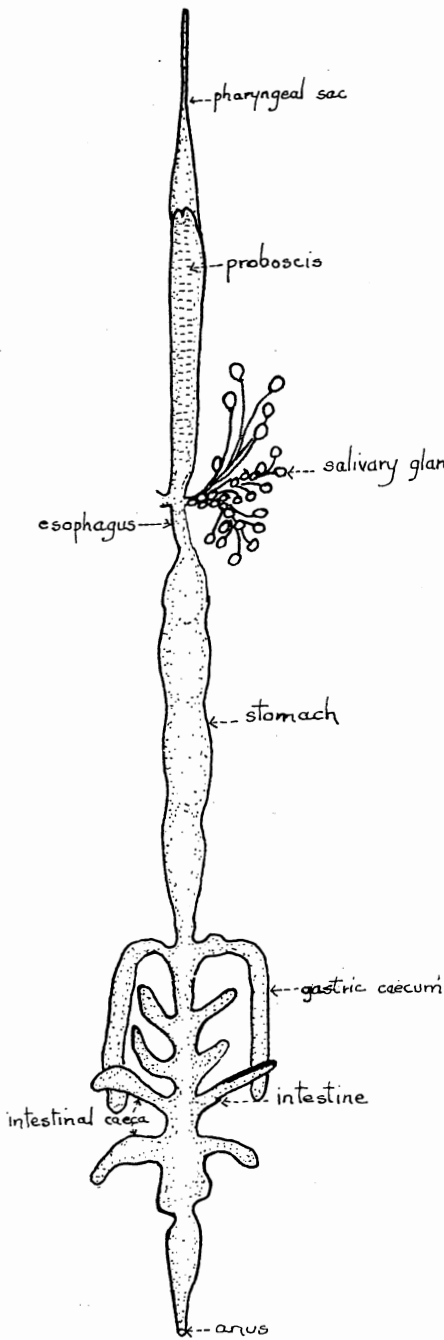
Fig. 4

Species of Placobdella

Plate IV

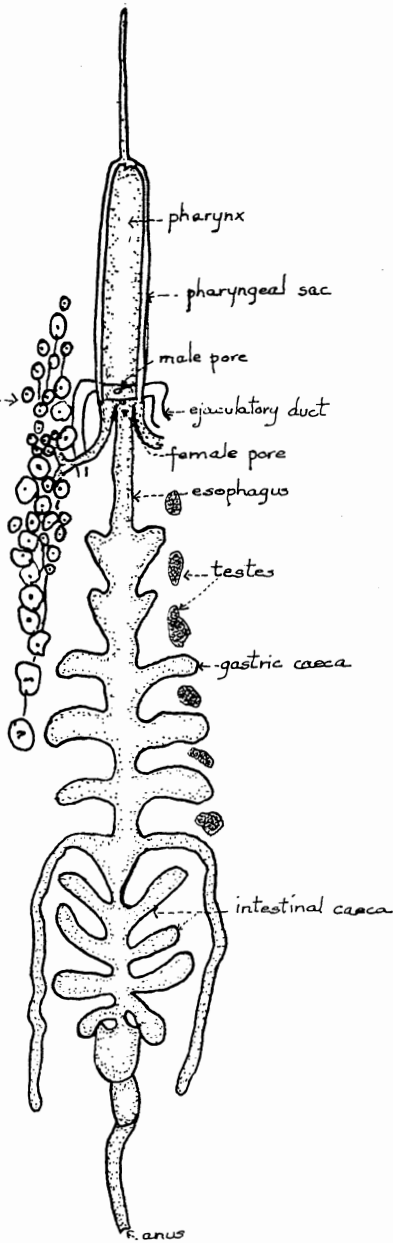
- Figure 1. The alimentary tract of G. sternalis showing the salivary glands on the right side only, the single pair of gastric ceca and the intestinal ceca.
- Figure 2. The alimentary tract of G. fusca and portions of the reproductive system. The salivary glands are shown on the left side only. There are six pairs of gastric ceca and four pairs of intestinal ceca.
- Figure 3. The alimentary tract of G. complanata, the location of the brain, and portions of the reproductive system. Seven pairs of more or less branched gastric ceca and four pairs of intestinal ceca are shown.

Plate IV



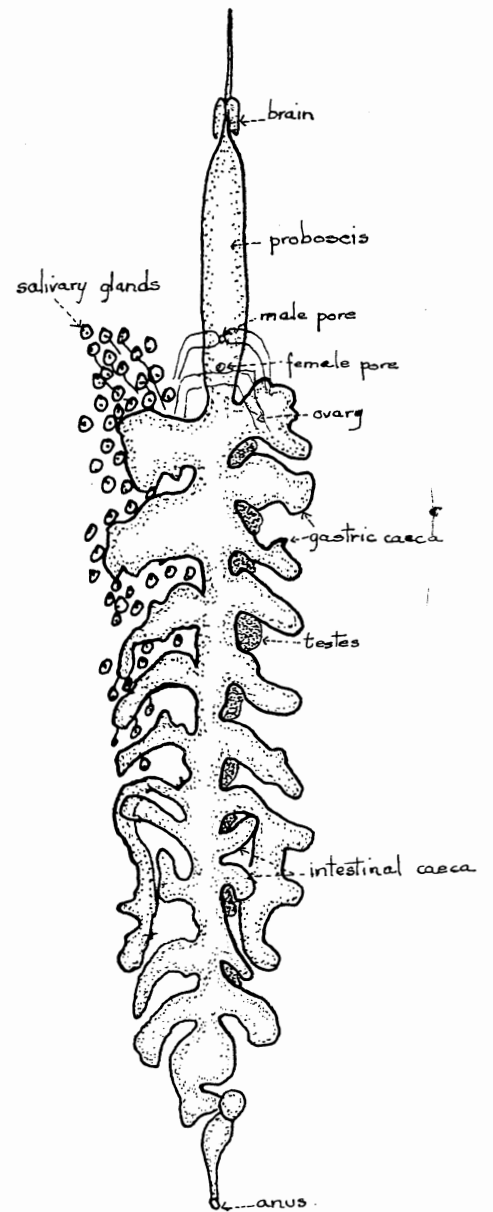
G. stagnalis

Fig. 1



G. fusca

Fig. 2



G. complanata

Fig. 3

Alimentary tract in Glossiphonia

Family Ichthyobdellidae. (from Moore, 1912)

Leeches of small, medium or large size. Form much varied; short and stout or elongated and slender, terete or depressed, usually more or less divided into a narrower anterior and an expanded posterior region. No distinct clitellum, but diffuse clitellar glands abundant. Segments smooth, or more rarely papillated, often provided with lateral pulsating vesicles or gills on a certain number of segments. Complete somites with 2 to 14 annuli, greatly varied in proportions. Both oral and caudal suckers usually large and deep and more or less prominently set off on pedicles. Eyes 1 to 3 pairs widely separated on posterior part of head, often absent. Eye spots often on caudal sucker. Mouth and proboscis as in Glossiphoniidae; stomach straight and usually simple, only rarely with lateral ceca, one pair of large posterior gastric ceca, variously and sometimes completely united. Genital orifices much varied in position according to the number of rings per segment. Testes usually five or six pairs, the sperm ducts relatively short, the epididymus and ejaculatory duct not much convoluted, ending in an atrium that may be simple or more or less complex; no filiform penis. Ovisacs paired or united into one, pyriform or globular, their ducts simple. Eggs laid in usually stalked cocoons. Chiefly semi-permanent parasites on fishes, sometimes on crustaceans. Nearly all are marine. Piscicola and closely related genera only are found on fresh water fishes.

Genus Actinobdella Moore

Rather slender and elongated, moderately depressed or half round. Oral sucker slightly developed; caudal sucker large, deep, and provided with a circle of numerous marginal papillae and glands. A few dorsal papillae, some median. Complete somites of six unequal rings. Eyes, one pair on III, united. Pharyngeal salivary glands diffuse;

gastric ceca seven pairs, branched. Genital orifices separated by four rings; sperm ducts lacking long loops, moderately compact. Small blood-sucking leeches, probably parasitic on fishes.

Actinobdella inequiannulata Moore

The Lake Pepin specimen measures 12 mm in length and has nearly the form of the type except that the middle region of the body is somewhat widened. The form is slender and depressed throughout, with the dorsal surface convex, the ventral flat and the margins sharp. The breadth is nearly equal or somewhat greater in the middle region, but contracts suddenly at the posterior end to constitute the narrow pedicle of the conspicuous caudal sucker, and at the anterior end tapers gently to the broadly rounded upper lip.

There is no conspicuously expanded anterior sucker or head as in typical ichthyobdellids, but this end of the body is formed exactly in the fashion of a glossiphonid. Four somites of simple structure enter into its composition, the posterior ventral rim being formed by the fourth and fifth somites in that region largely coalesced. On the middle of somite III it situated the single pair of small eyes conjoined in a single median pigment mass and looking forward and outward. Some detached pigment cells occur caudad and lateral of this position.

Most remarkable of all the external features of this leech is the posterior sucker. It is much wider than any part of the body, largely free around its entire circumference and supported by a narrow central pedicle. The ventral surface is very deeply cupped and the rim somewhat contracted, making the diameter of the opening somewhat less than that of the internal cavity. From the internal face of the sucker, a short distance back from the sharp margin, spring about thirty slender

finger-like papillae, which project more or less freely beyond the margin. Owing to their contractile nature they vary in length and diameter but when extended the longest are about .4-.5 mm in length and about .1 mm. in diameter. Each one contains an axial gland duct or group of ducts surrounded by a sheath of muscle fibers which spring from the muscular ridges passing radially down the inner surface of the sucker. The gland ducts arise from a circle of whitish spots arranged around the sucker about midway between the margin and the pedicle and which raise the outer surface into a slightly marked encircling ridge.

A median series of rather prominent conical papillae with the long diameter of their elliptical bases directed in the longitudinal axis of the leech occur on annuli b3 and b5. In the Lake Pepin specimen these papillae begin on VIIb5 and continue to XXVIb3; in the type they are distinctly developed only on the somites XI to XXV inclusive. In the new example also traces of supra-marginal and intermediate series of papillae are found on the somites of the middle region. Segmental sensillae are very beautiful and regular-
shown
ly in this specimen on all of the somites and both dorsally and ventrally. Thus it will be seen that the sensillae have the arrangement characteristic of the Glossiphonidae. Well developed rings of small sense organs are visibly on annuli b2, b3 and b5 of each of the complete somites and are more or less discernible on all primary annuli and more comprehensive divisions throughout the body.

Somites I, II and III are each uniannulate; IV is also practically uniannulate but shows some signs of division above in the Pepin example and below is largely united with V. The latter, together with VI and in the type, VII also, is biannulate, an interesting feature being the rather larger size of second annulus.

Somite VIII is quadriannulate, being composed of a1/a2/b5/b6, the latter two being very narrow. Somites IX to XXV inclusive may be regarded as complete, but some individual variations are exhibited and especially the first two and the last are transitional. In the original specimen the complete somites are sexannulate, the full number of secondary annuli being developed, but of very unequal size. Two annuli (b3 and b5) are enlarged, the latter most so, and bear the dorsal cutaneous papillae, and the former metameric sensillae as well; b1, b2 and b6 are about equal and b4 is the smallest of all. The small annuli b1, b4 and b6 appear to be entirely unadorned, while b2 like the large papillated annuli exhibits a circle of sense organs. The conditions in the new specimen are essentially the same, but the somites are somewhat further elaborated. The remaining post-anal somites XXVI and XXVII are typically triannulate. Two post-anal annuli are present in the type and four in the new specimen.

