

SOME TASMANIAN HIRUDINEA

By

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(With 61 Figures)

ABSTRACT

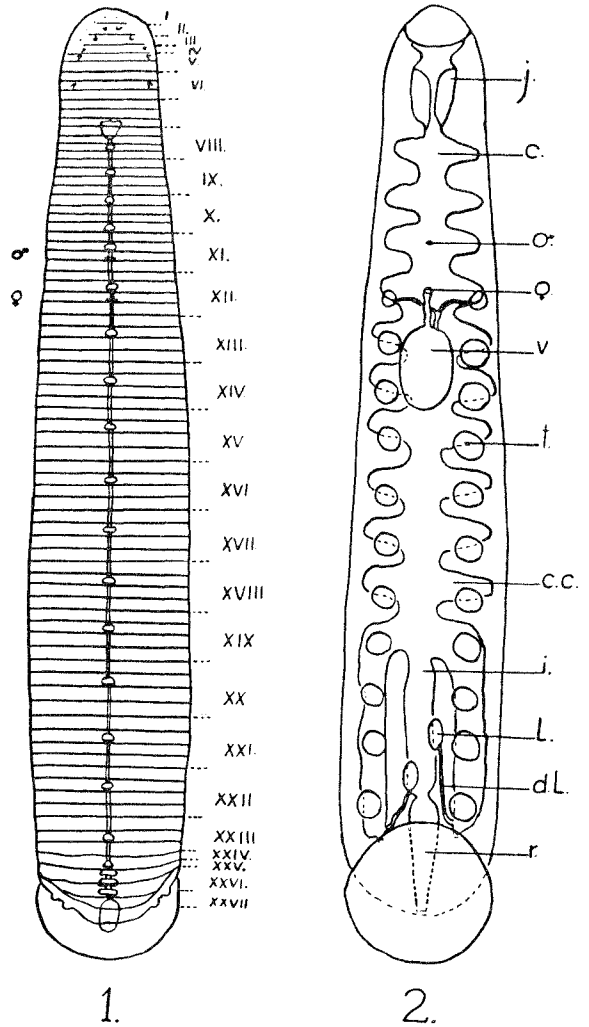
Descriptions are given of two species of Haemaphysidae, one, *Philaemon grandis* sp. nov., the other *Philaemon pungens* Blanchard. The egg-capsule and newly hatched young of the latter species are also described. *Limnobdella australis* (Bosisto) (*Hirudinidae*) is recorded for the first time as occurring in Tasmania. Three new species belonging to the Piscicolidae are also described, namely *Austrobdella bilobata* from *Rhombosolea tapirina* Gunther, *Trachelobdella leptocephali* from the gills of *Leptocephalus conger* (Linnaeus), and "*Ichthyobdella*" *platycephali* from *Platycephalus bassensis* Cuvier and Valenciennes. A brief description of the egg-capsules and young of *Austrobdella bilobata* is also included. In addition, some account is given of specimens of *Branchellion parkeri* Richardson, taken from *Raja lemprieri* Richardson, *Pristiophorus* sp. and *Dasyatis* sp. Further information concerning *Pontobdella tasmanica* (Hickman), its occurrence on a piece of seaweed, and also on a skate, is provided. Three members of the Glossiphoniidae, namely, *Glossiphonia tasmaniensis* sp. nov., *Glossiphonia australiensis* Goddard, and *Placobdella bdellae* sp. nov., are described, the last named species occurring in the buccal cavity of the pouched lamprey *Geotria australis* Gray. The structure of the nephridia in *Glossiphonia australiensis* Goddard is given for the first time.

INTRODUCTION

Three leeches have been recorded previously from Tasmania, namely *Glossiphonia australiensis* Goddard, 1908, *Philaemon pungens* Blanchard, 1898, and *Pontobdella tasmanica* (Hickman, 1942). In the present paper additional records and notes are given on these three species. A new occurrence of *Limnobdella australis* is recorded; an account is given of a Tasmanian example of *Branchellion parkeri*; and the following new species are described:—

1. *Philaemon grandis*.
2. *Austrobdella bilobata*.
3. *Trachelobdella leptocephali*.
4. "*Ichthyobdella*" *platycephali*.
5. *Glossiphonia tasmaniensis*.
6. *Placobdella bdellae*.

Type specimens, some of which are serial sections, are in the Department of Zoology, University of Tasmania.