A few anatomical facts gleaned from the Lake Pepin specimen, though very fragmentary, are nevertheless of great interest; for it will be seen that in all essentials the alimentary canal is constructed on the plan prevalent in the Glossiphonidae. The position of the mouth at the extreme anterior margin of the oral sucker in somite II, or perhaps even in I, is paralleled in the Ichthyobdellidae only in Notostomum. The proboscis is long and slender, reaching when retracted, from VI to X, at its posterior and receiving apparently three pairs of slender ducts from the salivary glands. The latter consist of very numerous small gland cells scattered diffusely all through the preclitellar somites as far as the head. The esophagus is slender and distinctly differentiated from the stomach. At least six pairs of well marked, long and slender

gastric ceca are developed, arising in somites XIV to XIX inclusive. Unfortunately they are empty and shrunken and on account of the numerous gland cells which fill the region difficult to see clearly, but they are certainly somewhat branched and extend far forward toward the margins of the body. Those of the last pair are long and reflected and extend as far as XXII, lateral branches arising in each intervening somite in the characteristic Glossiphonid fashion. The intestine is a narrow tube which gradually tapers to the anus, and shows the differentiations usual in the higher glossiphonids, including four pairs of prominent slender ceca which arise in somites XX to XXII and lie dorsad of the last pair of gastric ceca. The first two are bent forward, enlarged at the end and somewhat subdivided, the third is bent backward and slightly lobulated and the last is simple and directed rather strongly caudad from its origin. The anus is situated at the posterior margin of XXVII, in this case within the limits of that somite.

Very little of value can be made of the internal genital organs. The testes are not certainly discernible. There is a pair of short wide sperm sacs crowded with spermatozoa extending from the posterior limit of somite XIII to a point just abreast of the male bursa, where they pass into the narrower ejaculatory ducts which curve around the anterior face of the bursa toward the median plane and then bend dorsad and caudad to the summits of the prominent nearly spherical prostate cornua. The latter open on each side into the dorsum of the small bursa. The ovaries are enlarged pyriform bodies which lie rather widely separated just caudad of the sperm sacs; from their anterior enlarged ends narrow oviducts pass mesiad and slightly cephalad to the female orifice. The external genital orifices are situated in the positions usual in the higher Glossiphon-

idae, the male at XI/XII, the female approximately at XIIa₂/a₃. Nephridiopores are quite easily distinguishable on the post-clitellal complete somites just anterior to the sensillae line on annulus b₃ and well mesiad of the margins.

According to the label the Minnesota specimen was colored green during life. It was pumped from the bottom of Lake Pepin. Nothing is known of the habits of this leech.

Actinobdella annectens: Moore(1906)

Most interesting of the leech collections is a specimen, fortunately well preserved, of a new species of Actinobdella which, together with A. inequiannulata clearly shows that this genus belongs to the Glossiphonidae and not to the Ichthyobdellidae. At the present time it seems evident that Actinobdella approaches Placobdella most closely, especially in the character of the reproductive organs, gastric ceca, and sense organs, while it differs from that genus and resembles Glossiphonia in the possession of diffuse instead of compact salivary glands. The fact that certain species of Placobdella, notably P. phalera and P. montifera, possess small marginal papillae on the caudal sucker is a further indication of relationship which may eventually necessitate a generic grouping somewhat different from that here adopted.

A. annectens, like A. inequiannulata, is a small blood-sucking glossiphonid, the type of which is 9mm. long, 2mm. wide, and about 1mm. high. The general form is much like that of Glossiphonia fusca but considerably more slender; the body is strongly convex above, flat below, the region of gastric ceca about half round; the head end, with the sucker and mouth, have the typical glossiphonid form; and the thick, prominent, hemispherical caudal sucker measures 1.2 mm. in diameter and its pedicle is contracted and central-

ly attached, indicating great mobility in this region. The marginal papillae of the caudal sucker form a ready means of distinction between this species and A. inequiannulata, for whereas the latter possesses about thirty very prominent papillae, A. annectens has about sixty much smaller ones. They are clearly continuations of radiating ridges on the ventral surface of the sucker and have the same structure and relation to compact aggregated glands as in the type species. These glands form a conspicuous ring a short distance from the margin of the sucker, the dorsal surface of which they elevate into a circular ridge. In correspondence with smaller and more numerous papillae these glands differ from those of A. inequiannulata, and at places the continuity of the ring is interrupted by the absence of several together.

A single pair of very large and conspicuous eyes ¹⁵ are situated on somite III, with their pigment cups in contact and united in the middle line and reaching into IV. Immediately behind the eyes is a large aggregation of reserve cells extending over the middle portion of somites IV and V and margined by pigment cells. A similar patch occurs on annuli VIa3 and VIIa1, and others are distributed much as in P. phalera. The position of the genital pores is quite as in Placobdella, the male orifice being situated between the somite XI and XII and the female between the second and third primary annuli of XII. The anus is behind XXVI.

The metameric sensillae are very obscure on the ventral but easily distinguished on the dorsal surface; they present quite the arrangement typical of the family. Dorsal cutaneous papillae are also well developed from somites XIII to XXVI inclusive, and the larger ones may be traced faintly anterior of the genital somites

as far forward as VI. As in A. inequiannulata the strictly median series is by far the most conspicuous and dominant one and is represented on the complete and typical somites by a large papilla on the annulus b3 and a somewhat smaller one on b5. On XXIII these papillae suddenly become reduced greatly in size and by XXV have disappeared, while rather prominent dorso-median papillae are coincidentally developed on each side and continue to XXVI. Dorso-lateral papillae on b3 are nearly as constant but much smaller as far back as somite XXVI, and on many of the typical a corresponding but still smaller papilla occurs in a more median position on b5. It will be noticed that in the arrangement of the papillae, as in so many other characters, this species stands between A. inequiannulata and Placobdella montifera and P. phalera.

In the manner of subdivision of typical somites into annuli this species follows closely the type of the genus. The first primary annulus (a1) is always much smaller than a2 or a3, and is completely subdivided into two short equal or nearly equal rings (b1 and b2); the primary annulus (a2) is divided into a larger anterior ring (b3), which bears the papillae and metameric sensillae and a much smaller posterior ring (b4); the third primary annulus (a3) is similar in size and subdivision to the second, and its larger anterior annulus (b5) bears the papillae, while the small b6 is naked. Somites VII to XXII are complete, although a3 is already much smaller than a2 even on XXI; and on XXII the furrow b5/b6 is not quite complete. On XXIII all secondary furrows are nearly absent and a3 is a small simple ring. On XXIV a3 is barely separated from a2; XXV and XXVI are typically biannulate, and several obscure annuli in the caudal pedicle represent postanal somites. The annulation of the anterior incomplete somites is very clear, and shows that elaboration has progressed farther in this species than in A. inequiannulata. Somite

VI has a1 undivided, V is triannulate with a2 somewhat enlarged, IV is biannulate with the furrow a1/a2 indicated, III is a broad, practically undivided annulus, and II and I are simple and undivided.

A few features of the internal anatomy may be noted. The proboscis slender and, as retracted in this specimen, reaches from XI to VIII. The salivary glands are of the diffuse type and open into the esophagus in X or XI; they are greatly developed and densely packed by the sides of the alimentary canal as far forward as the anterior part of somite VIII. Exactly similar glands are developed in large numbers along the sides of the body to somite XXIV, but it is impossible to determine definitely in the entire leech to what extent these are salivary or clitellar and cutaneous glands. There are seven pairs of well developed branched gastric ceca arising in somites XIII to XIX, inclusive, arranged as in Placobdella, though not so large and completely branched as in the broad flat species of that genus. The first pair have slender anterior lobes which reach forward by the sides of the reproductive organs to the anterior end of XII; the seventh pair reach backward beside the intestine to XXIII, with five lateral lobes in somites XIX to XXIII. The narrow and posteriorly somewhat tortuous intestine bears the usual four pairs of ceca crowded into three somites (XX to XXII). Although conforming to the general type of the reproductive organs of Placobdella the male afferent ducts are more elongated and slender than in most species and reach to a sperm sac situated on the boundary between XII and XIII, being thus less compact and more open in arrangement than in most species of Placobdella. The greater part of the sinus system was found to conform in most respects to what is found in the Glossiphonidae generally, one important characteristic being that of the submarginal circular sinus of the posterior sucker is connected with the axial sinus behind the anus by 15 or 16 radiating canals.

Genus Piscicola Blainville.

Size small; form slender and elongated, terete or subterete. Both suckers large and explanate, the posterior usually deeply cupped. Complete somites of 12-14 very short tertiary annuli. Sensillae and cutaneous papillae very inconspicuous or absent. Eyes one or two pairs widely separated on base of "head". Atrium simple and intestinal ceca nearly completely coalesced. Parasitic on fishes, but often found free.

Piscicola punctata (Verrill)Ichthyobdella punctata Verrill (1871)

Description - The usual size of this species is from 15 to 25 mm. long and 2 to 3 mm. in greatest diameter, but the largest examples are capable of extending to a greater length. In extension the body is circular in cross section and very slender, widest at the beginning of the posterior third. When contracted the distinction between the anterior and posterior regions of the body is much emphasized and the latter becomes distinctly flattened. Although it has the form characteristic of the genus the head is much smaller than in the well known P. geometra.

Only one pair of eyes has been detected in a large number of specimens which have been received from various localities. These have conspicuous pigment cups situated in somite four and consequently correspond to the posterior eyes of P. geometra, which they resemble also in the fact that they look caudad instead of cephalad as do the first pair of that species. The smaller posterior pair described by Verrill possibly had some of the conspicuous pigment cells scattered through the head thus simulating eyes.

During life the posterior sucker is widely expanded and hemi-

spherical, but in preserved specimens it is always contracted and directed caudad. Just anterior to it is the minute anus among a group of small wrinkled annuli.

The genital region (clitellum) is more or less distinctly limited by anterior and posterior constrictions at the furrows IX/X and XII/XIII respectively. In contraction XII may be more or less retracted within the border of XIII and all three somites of this region are of simpler structure than the typical complete ones adjoining. Clitellar glands are greatly developed and form a thick layer just within the longitudinal muscle layer and extending from the clitellum nearly to the anus. They are arranged in four longitudinal bands on each side leaving narrow, neural, median dorsal, and lateral spaces clear. The latter are occupied by the lateral vessels which exhibit metameric enlargements in the somites of the posterior region.

Ten pairs of large nephridiopores are present in the latero-ventral region of somites XIV to XXIII inclusive. They lie in annulus c6. No especially metameric sensillae have been certainly distinguished but numerous small sense organs arranged in transverse rows in many of the annuli are present.

Complete somites have the full number of tertiary annuli (c1 to c12) developed and in many one or two of these, usually in the cephalic third of the somite, are divided into two, making in the latter case fourteen annuli; but in connection with this feature and the simpler somites at the ends of the body that the variability occurs.

Unlike Actinobdella the mouth is situated far back in the oral sucker at III/IV or possibly within the limits of IV. The rather short proboscis ends in VIII where it receives the several ducts of the diffuse salivary glands occupying the pre-clitellial region.

The stomach is moniliform, constricted into six spheroid chambers occupying somites XIV to XIX inclusive and entirely without lateral ceca. The last one passes into a long capacious unpaired cecum which shows no apparent traces of its dual origin and extends with slight sacculations to a point immediately beneath the anus. The stomach and cecum, as might be expected, have a precisely similar histological structure and both have a green color owing to the presence of numerous branched pigment cells in their walls. The intestine arises from the dorsum of the last gastric chamber in XIX by a constricted opening and lies dorsad of the cecum throughout its length. At its commencement it bears a pair of short wide pouches which project forward. About its middle is a constriction and caudad of this an enlargement bearing another pair of ceca. Smaller ceca may occur between.

There are but five pairs of testes alternating with the gastric sacculations. Very delicate vasa efferentia start at the dorso-mesial side of the testes and then pass forward and outward among the ventral clitellar glands to the vas deferens, a very delicate tube resting on the ventral body walls. Passing ganglion XIV the vas deferens becomes larger and its course wavy and just in front of ganglion XIII expands into a short, wide sperm sac which is looped caudad and after a constriction passes into the ductus ejaculatorius of half its diameter and twice its length. The latter becomes very narrow as it enters the thick loose layer of unicellular glands which conceal the median eversible bursa from view. The male orifice is located at XI/XII. The paired ovaries are large elongated simple sacs which even in their much folded condition reach as far caudad as somite XVI. They open at or about XII a2/a3.

Verrill describes the colors during life as "translucent green-

ish, with a pale median dorsal line and with minute black specks arranged in transverse bands; along each side are eight light spots, alternating with the dark punctate bands." The black specks are branched pigment cells which are scattered through the integument with singular regularity. Large individuals become more opaque owing to the great development of clitellar glands.

Habits - This is our commonest fresh water fish leech. It is common in the ponds and lakes of the northern states and the Mississippi Valley and is especially abundant along the Ohio shore of Lake Erie. It lives upon the exterior of the body of various species of small fishes feeding upon the mucous which covers the surface as well as upon their blood. It appears to be in no way injurious to its hosts. Many examples may also be found living among water plants to the stems of which there is good reason to believe its stalked cocoons are attached.

Piscicola milneri, Verrill

Ichthyobdella milneri Verrill (1872)

Description from Eyerson(1915)

In size this leech varies from 18 to 35 mm. in greatest diameter. The body is slender and rounded, tapering toward the anterior end. There are two pairs of eyes plainly visible. The anterior pair are larger and farther apart than the posterior pair. The suckers are two or three times as wide as the body and are deeply cupped and excentrically attached. In the lateral region of the body seventeen pairs of vesicles were observed. The color is deep yellow with a symmetrical pattern in brown. There ^{are} four longitudinal yellow bands, dorsal median, lateral and ventral median. The brown color in the form of irregular pigment cells, is laid down in twelve longitudinal lines which are arranged in four groups of three, each group alter-

Plate IV

Figure 1. Anterior end of Actinobdella inequi-
annulata showing the position of the
eyes, the annulation and the location
of sensillae and median papillae.

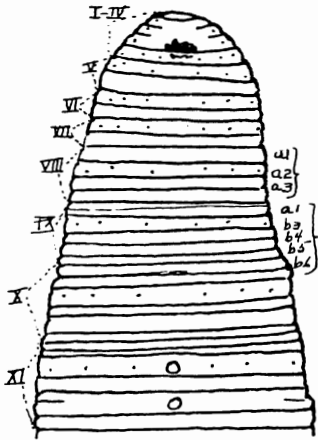
Figure 2. Posterior end showing sucker.

Figure 2. Anterior end of A. annectens showing
position of eyes, sensillae and papil-
lae. Posterior end showing sucker.

Figure 3. Anterior end of Piscicola punctata
showing location of eyes and details
of annulation. Lateral view.

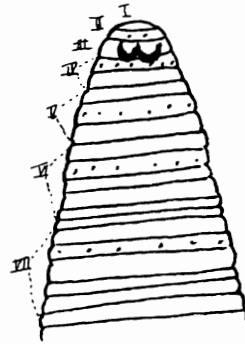
Figures 1 and 3 taken from Moore (1912) and
2 taken from Moore (1906)

Plate IV



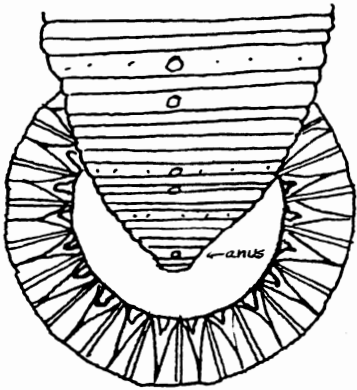
A. inequiannulata

Fig. 1



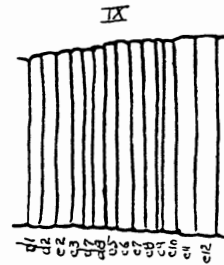
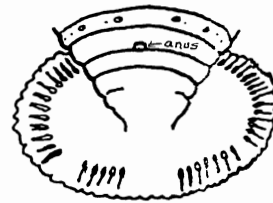
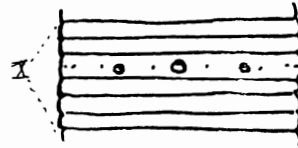
A. annectens

Fig. 2



P. punctata

Fig. 3



Actinobdella. Piscicola.

nating with the yellow bands.

In each group of brown lines the uppermost line is more or less broken, showing a tendency to a series of heavy brown metameric bars. On the posterior sucker twelve dark brown eye spots were observed. Verrill speaks of a tinge of green, but this was not observed in any of the specimens in the collection. The absence of this color, however, may be due to the effect of the preserving fluids.

These specimens were taken on lake trout (Cristivomer namaycush).

Family Hirudinidae (from Moore, 1912)

Leeches mostly of large size, more or less elongated, with thick, little depressed bodies. A well-developed zonary clitellum in most species during the breeding season. Oral sucker forming lips surrounding the large mouth; caudal sucker rather small or well developed, discoid. Complete somites usually of 5, rarely of 3 or 7, annuli. Eyes usually of 5 pairs, forming a marginal arch on somites II to VI. Metameric sense organs usually conspicuous colorless spots on the neural annuli, 6-8 above and 4-6 below. Cutaneous papillae small or absent. Mouth large, occupying entire oral sucker; pharynx not protrusible, usually preceded by three compressed, muscular, toothed jaws, one dorsal and two ventro-lateral, the former alone, or all three sometimes absent. Stomach with a single posterior pair of simple ceca, or provided with one or two pairs of ceca in each segment; no intestinal ceca. Genital pores variable, the male usually on XII, female on XIII and usually separated by 5 annuli; associated copulatory glands may be present. Testes sacs usually 10 pairs belonging to somites XIV-XXIII. Genital ducts complex, the male terminating in an unpaired atrium with prostate gland and a usually filiform penis. Ovisacs 1 pair, small pyriform, opening

into an unpaired oviduct terminating in a long vagina. Copulation occurs, during which the penis of one individual implants the spermatophores in the vagina of the other. Eggs enclosed in vesicular or spongy chitinoid cocoons deposited in damp earth. Fresh water or more rarely terrestrial leeches, which are voracious blood suckers or predatory destroyers of weaker invertebrates. Mostly active swimmers.

Genus Macrobdella Verrill.

Size large. Dorsum marked by metameric red and black spots. Jaws prominent each bearing numerous small teeth in a single series; gastric ceca very spacious, two pairs to each somite from X to XVIII. Genital orifices separated by from $2\frac{1}{2}$ to 5 rings, followed by the two pairs of copulatory gland pores, which form a quadrate figure opening in the furrows XIII/XIV and XIVb1/b2; penis short and conical; atrium and vagina both short, globoid. Active blood-suckers, attacking vertebrates.

Macrobdella decora (Say) Verrill

Hirudo decora Say (1824), Leidy (1868)

Description - Macrobdella decora, the American medicinal leech, reaches a length of eight to ten inches and a breadth of $\frac{3}{4}$ inch, but the examples most frequently met with are much smaller than this, while the largest may exceed this size. The body is depressed throughout, more so than in any native species of the family and the margins are sharp. During life, however, the body is very soft and assumes a great variety of attitudes and shapes.

The oral sucker is a powerful organ provided with a rather wide unsegmented and very mobile border which very materially increases its extent. Anteriorly a distinct median emargination corresponds

with a deep ventral sulcus which divides the upper lip and is flanked by a pair of somewhat shallower sulci. The upper lip can be folded into the buccal chamber and almost concealed by the lateral lobes which close beneath it. As usual in the family there are five pairs of eyes, larger in this species than in the species of Haemopsis. The posterior sucker is large, broadly attached and circular.

When fully developed the clitellum is firm and thick and extends over eighteen annuli, from Xb5 to XIV b2, but it is seldom so well marked or so extensive. In the ordinary condition the male pore appears as an opening of considerable size in the furrow XI/XII, into which the surrounding rugosities converge. When these inflected parts are everted they form a more or less prominent conical penis which reaches a length of about three mm. when fully protruded. In this condition it is supported almost entirely on annulus XIIb1 which has greatly encroached on the preceding annulus in the middle region. The female orifice is a small opening with rugous margins at XII/XIII or XIIb1.

Very characteristic of the genus are the copulatory glands, which form conspicuous masses occupying a large part of the middle region of the floor of somites XIII and XIV. Their external openings are four in number, arranged at the four angles of a nearly square figure, the first pair opening in the furrow XIII/XIV and the second in the furrow line XIVb1/b2. Surrounding each of the pores is a slightly tumid region extending over the contiguous halves of the two annuli between which the pore lies. When fully developed the four tumosities are separated only by shallow furrows and together form a conspicuous rugous quadrate area extending over the posterior half of XIIb6, the anterior half of XIVb2 and all the intervening annuli. Longitudinal and transverse diametral furrows divide it into

quarters.

The surface of the body of this species is quite smooth and free from papillae, although more or less roughened in some preparations by the scattered sense organs. Nephridiopores and sensillae have the customary disposition. The latter can be very favorably studied on the dorsal surface but are difficult to distinguish on the generally light background of the ventral surface.

Somites I, II and III are uniannulate, IV and V biannulate, and VI triannulate on the dorsal side. Somites VII and VIII are respectively triannulate and quadriannulate but VIIa3 and VIIIa1 are enlarged and quite distinctly subdivided dorsally. Then follow sixteen complete quinquannulate somites, IX and XXIV inclusive, in which the neural annulus is typically shorter than any of the others. At the posterior end XXV is again quadriannulate, there being only one post-neural annulus (a3) instead of two, XXVI is biannulate with a1 more or less distinctly separated from a2. The large anus cuts into the margin of XXVII.

As in all of the predatory leeches of this family the mouth is of large size and may be considered to be coextensive with the opening of the oral sucker. The three jaws exhibit the usual relations, but their form is characteristic of the species among the leeches of the northern United States. They are about twice as long as high and each bears about 65 fine conical, slightly retrose, uniserial teeth. A very short pharynx with several longitudinal folds reaches to about IX, within which segment it is succeeded by a still shorter esophagus which can scarcely be distinguished from the stomach, as sacculations begin to be evident immediately. From X to XVIII inclusive each somite includes two pairs of gastric ceca of which those from XIII backward are of large size. The last pair, which originate from the stomach in the anterior part of somite XIX, are of very great ex-

tent, reaching XXIV or XXV, and bear two wide lateral branches in each of the intervening somites. The straight narrow intestine presents no noteworthy features.

Ten pairs of testes are situated, intermetamerically, as most usual in the leeches, at XIII/XIV to XXII/XXIII inclusive. The vasa deferentia are enveloped in crowded unicellular glands and follow somewhat sinuous courses. In somite XI they lose their glandular covering and appear as delicate ducts, which opposite to ganglion XI pass abruptly into the anterior end of the compact massive epididymes. From the posterior end of the latter wide somewhat folded ducti ejaculatorii lead to the terminal organ. Just before entering the outer glandular covering of the bursa or atrium the ducti become constricted and then rise as a pair of slightly enlarged sacs which open into the summit of the invaginated bursa to which they stand in the relation of cornua. This median organ which evaginates to form the penis is in its retracted condition spherical or inverted pyriform and has thick muscular and glandular coats.

The colors during life are very showy. Above the ground varies from a light sage green to a rich olive green with obscure longitudinal stripes or short lines in the median areas. The median metameric spots are cadmium orange or light red and the marginal spots are black. The ventral surface is a rich orange sometimes plain, sometimes spotted with black. The colors fade very quickly in alcohol.

Habits - This species approaches closer to the European Hirudo medicinalis, both in structure and habits, than any other indigenous American species, and, when the use of leeches for blood-letting was more general than now, was largely employed by physicians. To a limited extent it is still gathered in the swamps below Philadelphia and sold for this purpose. It is widely distributed throughout the

northern half of the United States and in Canada and is an inhabitant of standing water rather than of streams or rapidly flowing water. Great numbers often occur in ponds and lakes. Altogether it is the best known of all the American leeches and has been frequently written about since its discovery by Say in 1824, 1825.

Macrobdella is more strictly aquatic than the species of Haemopsis and probably does not leave the water voluntarily though it will live for weeks buried in the mud left by the drying up of small ponds and pools in dry summers. It is an active predaceous creature and swims actively at the surface at night or during the day if attracted by food. It is well known to the American boy who frequently comes from his plunge in the meadow pond with several of these leeches firmly attached to his skin, an experience so frequent as to have gained for it the general name of blood-sucker.

It also attacks cattle which enter its domain to drink or cool but its natural food is the blood of fishes, frogs and turtles which it attacks and frequently kills. Small aquatic annelids in large numbers and occasionally larval insects have been found in the stomach. In the spring frog eggs are devoured in large numbers, the eggs being sucked out of the gelatinous envelopes which have been cut by the sharp saw-like teeth of the leech.

In coitus the leeches cohere by means of the secretion of the copulatory glands at the same time coiling somewhat about each other. Cocoons are formed and deposited in the mud by the side of the pond, and there left to hatch.

Genus Haemopsis Savigny.

Size large to very large. Dorsum plain or marked by a median stripe or by irregular non-metameric spots and blotches. Jaws small and bearing a few large double teeth, or absent; one pair of

posterior gastric ceca only. Genital pores separated by five rings; no copulatory glands; penis filiform; atrium and vagina both much elongated. Food chiefly worms, insect larvae, etc., not normally blood-suckers.

Haemobis marmoratis (Say) Moore.

Hirudo marmorata Say (1824)
Aulastomum lacustre Leidy (1868)

Description - The size is medium, seldom exceeding six inches in length and one-third of an inch in diameter, though larger specimens are sometimes met with. Owing to the extensive development of botryoidal tissue the body is exceedingly soft and limp and consequently varies greatly in shape. Compared with the other species of Haemobis described in this paper the form is rounder and less flattened.

Although the anterior sucker is relatively large and the lips broad, the unsegmented margin is very narrow and there are no distinct inferior sulci as in Macrobdella. Of the five pairs of eyes the first three pairs are conspicuous and are arranged in a regular arc on the first three annuli; the fourth and fifth are on the sixth and ninth annuli respectively and are much more obscure, being deeply placed. All of the eyes are smaller than the corresponding ones of Macrobdella. In mature individuals the clitellum is very distinct and equally well developed dorsally and ventrally and often is the widest region of the body. It extends over fifteen annuli, from Xb5 to XIIIa2 inclusive. The posterior sucker is relatively small, circular and broadly attached; about one-third of it projects beyond the body posteriorly and its anterior margin reaches to XXVa2.

Somite I can seldom be distinguished from II which again is imperfectly separated from III; IV is biannulate, as is V also, but the latter is more fully elaborated dorsally. On the typically biannulate somite VI, a1 and a2 are more or less separated by a fur-

row confined to more or less of the middle dorsal region. Somite VII is fully triannulate but is peculiar in the large size of a3, which, moreover, may exhibit a faint dividing furrow; VIII is quadriannulate and a1 resembles VIIa3 in being enlarged and partly subdivided. There are thirteen (IA to XIII) quinquannulate somites, in which all of the annuli are approximately equal. Somite XXIV is quadriannulate and sometimes the last annulus (a3) is faintly subdivided, usually on the ventral surface; XXV is triannulate, but a1, which is normally of larger size than the remaining annuli, is subject to much variation. The following somites, XXVI and XXVII, are variable and difficult to interpret, but the uniannulate condition is probably the most usual.

Just anterior to the jaws and separating them from the buccal area is a slight circular sulcus and fold. The jaws are low and rounded, not at all compressed on the free edge. As usual they may be retracted into little pockets so that the entire tooth-bearing surface is concealed. Each jaw bears a double file of large, coarse teeth arranged in from 12 to 16 pairs. The pharynx reaches to X and has from nine to twelve or more longitudinal folds, three of which unite into a strong ridge behind each jaw. The long narrow stomach reaches to XIX, and is provided along its entire length with numerous small pockets; at its posterior end a pair of large ceca arise and reach caudad to XXII or XXIII. The intestine is also straight and bears two or three pairs of quite large, short, globular ceca which lie dorsad of the large posterior gastric ceca. The anus is very large.

The customary ten pairs of testes are present in the anterior end of somites XIV to XXIII each reaching into the preceding somite. The collecting portion of the vasa efferentia and vas deferens are essentially similar to those of Macrobdella. The epididymus is a rath-

er a narrow tube, much convoluted, rather open and not at all massive. The epididymus opens into a small fusiform sperm sac in the posterior part of XIII and the latter is continued as the ductus ejaculatorius. This canal reaches forward to the level of the male pore and then bends back to join the closed end of the atrium, sometimes the right, and sometimes the left one, passing beneath the nerve cord. The atrium or penis sheath is very long and slender, with a sharp bend at ganglion XVII, from which point one limb reaches to the male pore, the other to the anterior end of somite XV; the ratio of the short and long limb is about as one to two and onethird. The penis is a slender filiform organ with a slightly bulbous extremity and is frequently extruded to a length of three times the width of the leech body. The male orifice is on the anterior part of XIb6 or, less frequently, between this and the preceding annulus.

The paired ovaries are situated in the posterior part of XIV dorsad of the nerve cord and in contact with the second pair of testes. There is a large albumen gland and a long narrow common oviduct which opens into the narrow anterior end of the pyriform ovisac lying in somite XVI. From the posterior end of the latter a long, slender, much convoluted vagina reaches to the female orifice at XIIb6 or XIIb5/b6.

Haemopsis marmoratis includes many color varieties. The ground is usually some shade of green, olive green or greenish brown, sometimes nearly plain, sometimes remotely spotted, but usually thickly and confluent blotched with irregular and intermixed spots of lighter grays and darker browns or black. The lighter kinds tend to predominate on the ventral side, from which the darker pigments may be altogether absent. The darker markings are sometimes so close on the dorsal side as to produce an almost black color.

Habits - The horse leech, as this species is called, is found in practically all parts of North America, where it has a known wider range than any of its near allies. It is semi-aquatic, living in the mud by the sides of ponds, pools and lakes rather than actually in the water, although it of course moves freely about in the water and is often found in the mud at the bottom. Along tidal rivers the species is most abundant beneath stones on the flats exposed at low water where it lives with several species of true earthworms. At times it wanders some distance away from the waters edge, burrowing in the soil in the search for earthworms on which it feeds; but it is not terrestrial in the sense that H. lateralis is, never leaving so far as has been observed, the near vicinity of water. Besides earthworms, various kinds of aquatic insects and their larvæ, aquatic oligochaetes, gastropods and pelecypods are pursued and eaten and large quantities of mud containing organic matter are swallowed. The species is also, like many other leeches, a scavenger and great numbers will collect on the body of a recently killed animal thrown into their haunts. Blood is taken when the opportunity is afforded of attaching itself to drinking cattle or the legs of boys wading in its haunts. It would be interesting to know if it ever enters the pharynx of cattle, as is well known to be the habit of the Limnatis so common in some of the countries bordering on the Mediterranean.

Haemopsis lateralis (Say) Moore

Hirudo lateralis Say (1824)

Macrobdella valdiviana et gigas Phillipi (1872)

Semiscollex terrestris Forbes (1890)

Description - Although there are some minor differences I am unable to separate the aquatic leech originally described by Say from

specimens procured in Minnesota from the interesting terrestrial form which Forbes has described and which was found by him in considerable numbers in garden soil in Illinois. So far only the aquatic variety has been found in Minnesota and was represented in the Survey collections by two living examples which unfortunately escaped me and were lost.

Compared with the terrestrial variety, of which even Prof. Forbes' contracted alcoholic specimens reach a length of eight inches, a large number of the aquatic form, chiefly from Ohio and Maryland, average much smaller, about five inches and $\frac{1}{2}$ inch wide being the usual size. This species is much more slender than H. marmoratis and the greatest width lies farther caudad. The body is rather more muscular and as a consequence firmer, but during life exhibits the same variety of shapes and postures.

The mouth is somewhat smaller and the oral sucker narrower than is H. marmoratis, while a further slight distinction is found in the better developed longitudinal grooves beneath the lips of this species. The eyes have the same number and position as in the species last described.

In the few cases in which a clitellum has been observed it differs in no respect from H. marmoratis. Although not differing in any way from the typical arrangement in the family, the 17 pairs of nephridiopores on the posterior margin of b2 of somites VIII to XXIV inclusive are unusually distinct and lie just behind a sort of slight spout-like projection. The posterior sucker is noticeably small.

Throughout the entire length of the body the annulation is very distinct, and at the margins most of the annuli are rather sharply angulated. In most respects the somites are constituted just as in H. marmoratis but the following features are diagnostic: somite VII

is fully quadriannulate and VIII quinquianulate, owing to the complete subdivision of VIIa3 and VIIa1 each into two annuli; as a consequence this species has two more annuli in the anterior region; VIa3 and VIIa1 are always relatively wider and may exhibit an incipient furrow; on the complete somites the annuli are not equal but bear the relation - a_2 is less than b_2 is less than b_5 equals b_6 , except at the posterior end of the series; finally XXVI and XXVII are typically biannulate.

Including the rudimentary denticles at the posterior end each jaw bears from 20 to 25 pairs of teeth, of smaller size and more irregular form than in H. marmoratis. In other respects the digestive organs are essentially similar in the two species.

The sperm sacs and epididymes do not reach beyond ganglion XI anteriorly, or ganglion XII posteriorly; the latter are massive and compact and partly envelope the sperm sacs to which they are closely molded. The posterior bend of the atrium is at ganglion XIV and the relative length of the two limbs is as one to one and seven tenths in the three examples measured. Although the genital pores are in the homologous annulus they lie two annuli farther from the mouth than in H. marmoratis. The ovaries are always within somite XII and the vagina never extends posterior to ganglion XIV.

Forbes thus describes the colors of living examples of the terrestrial variety - "sooty drab, varying to plumbeous black, somewhat lighter beneath, uniform in tint and quite without spots or mottlings of any sort. A darker median longitudinal stripe, very conspicuous and well defined, is almost invariably present; a pale marginal stripe often approaching buff, less constantly so; and a ventral submarginal stripe of the same color as the median dorsal one likewise quite frequent." The ground color of the aquatic variety is

similar, but while the dorsal black stripe is less constant it may be very conspicuous; more frequently it is faint and obscure, broken into small spots or totally wanting. A few dark spots are sometimes scattered over the dorsum. Sensillae are much more distinct in the aquatic than in the terrestrial variety; indeed Forbes failed to find them in the living specimens of the latter.

Habits - In habitat, food, movements, resting attitudes etc. the aquatic variety is essentially like H. marmoratis. It is capable of a greater degree of extension and appears to be a more active swimmer than that species. Two examples sent me by Prof. Nachtrieb and the only ones included in his collections were placed in an aquarium with H. grandis. One night the cover was accidentally left displaced and on my arrival the following morning both were gone, but none of the other species were missing. A shining track of dried mucous on the polished floor showed the course of their wanderings. One quickly disappeared beneath a wall case. The other was tracked for a measured distance of more than fifteen yards, when it too disappeared beneath the wash-board. Neither was recovered, but the circumstance is mentioned as showing the tendency of this species to wander and its ability to live in a perfectly dry situation, and as further confirmation of my opinion of the identity of this with the land leech of Illinois. Under the same circumstances H. marmoratis or Erpobdella punctata would have quickly died before having crawled nearly so great a distance. Concerning the terrestrial form Prof. Forbes writes of having obtained 56 specimens, all from earth in central Illinois and some of them half a mile or more from the nearest water, while none occurred in the course of a large amount of aquatic work done in the same regions during the same period. Its only known food is earthworms which it swallows entire.

Haemopsis grandis (Verrill)Semiscolex grandis Verrill (1874)

Description - As Prof. Verrill indicated in his original description this is a monster among American leeches, exceeding the North American Representatives of the terrestrial variety of H. lateralis and at least equalling the larger representatives of that species which Philippi has described from Chil . Living examples not infrequently exceed a foot in length and specimens of 15 and 18 inches have been reported from the lakes of Minnesota. However this is an unusual size and smaller individuals having a length from 5 to 8 inches are more common.

The body is very robust and heavy posteriorly, but rather slender anterior to the clitellum. While seldom much depressed the body does not assume the quite rounded form frequent in H. marmoratis, which some varieties of this leech closely resemble in general aspect. In life the body is soft and limp and possesses a great facility for contraction and elongation and other changes in form.

While large, the mouth is more contracted than in H. plumbeus and the lip narrower and more prolonged. The five pairs of eyes have the arrangement usual in the family; they are all of relatively small size and the fourth and fifth pairs are quite inconspicuous.

The clitellum is a thick and prominent glandular girdle extending over fifteen annuli from Xb5 to XIIb2, often rather within the latter but apparently never as far as its middle. The female orifice is similar but drawn out laterally to a slit-like form and usually well within annulus XIIb5, sometimes as far back as its middle or so far forward as to lie in the furrow XIIa2/b5.

Seventeen pairs of nephridiopores can be readily distinguished

on the posterior margins of the first annulus (a1) of VIII and the second annulus (b2) of somites IX and XXIV inclusive. They, together with the metameric sensillae, have the positions usual in the genus and the marginal sensillae show the same tendency to become subdivided. There are no cutaneous papillae, the skin being smooth. However, the short shallow wrinkles seen in many leeches are remarkably conspicuous in preserved specimens of this species and give to the interannular furrows a peculiar zigzag course which is especially pronounced toward the ends of the body. The usual non-metameric sense organs are present in abundance and are especially abundant on the lips. The annulation differs in no essential feature from that already described for H. marmoratis.

While retaining all of the characteristics of the genus the reproductive organs differ considerably in the proportions of the several regions of complicated ducts from all the other species found in Minnesota. The epididymus is remarkably massive and lies chiefly caudad of the corresponding sperm sac which is consequently not so largely enclosed in its coils as in *H. lateralis*. The sperm sac is remarkably large, being much wider and about half as long as the atrium when fully distended. Its anterior end is just behind ganglion XII and tapers into the ductus ejaculatorius which is noteworthy for its shortness. In almost every instance the atrium is doubled on itself at about the middle, so that the two limbs are approximately equal and the blind glandular end is usually a little anterior to the male pore. Either the right or left ductus ejaculatorius may pass beneath the nerve cord.

The ovaries are situated in the anterior part of XII immediately behind the female pore, and both may lie dorsad of the nerve cord or one pass beneath it. There is a large pyriform albumen gland,

a short common oviduct and a relatively short, thick vagina.

A median and one or two pairs of lateral longitudinal furrows, together with some less constant and minor ones, mark the ventral surface of the lip. The transverse sulcus dividing the buccal chamber from the pharynx is deeper than usual, which is perhaps correlated with the entire absence of dentigerous jaws in this as in H. plumbeus. Although somewhat variable and irregular there are typically about twelve prominent longitudinal pharyngeal folds. Nine of these are in three groups of three each coalescing anteriorly at what would be the position of the jaws in other species. Three, unusually simple and frequently incomplete folds, alternate with these. The stomach scarcely shows any indication of lateral pouches and the posterior pair of ceca are remarkably short, scarcely one half the length of the intestine.

On the dorsal surface the ground color varies from tawny olive through olive and olive green to oil green, the green colors being nearly pure in some examples, especially in those which are least spotted. In others they are impure from the suffusion of brown or dusky pigments in the deeper tissues, in extreme cases imparting to the entire dorsum a brownish hue. The lighter greens appear most frequently toward the anterior end and on the caudal sucker, but in many examples these regions become dusky. Frequently a marginal rufous or orange stripe is present, especially toward the posterior end, but it is seldom or never so clearly defined as in H. plumbeus. The ventral surface is gray, yellowish or light brown but always paler than the dorsum.

There is a great range in the degree of maculation which, as compared with H. marmoratis, is characterized by a greater boldness and distinctness in this species. Perhaps the most typical condi-

tion is that in which the dorsum of each complete somite is marked by 8 or 10 irregular but somewhat quadrate black spots, most of which are confined to the limits of one annulus, but a few, especially toward the margins, are larger and more irregular. In other cases the spots are more numerous and confluent so the real ground color appears as lighter areas on the dark field. Still others are as nearly free of spots as some examples of H. plumbeus. The ventral surface bears fewer spots than the dorsal and not infrequently is quite immaculate.

Habits - This great leech is found on the shores of the Great Lakes and abounds in the numerous lakes and ponds of Wisconsin, Minnesota and Michigan. Eastwardly it extends its range through New York into New England but is rare in the Middle States.

It appears to live chiefly about the borders of the bodies of water which it affects, concealing itself beneath stones. According to Barrows it secretes an unusual abundance of mucous and I suspect from this fact and the large size of the nephridial bladders that it may upon occasion leave the water. Stomach examinations show that its food consists of earthworms and allied aquatic worms, smaller leeches, particularly nephelids, snails, insect larvae and organic mud. In captivity several individuals fed voraciously on earthworms but could not be induced to attack fishes, frogs or turtles even when the skin was abraded so that the blood flowed, from which behavior it would appear that the accounts of this species habitually attacking fish require verification.

Haemopsis plumbeus Moore

Hirudo lateralis Say (1824) in part.

Description - Though resembling H. lateralis quite closely in

color this hitherto unnamed species stands closer to H. grandis, in respect to both external and internal structure. Probably it does not equal the latter in size, the available specimens varying from two to six inches in length. The form is heavy like that species, and the oral sucker larger and the lips much broader. A rather wider unsegmented rim borders the sucker. Except that they are rather larger the eyes are like those of H. grandis in structure and arrangement. The sensillae, nephridiopores and anus present no distinctive features.

The annulation is essentially like that of H. grandis but a few differences occur, which may disappear when a larger series of specimens comes to be examined. The furrows are well marked but present little of that zigzag character and secondary wrinkling which is so conspicuous in the larger species. The furrow Val/a2 is quite incipient and the annuli VIIa3 and VIIIa1 are relatively much smaller and very much less distinctly divided than in H. grandis.

The mouth is very large and the ventral surface of the lip shows no trace of longitudinal sulci. Jaws are absent and the capacious pharynx bears twelve low longitudinal folds. The remainder of the alimentary canal appears to differ in no way from that of H. grandis.

The external genital orifices are constantly in the middle of annuli XIb6 and XII b6 respectively, The penis is filiform and may protrude to a length of two and one half times the width of the body at the male orifice. It is in the structure of the internal reproductive organs that the most evident differences between this species and H. grandis are found. In fact the resemblance is much closer to H. marmoratis in respect to these organs. The atrium extends caudad

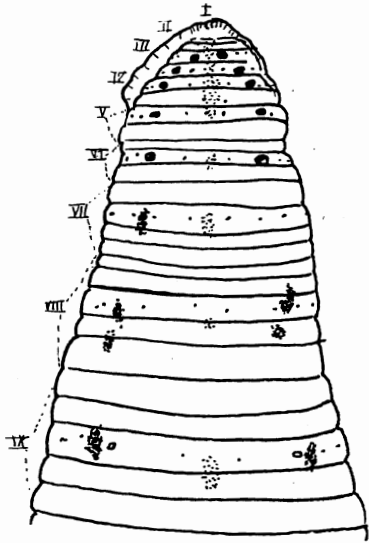
far beyond the vagina to the neighborhood of ganglion XVI where the usual sharp bend appears. The short limb is about one half as long as the long one. Relatively small sperm sacs, which are not more than one fourth or one fifth of the length of the atrium, lie far forward in the region of the male orifice. The coils of the epididymes lie chiefly side by side of the sperm sacs and not heaped up at their caudal end as in H. grandis. Unlike any other species of the genus described in this paper the vagina is very much shorter than the atrium, reaching only to the caudal end of somite XIV. The common oviduct lies on the dorsal side of the vagina; the albumen gland is large and nearly spherical and the ovaries are just in advance of the female pore.

The color is remarkably uniform leaden or slaty gray, usually purer and sometimes darker below, and often showing a light olive or yellowish tinge above. Along the entire margins from the caudal sucker to the lips is broad, dull but conspicuous rufous or orange band which broadens and encroaches on the dorsal surface as it approaches close to the head, but contracts again on the lip to a narrow marginal line. The ventral margin of this band is, owing to the purer ground color below, more sharply defined. Small irregular spots of black are scattered more or less remotely over the dorsum, being usually most numerous towards the margins and ends of the body. Sometimes they are almost absent and are never numerous. Except for a few along the lateral rufous band the ventral surface is free from spots. The caudal sucker is of the ground color both above and below, with a narrow rufous border.

Plate VI.

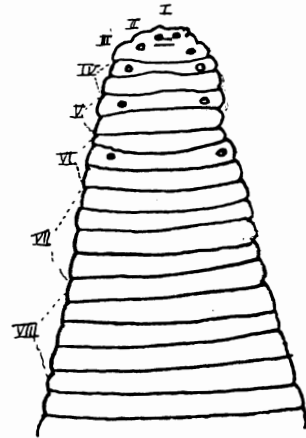
- Figure 1. Anterior nine somites of Macrobdella
decora showing the location of the eyes
the sensillae, the median red spots and
the lateral black spots.
- Figure 2. Anterior somites, lateral view, of
Haemopsis marmoratis showing location
of eyes and sensillae.
- Figure 3 Anterior eight somites of Haemopsis
lateralis showing location of eyes.
- Figure 4. Anterior end of Haemopsis grandis
showing location of eyes.
- Figure 5. Anterior end of Haemopsis plumbeus
showing location of eyes and sensillae.

Plate VI



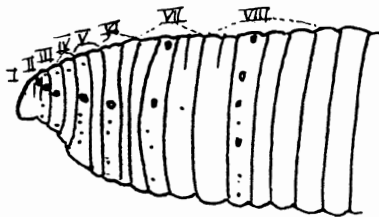
Macrobdella decora

Fig. 1



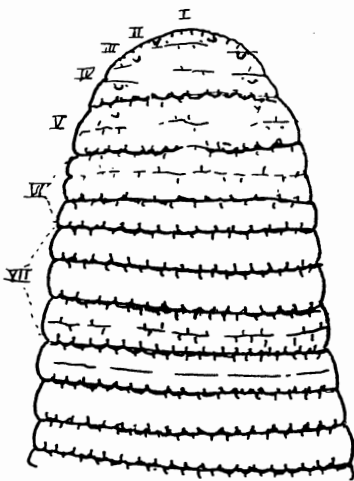
Haemopsis lateralis

Fig. 3



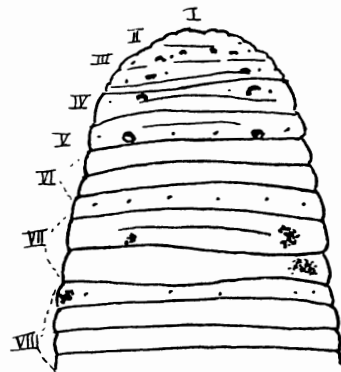
Haemopsis marmoratis

Fig. 2



Haemopsis grandis

Fig. 4



Haemopsis plumbeus

Fig. 5

Macrobdella. Haemopsis.

Family Herpobdellidae

Leeches of mostly moderate size and slender elongated form, usually terete anteriorly, often much depressed posteriorly. Clitellum as in Hirudinidae. Oral sucker small, forming lips: caudal sucker also small, discoid. Complete somites fundamentally of five rings, but one or more often subdivided, forming six to eleven rings. Eyes usually four pairs, two pairs on somite II often coalesced, two pairs of smaller size on IV; but sometimes eyeless. Cutaneous sense organs and papillae numerous; not obviously metameric. Mouth and pharynx as in Hirudinidae, but the latter with three longitudinal muscular ridges and no jaws. Stomach and intestines straight, simple and without diverticula. Genital orifices variable in position, the male usually on XII, the female on XIII. Testes sacs small and numerous, extending through about segments XVIII to XXIII. Sperm ducts very long and much convoluted, paired until they empty by means of short prostate cornua into the small median atrium. No protrusible penis. Ovisacs long and slender as in the Glossiphonidae but each doubled on itself, united only at the external orifice. Copulation takes place and spermatophores are implanted on the integument. Eggs enclosed in flat, pouch-like chitinous cocoons fastened by one side to stones, sticks and plants. Fresh water predaceous leeches, feeding on insect larvae, worms, etc., occasionally suck the blood of vertebrates.

Genus Erpobdella Blainville.

Size moderate; posterior region not greatly depressed. Sperm duct forming a long loop (reaching to ganglion XI) anterior to atrium which is provided with a pair of simply curved horns. None of the five annuli of complete somites distinctly enlarged and subdivided.

Erpobdella punctata (Leidy) Moore.Nephelis punctata Leidy (1870)Nephelis lateralis Bristol (1898) in part.

Description - The form is elongated with the sides nearly parallel, tapering anteriorly to the clitellum but very little at the posterior end. Anteriorly it becomes almost circular in section and posteriorly, although margins are sharp and prominent, is little depressed and widened. The size is large for the family, reaching a length of about five inches. The body is very firm, hard and muscular.

The oral sucker is very small, being little more than a short lip overhanging the nearly terminal mouth. Normally there are three pairs of eyes, the first decidedly the largest and situated close together on somite II and directed forward; the others more widely separated on the sides of IV and looking somewhat backward. The clitellum is frequently seen in full development, in which condition it is a wide, thick complete girdle covering the 15 annuli from Xb5 to XIIIa2 inclusive. The male pore is a rather conspicuous opening at XIIb2/a2, the female a much smaller one at XIIb5/b6 or two annuli farther caudad.

Somites I, II and III are uniannulate; IV and V are biannulate, VI is triannulate, VII is quadriannulate; and VIII to XXIV inclusive, or 17 somites, are quinquannulate. At the posterior end somite XXV is quadriannulate, though the last annulus (a3) may be more or less distinctly subdivided on the dorsum; XXVI is either biannulate or triannulate and XXVII is usually uniannulate.

In the complete somites the annuli are of approximately length and b6 is not obviously enlarged or more completely subdivided than the others. Numerous small cutaneous papillae bearing sense organs

appear arranged in an irregular transverse row on each annulus. They are largest dorsally, and on the neural annulus. The annuli of the simpler somites frequently exhibit two such rows, indicating their composite character.

The testes are numerous, about 50 or 60 on each side of somites XVIII to XXIV, mostly with separate vasa efferentia. The enlarged and much convoluted epididymis or sperm sac reaches from XVIII to XIV. There is a long preatrial loop to the ejaculatory duct reaching to ganglion XI. The atrium consists of a small eversible bursa and a pair of elongated semi-erect, curved prostate cornua, the bases of which are enveloped by a thick layer of prostate glands. The ovaries are elongated sacs each doubled on itself and reaching for a variable distance through the ventral sinus.

In this species the color varies extremely. Young individuals usually contain little or no pigment, permitting the red color of the blood to appear through the translucent tissues. The adult pigmentation is assumed gradually with increase in age and size. When full grown the ground color may be plumbeous, slate color, brownish gray, olive brown, fuscous, light brown or chocolate, always somewhat lighter ventrally and in the furrows and enlivened on the margins by the red tint of the lateral blood vessels. Sometimes a beautiful golden green hue overspreads the entire dorsum. The browns are most usual and may be plain or more or less marked with irregular black spots with light centers, arranged in two or four longitudinal lines leaving the middle of the back and margins clear.

Habits - Within the area of its distribution, which is extensive, this leech occurs under a great variety of conditions. Almost every spring, brook and river, ditch, pond and lake, no matter how pure and cold, or how warm and foul, is its home. And in most situations

it is by far the most common species of leech present, exceeding numbers even the omnipresent Glossiphonia stagnalis. The size varies greatly with the size of the body of water and the richness of the food supply. Small clear brooks and ditches almost invariably yield only small individuals, while by far the largest individuals which I have seen come from large rivers and ponds and the Great Lakes. Bristol has pointed out that in any particular pond they congregate on the shore which receives the richest food supply and my own experience substantiates this.

Like many other species of leeches this one conceals itself during the day beneath stones, logs, leaves or whatever happens to be convenient for the purpose, but leaves its shelter at night and searches actively for food. In aquaria the rhythmic respiratory movement, which takes place while either both or only the posterior sucker is attached, may be frequently observed. It is so muscular and the body so hard, wiry and slippery that it is really quite difficult to hold a living one between the fingers. When picked up it struggles and writhes violently and when disturbed creeps rapidly. It is also the most expert and active swimmer of any of our common leeches. When swimming it turns edgewise and undulates the body in eel-fashion, sometimes elevating the head above the water.

Although somewhat of a scavenger, it subsists chiefly on aquatic insects and their larvae, and aquatic oligochaetes, but will attack fishes and frogs or draw blood from the legs of wading boys. Not infrequently cannibalistic tendencies appear, large individuals devouring the smaller ones of its own species. It is very active in seeking food and will pursue its prey with considerable tenacity.

Breeding continues over a long period - most of the spring and summer. Spermatophores are formed and attached to any part of the bo-

dy except the anterior end which seems to be avoided. In copulation the two leeches wind about each other and adhere by means of their suckers and the exchange of spermatophores may be mutual. The small, flat amber-colored egg cases are familiar objects to students of fresh water life and are often found in great numbers attached to the underside of stones, etc, in the water.

Genus Nephelopsis Verrill

Size large; much depressed posteriorly. Sperm duct forms a loop as in Erpobdella; atrial cornua prominent and a complete spiral turn. All annuli of complete somites more or less distinctly subdivided.

Nephelopsis obscura Verrill

Description - Like the species last described this is a rather large leech, attaining a length nearly equal to Erpobdella punctata and considerably exceeding it in the breadth of the posterior region of the body. Compared with other species of the family belonging to the Minnesota fauna the body is more depressed and in its posterior part very much broader than they. The margins are sharp and prominent. The region anterior to the clitellum is relatively slender and depressed with rounded margins. Texture hard and firm.

Nothing characteristic appears in connection with the mouth and lip which is rather broad. There are four pairs of eyes of about equal size; the anterior two pairs are situated nearly side by side in somite II, or the more lateral pair in a slightly more caudal position on the furrow II/III. Both are directed forward and slightly lateral. The remaining two pairs are situated farther back but similarly close together on the sides of the oral annulus IV. Usually they are on the posterior part of the larger annulus but their

pigment cups may lie beneath the furrow a2/a3. Both are directed caudad and laterad.

Fifteen annuli, Xb5 to XIIIa2 inclusive, are occupied by the prominent clitellum. The external genital orifices are separated by two annuli situated as in E. punctata at the furrows XIIb2/a2 and XIIb5/b6 respectively. In individuals which are in active sexual condition, the male orifice is a conspicuous opening more or less elevated on pouted lips marked by radiating furrows. Occasionally the genital bursa is everted as an elliptical disc with a central platform-like elevation by a single median pore or pair of pores, dependent on the more or less complete protrusion of the organ. In small individuals and those not sexually active the male pore is minute as the female invariably is.

The anus is a rather large transverse slit with wrinkled margins situated on XXVI and succeeded by several rather ill defined annuli belonging to XXVII. The caudal sucker is a thin, flat, expansive and largely exposed disc. Its dorsal surface is marked as in E. punctata by six or eight radiating ridges.

In one respect the reproductive organs are very characteristic. While in general resembling E. punctata the atrial cornua are larger and coiled in a complete spiral turn, which is invariably present in a large number of individuals of all sizes and conditions which have been dissected. The pre-atrial loops reach ganglion XI.

The ground color is generally gray, clay color or brownish, the latter occurring most frequently on plain unspotted examples. By far the greater number of specimens are thickly spotted over the entire dorsal surface with black. These blotches are not coarse and heavy as in Haemopsis marmoratis to which the species exhibits some

resemblance in color, but are finely branched and ramifying; with frequently anastomosed terminal branches, thus affecting a more or less continuous network. Sometimes the black spots are quite few and remote, again they become so prominent that the ground color is very largely obliterated and the dorsum presents a generally slate black color spotted more or less remotely with the lighter ground.

In any case, whether the spots be few or many, there is no evident metamerism in its pattern and no tendency toward the formation of longitudinal stripes, the pigment being quite as continuous across the middle line as elsewhere. Except in the very heavily blotched specimens, in which a few spots occur, especially toward the margins, the ventral surface is immaculate.

Habits - The exact geographical range of this species is not yet known but it is especially characteristic of the Mississippi valley and the lake region drained by the headwaters and tributaries of that river. It is exceedingly abundant in Wyoming, Wisconsin and Minnesota, but is known as far south as Alabama. The stomachs contain large numbers of insect larvae, which appear to furnish the chief sustenance, but also various species of Oligochaeta, aquatic snails etc. No opportunity has been afforded me to study the habits of this species but there is no reason to believe that they differ materially from those of E. punctata. Verrill has described the egg cases as "broad oval or elliptical, terminating in a point or mucro at each end, flat below, smooth and slightly convex above, with a thin margin. They were 5.5 mm. to 8 mm. long by 3.5 mm. to 4 mm. broad."

Genus Dina R. Blanchard.

Size rather small; not greatly depressed posteriorly. Sperm duct not forming a long anterior loop reaching to ganglion XI; atri-

al cornua small. Last annulus of each somite obviously enlarged and subdivided.

Dina anoculata Moore

Description from Moore (1898)

Behind the genital region the body is much flattened, and both width and depth remain nearly constant from the cliteillum nearly to the posterior sucker. Toward the posterior end it becomes slightly narrower, and then margins approach in a curve and pass into a broad acetabular peduncle. The margins of the body are rather obtuse, except on this posterior curve, where they are sharp and compressed. The acetabulum is small, less than half the greatest width of the body, and faces ventrad. From the genital region the body decreases in breadth and increases in relative depth toward the anterior end, which is quite terete. The mouth is very large, the opening in the individual measured being nearly 1 mm. It is round and owing to the shortness of the prostomium, scarcely oblique. It is bounded by the prostomium, the first and second annuli.

The prostomium consists of a larger lip and a narrower posterior incomplete annulus. It presents a median lobe beneath, bounded by a pair of sulci. There are in all 105 annuli behind the prostomium. The second one is complete and bounds the mouth posteriorly. Its free margin is crenulated. The first three somites consist of a single annulus each, the fourth and fifth annuli of three each, while somites VI to XXIII are complete consisting of five annuli each. In all of these the third or middle annulus is enlarged, and shows evidences of subdivision into two tertiary annuli. The annulus anterior to the male pore

and occasionally other annuli, show a similar biannulation. Somite XXIV has three annuli, and XXV and XXVI one or incompletely two. The anus is situated between somites XXIV and XXV.

The male pore lies between annuli 34 and 35 (somites X and XI) It is a conspicuous opening surrounded by a circle of papillae, situated at the summit of a prominent, broadly conical elevation which affects three annuli in front as well as behind. Annulus 34 is biannulate. The inconspicuous female pore is situated between annuli 36 and 37.

The ground color of alcoholic specimens is dull yellow, immaculate below and on the margins, but largely replaced above by four longitudinal stripes of grayish or dull black, of which the outer pair are submarginal, duller in color, and narrower than the more distinct inner pair, which are well separated by a median stripe of the ground color. Anterior to the clitellum the two stripes on each side become confluent, but at the same time more diluted with the ground color, and finally broken and replaced by the widening middle stripe. This anterior expansion of the middle stripe is clear yellow and peculiar in the distinctness with which the longitudinal muscles are there visible. In many specimens the two dark stripes are partly or wholly confluent behind as well as in front of the clitellum. In such the lateral light stripes become merely a succession of more or less confluent spots, or entirely wanting. All degrees of transition between two and four striped varieties are found the former giving the impression of light, the latter of dark, colored worms. The median and marginal stripes are always well marked. Posterior sucker yellow. No pigmented eyes. Length of larger specimen 12.5 mm.

Dina parva Moore

Description - A number of small and imperfectly preserved leeches from Gull Lake show characters which readily distinguish them from any species of Dina previously described. The species exhibits certain resemblances to D. fervida,

None of the specimens at hand exceed an inch in length in the partly contracted state and if alive and extended would not be more than an inch and a half. Posteriorly the body is relatively wide and flat but anteriorly becomes nearly circular behind the mouth. The mouth and lips have the customary form. Unlike most of our American species there are four pairs of conspicuous black eyes, though variations in which one or both of the anterior lateral ones are absent occur in about ten percent of those studied. The anterior eyes are larger than the posterior, those of the two pairs almost in contact and their pigment cups situated well within somite III. The posterior eyes are smaller, looking outwards and backwards from the lateral faces of the posterior part of IV.

The genital orifices are separated by a greater distance ($3\frac{1}{2}$ annuli) than is the case in any known American species. The male pore is a conspicuous transverse opening elevated on a broad low papilla in the middle of XIIa2, and the female a very minute opening between the annuli XIIIb1/b2. Considerable variation in the posterior direction, occurs in the position of the male pore. No variations in the position of the female pore have been observed. Nothing of importance can be noted regarding the nephridiopores, anus or posterior sucker.

Both somites II and III appear to be biannulate and at least the outermost pair of eyes of the anterior group are well within the

latter. Somite V is also biannulate, VI triannulate and VII quadriannulate. Beginning with VII annulus b6 shows its larger size and by IX is fully subdivided. In most of the complete quinquannulate somites, of which there are 17 (VIII to XXIV), this large size of b6 and its subdivision is clearly manifested. Toward the caudal end XXV is quadriannulate, XXVI triannulate and XXVII two or three small rings behind the anus.

Apparently the testes are smaller and more numerous than usual in the family. The specialized anterior portion of the vasa deferentia extends through a smaller number of somites than usual, the sperm sac reaching from ganglion XVI to XIV or thereabout, with in which region it is of large size and much folded. The pre-atrial loop of the ejaculatory canal reaches to ganglion XI and just before entering the atrial cornua the duct is folded laterally several times. The atrium itself has simply curved horns. Its median part crowds the twelfth ganglion somewhat caudad out of its usual position.

Whatever pigment may have been present has faded out completely in the preserved material. Nothing is known concerning the habits of this species.

Dina microstoma Moore

Description from Moore (1901)

This is a generally slender species. Well-preserved specimens are nearly terete and in extension linear. Total length 42 mm. Complete somites quiquannulate, b6 enlarged and subdivided; first pair of eyes in III; male orifice at XIIb2/a2, female orifice at XII/XIII; median chamber of atrium relatively and without median groove; prostate cornua inconspicuous, shorter than diameter of

median chamber; vasa deferentia^e lacking anterior loop and ending abruptly at the atrium.

The width is greatest at about the middle of the body but varies little in the entire postclitellar 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 papillae arranged in zones on every annulus.

The mouth is small, the upper lip extended, slender and prominent and is often most sharply distinguished from the succeeding annuli by a deep furrow which passes behind the post-oral 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 situated on somite III, instead of 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 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 usually present. It

is thick both dorsally and ventrally, sharply defined and extends over 15 annuli. 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 papillae disposed in pairs mark the upper surface. Anus large, with a much wrinkled margin, XXVI/XXVII.

The external features of metamerism in this species differ but little from those of *E. punctata*.

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 indicated in figure. 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. The efferent male apparatus of this species has many characters in common with *D. fervida*. The median chamber 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 are small and their attachments far apart on the dorsal surface of this chamber, with which they remain in loose 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 present no peculiar features.

Not one of the 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.

Dina fervida (Verrill) Moore

Nephelis fervida Verrill (1874)

Description - The length of this species is not known to exceed three inches and more often reaches but two. The body is depressed posteriorly but rounded anteriorly. The mouth is relatively large and the lips broadly rounded. More characteristic is the large size of the caudal sucker which has a greater expanse than in most of the small nephelids, the anterior margin being more widely free and reaching as far forward as XXVa2. If one may judge from the preparations the body is not of particularly firm consistency; certain it is that the muscular system is less well developed than in the hard species. The usual thick prominent clitellum reaches from Xb5 to XIIIa2 covering 15 annuli. The external genital orifices are separated by two annuli, the male being situated at XIIb2/a2, the female at XIIb5/b6. Three pairs of eyes are more usual than four. They resemble those of E. punctata except that the pigment cups of the first pair lie chiefly within somite III.

There is little of diagnostic value in the annulation. Some features of the sense organs are peculiar but have no considerable value in defining species. The last annulus (b6) of each somite is much longer and more fully and constantly subdivided than any of the others, as in other members of the genus.

The species is very readily distinguished from D. parva by the

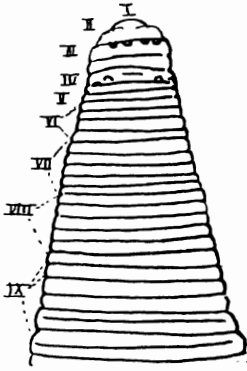
Character of the reproductive organs. The testes occupy the lateral portions of somites XVIII to XXIV, and average in the one individual in which they were all counted 32 on each side of a somite. The several regions of the sperm ducts exhibit no peculiarities until the atrium is reached. Here the entire absence of a preatrial loop is noted, the ejaculatory canals stopping abruptly at the apices of the atrial cornua into which they enter. When the copulatory organ is fully retracted the ducts form no loop whatever anterior to the atrium itself but when, in protrusion, the cornua are drawn somewhat caudad, they sweep somewhat anterior to it in a broad curve. The atrium itself is characterized by the relatively large size and quite undivided form of the median portion and the widely divergent short cornua. In these respects and also in the fact that the prostate gland covers the dorsum of the median chamber as well as the bases of the cornua, this species resembles D. microstoma most closely.

Two distinct color varieties occur, both of which have a dusky red color, during life, due to the blood. In one, pigment appears to nearly or quite absent, a condition which characterizes all of the young and a few of the adults. The older and more usual variety has the dorsum marked with more or less numerous minute black flecks which vary greatly in number and somewhat in arrangement. Many of the specimens are so little pigmented as to appear quite light colored; such are usually marked with a pair of dark longitudinal stripes one on each side of a clear median area, in others these stripes become very broad and in still others the whole dorsum except the margins is deeply pigmented.

Habits - So far as now known Dina fervida belongs to the fauna of

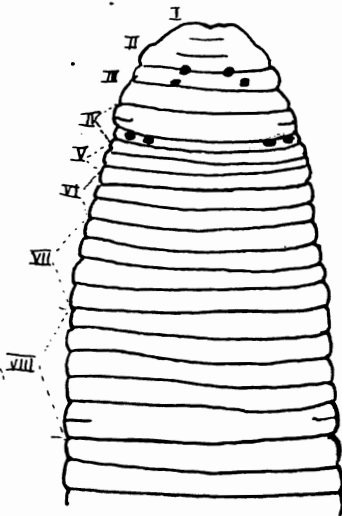
the Great Lakes and the immediately surrounding region, where it is quite common. The food contents of the stomach consist largely of tubificid worms and some insect larvae. Verrill has described the egg capsules which are attached to the leaves of Nuphar as "broad-oval or elliptical, above smooth and convex, translucent yellowish brown, with a thin, flat lighter border, each end prolonged into a tubular neck, with a terminal orifice. Lower surface flat." They measure from 9.5 to 11.5 mm. long which seems remarkably large for a species of the size of this.

Plate VII



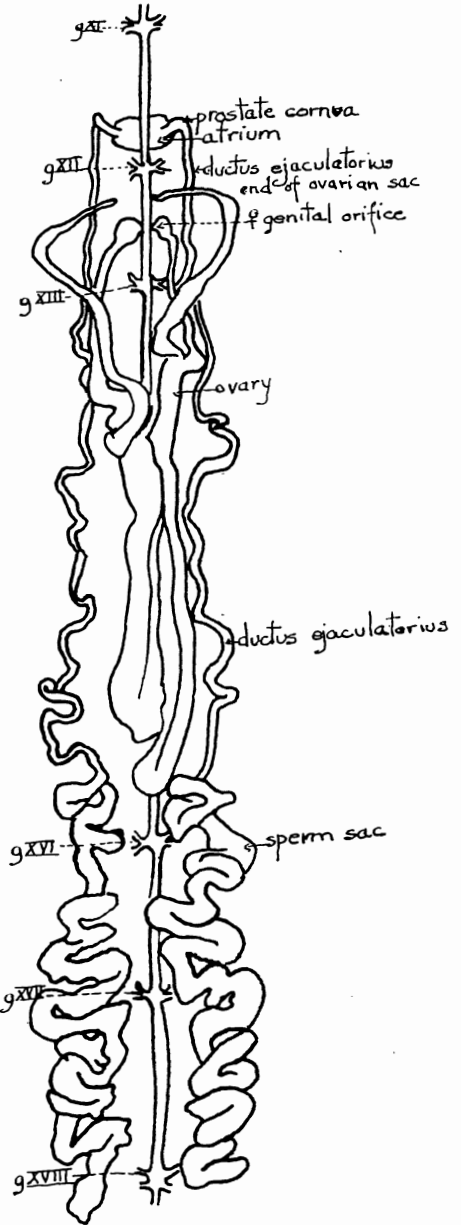
Nephelopsis obscura

Fig. 1.



Dina parva

Fig. 2



Dina microstoma

Fig. 3

Plate VII.

Figure 1. Anterior nine somites of Nephelopsis
obscura showing location of eyes.

Figure 2. Anterior eight somites of Dina parva
showing location of eyes.

Figure 3. Dorsal view of reproductive organs of
Dina microstoma in relation to nerve
ganglia. Testes omitted.

Douglas Lake Observations.

Glossiphonia stagnalis, (Linn.) Johnston.

Fourteen specimens were collected between the dates of June 27 and July 24 at Fontinalis Run, Beaver Pond in Wilderness Park, and Douglas Lake near the mouth of Bessey Creek and at North Fishtail Bay. Two specimens collected on June 29 had young attached. In all cases the specimens were collected from the under sides of sticks and stones on a sandy bottom in slightly moving water at a depth of 4" to 10". The temperature range was from 23°C. to 25.5°C. Extended length ranged from 10 to 18 mm. Description and habits agreed with the type. This is an active dark-seeking leech and easily identified by the brown nuchal gland plate. When a small piece of liver was placed in the dish, the leeches responded quickly, investigated the piece, and then became indifferent. They fed on frog muscle.

Glossiphonia fusca, Castle.

Twenty-one specimens were collected from July 10 to Aug. 4, two of the "lineata" type from North Fishtail Bay, Douglas Lake, and seventeen of the "fusca" type from Beaver Pond in Wilderness Park, and Fontinalis Run. All were collected from under sticks and stones on a sandy bottom from 2" to 6" depth. The water was slightly moving and ranged from 22°C. to 25°C. in temperature. Extended length was around 20 mm. Several of the "fusca" type were carrying young. Two much smaller ones, measuring about 7 mm. in length, with their ceca beautifully marked in red, were collected by Dr. Cort in the mantle cavity of

the snail, Helisoma trivolvis, which came from Grand View swamp near Mullett Lake.

There is a striking difference between the two types of G. fusca. Those collected in Douglas Lake were relatively smooth and beautifully striated with double brown lines each composed of short transverse striations. Those from Wilderness Park were papillated and showed little coloring. In only one case were the papillae black. These leeches showed no interest either in liver or frog muscle exhibiting rather a tendency to avoid it.

Glossiphonia complanata, (Linn.) Johnston.

This leech was plentiful. Fifty-six specimens were collected between June 27 and Aug. 12 at Fontinalis Run, Beaver Pond in Wilderness Park, Nigger Creek, and near Bessey Creek and at North Fishtail Bay in Douglas Lake. They were found under sticks, boards, stones and on shells on either a sandy, muddy or debris substrate in slightly moving water at depths ranging from 1" to 8". Temperature ranged from 18°C. to 25.5°C. Extended length ranged from 18 to 25 mm. Color range was very great from very light to almost black but always speckled and with two distinctive longitudinal lines both dorsally and ventrally. A number of juveniles were found but no egg-bearing adults. Three of the smaller juveniles had the ceca brilliantly marked with red.

Placobdella pediculata, Heminway.

The one specimen in the collection under this label was originally identified as ~~as~~ P. picta. Dr. Eggleton placed it tentatively under P. pediculata because of its exceptionally large posterior sucker. It was collected at Fontinalis Run on June 27

under a stick on sand where the water was warm and moving very slightly.

Placobdella parasitica, (Say) Moore.

Fourteen specimens were collected between the dates of July 2 and July 31 at Fontinalis Run, Nigger Creek, Beaver Pond in Wilderness Park, in Bessey Creek and North Fishtail Bay in Douglas Lake and in Ocqueoc Lake. This leech was invariably found singly and not associated with other species, attached to limbs of trees and frequently stretched at full length apparently searching for a host. It is very quick to seize upon any likely object. All specimens were found near the surface of the water except the one collected at Ocqueoc Lake which was on the under side of a log at a depth of 18". The extended length of adults ranged from 75⁺mm. to 100 mm. and the juveniles ranged from 18mm. to 35 mm. Temperature ranged from 18°C. to 25°C. These leeches evidenced interest in liver and frog muscle but were not observed to eat any of either.

Placobdella picta (Verrill)

Twenty-one specimens of this attractive little leech were collected July 7 to Aug. 12 from under sticks and on algae at Nigger Creek, Fontinalis Run, and Beaver Pond in Wilderness Park. The water in each case was moving slightly, the temperature was high, 23°C. to 25.5°C., and the substrate was muddy. The extended length ranged from 18 mm. to 25 mm. Younger forms investigated the piece of liver but the adults ignored its presence and neither ate it. Also, they showed little interest in frog muscle.

Placobdella rugosa (Verrill) Moore

Fourteen specimens of a typical P. rugosa were collected at

Beaver Pond in Wilderness Park, Fontinalis Run, Nigger Creek, and North Fishtail Bay in Douglas Lake, June 29 to July 18. They were found under sticks and stones at a depth of 3" to 12", temperature range from 18°C. to 25.5°C., on both mud and sand substrates. In all cases there was some water movement. A number of individuals were collected carrying eggs and in three cases the eggs hatched in the laboratory. Young were preserved and mounted. Attempts to mount adults carrying young were not very successful as the young detached when placed in relaxing fluids. Young shortly after hatching showed the seven pairs of gastric ceca clearly marked in yellow. Freshly hatched young have two hooks at the anterior end but these are soon replaced by the anterior sucker. The length range of these typical P. rugosa was from 40mm. to 60 mm. when extended.

A smaller form which otherwise shows all of the characteristics and habits of a typical P. rugosa was collected at Fontinalis Run, Beaver Pond in Wilderness Park, and Little Lake 16, July 18 to Aug. 5. The eight different specimens of this group ranged in length from 16 mm. to 30 mm. and one specimen was carrying young. Some of the young which cannot be distinguished from the young of the typical form, were preserved and mounted.

Piscicola punctata (Verrill)

Three specimens of this fish parasite were collected from the base of the dorsal fins of small rock bass (Ambloplites rupestris) taken in South Fishtail Bay of Douglas Lake on July 27. They measured 10 mm. in extended length. They were very noticeable in life attached by the posterior sucker and waving out in the water, but were not difficult to detach. The fish were brought in by Dr. Greaser.

Macrobdeella decora (Say) Verrill

Seventeen specimens of this leech were collected between July 2 and Aug. 5 from Nigger Creek, Fontinalis Run, Beaver Pond in Wilderness Park, near the mouth of Bessey Creek and North Fishtail Bay in Douglas Lake, and at Little Lake 16. They were found free-swimming, under stones and limbs, and attached to the collector's legs. They tend to drop from a stone when it is lifted and swim rapidly away. The substrate may be either sand or mud and they are frequently found in the vicinity of water lilies, both Nuphar and Nymphaea. The water was always moving slightly and its temperature ranged from 18°C. to 26°C. Extended length of adults varied from 60 mm. to 160 mm. On Aug. 5, five juveniles were collected at Little Lake 16, which ranged in extended length from 25 mm. to 40 mm. These leeches reacted to the presence of liver in the water but were slow in locating it. After doing so they twined about the piece for a short time but soon left it. Frog muscle was sucked.

Haemopsis marmoratis (Say) Moore.

Only one specimen of this leech was collected and this from the mud along the shore of Nigger Creek on July 13. The temperature was 18°C. and the depth 10". The extended length was 100 mm.

Haemopsis grandis (Verrill)

Two specimens of this large leech were collected, one at Elk Lake near Traverse Bay on July 5. It was seen to crawl under a board at about a 6' depth. The extended length was 220 mm. The color was a dull yellow all over with only occasional small black blotches. It was extremely limp and flabby when picked up. A second specimen of similar size but with a few more black markings was secured by dredging in Cheyboygan River on July 28.

Erpobdella punctata (Leidy) Moore.

This was by far the most abundant leech collected and not half of those seen were collected. One hundred and sixteen were taken from June 24 to Aug 12 at Grapevine Point, near the mouth of Bessey Creek and North Fishtail Bay in Douglas Lake; Beaver Pond in Wilderness Park; Nigger Creek, Munroe Lake, and Little Lake 16. As a general rule they were found under stones on a sandy bottom at 3" to 10" depth. The water was slightly moving and ranged in temperature from 20°C. to 25°C. Extended length ranged from 50mm. to 70 mm. for adults. Capsules were found abundantly from June 24 until August and some were laid in a finger bowl in the laboratory on July 28. The young were very transparent but grew and darkened rapidly. These leeches reacted promptly to the presence of liver and attacked it vigorously. There was considerably less trial and error in locating food than with other leeches, the tendency being to swim directly to it. They did the same with frog muscle. After eating, they relax quietly, usually in clusters intertwined especially in a dish where no concealment is provided.

Nephelopsis obscura Verrill

Nineteen specimens of this leech were collected on July 13 and Aug. 12 at Nigger Creek, Fontinalis Run and Grapevine Point in Douglas Lake. One was in the mud beneath the water, the others under stones and sticks at a depth of 8" to 12". The temperature of the water ranged from 18°C. to 25.5°C. and it was moving slightly. The extended length ranged from 30 mm. to 90 mm. The ground color was a slate gray thickly spotted with black. Egg cases were found on lily pads which hatched within a few days. Within two weeks these young leeches were showing the typical markings of the species.

When fed liver, they were all twining about the piece within a few minutes and burrowed their mouths deeply into it. They behaved the same with frog muscle. They show the same tendency to twine about each other as exhibited by E. punctata.

Dina fervida (Verrill) Moore.

In spite of the fact that this is reported to be a very common leech in the Great Lakes region, only three specimens were collected, all at Fontinalis Run on June 27. They were attached to the under side of a stick near the mouth of the Run which was blocked at that time hence the water was quiet and rather warm. The substrate was sand. The extended size was about 28 mm.

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