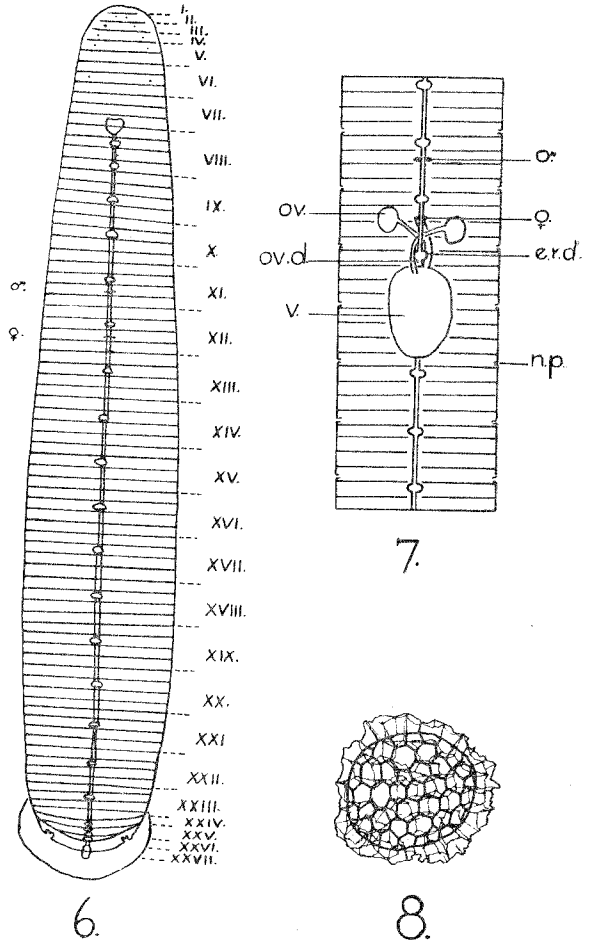
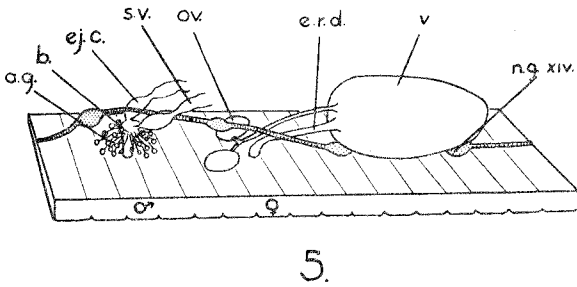
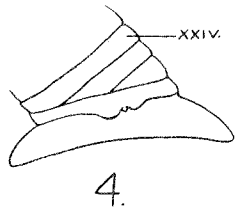
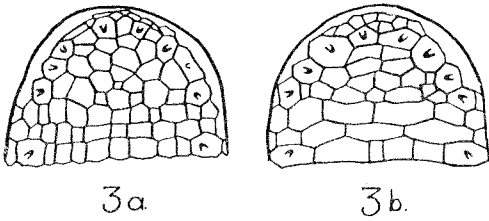


1. *Philaemon grandis* sp. nov.

FIG. 1.—Diagram of the dorsal surface of the body. The positions of the ganglia of the ventral nerve cord are shown. The somites (excluding those of the posterior sucker) are numbered I to XXVII.

FIG. 2.—General anatomy, ventral view. The male reproductive ducts are omitted.

c. crop; c.c. crop caecum; d.L. duct of Lambertian organ; i. intestine; j. jaw; L. Lambertian organ; r. rectum; t. testes; v. vagina; ♂. male reproductive aperture; ♀. female reproductive aperture.



Philaemon grandis sp. nov., and *P. pungens* R. Blanchard, 1898

FIG. 3 a.—Dorsal view of the head of *P. grandis* showing the irregular arrangement of the tessellae.

FIG. 3 b.—Dorsal view of the head of *P. pungens* showing the regular arrangement of the tessellae.

FIG. 4.—Lateral view of the caudal region of *P. grandis* showing the left auricle.

FIG. 5.—Diagram of the reproductive organs of *P. grandis* lying in somites IX to XIV. Only the terminal portions of the seminal vesicles are shown. The testes are omitted.

a.g. male accessory glands; b. bursa; e.j.c. ejaculatory horn; e.r.d. external reproductive duct; n.g.XIV. ganglion XIV; o.v. ovary; s.v. seminal vesicle; v. vagina; XXIV. somite XXIV; ♂. annulus bearing male reproductive aperture; ♀. annulus bearing female reproductive aperture.

Philaemon pungens R. Blanchard, 1898

FIG. 6.—Diagram of the dorsal surface, showing the somite limits and the positions of the ganglia. The somites (excluding those of the posterior sucker) are numbered I to XXVII.

FIG. 7.—Diagram of the female reproductive organs, in dorsal view.

FIG. 8.—Egg-capsule, drawn from a photograph.

e.r.d. external reproductive duct; n.p. nephridiopore; ov.d. oviduct; v. vagina; ♂. male reproductive aperture; ♀. female reproductive aperture.

Family HAEMADIPSIDAE

Genus *PHILAEEMON* R. Blanchard, 1897

DIAGNOSIS EMEDED

Haemadipsidae with the normal somite 4-annulate; 2 denticulate jaws present; auricles present; 10 pairs of testes; Lambertian or posterior organs of the alimentary canal present.

A large species of *Philaemon* occurs in Tasmania and the specific name *grandis* is proposed as being descriptive of its size.

PHILAEEMON GRANDIS sp. nov.

(Figures 1-3 a, 4, 5, 11)

DIAGNOSTIC FEATURES

P. grandis is a large species of *Philaemon*, first found in western Tasmania. The colour pattern is marked by longitudinal dark stripes. The head-tessellae are numerous and irregularly arranged. The number of rays in the posterior sucker is 76. Somites I-IV are 1-annulate, V is 2-annulate, VI-VII are 3-annulate, VIII-XXIII are complete, 4-annulate, and XXIV-XXVII are 1-annulate. The reproductive apertures are separated by $\frac{1}{2} + 3 + \frac{1}{2}$ annuli, the male being on 27, and the female on 31. Male accessory glands are present. The first pair of nephridiopores opens on the buccal margin between the somites bearing the second and third pairs of eyes, and the last pair opens beneath the auricle lobes; the remaining 15 pairs open laterally on their respective somites. The nephridial vesicles are very large. Posterior or Lambertian organs of the crop are present in somites XXI and XXII.

External Features

The leech measures 36.5 mm. long, 6 mm. wide, and 3 mm. high. The posterior sucker is 5 mm. wide by 4.5 mm. long.

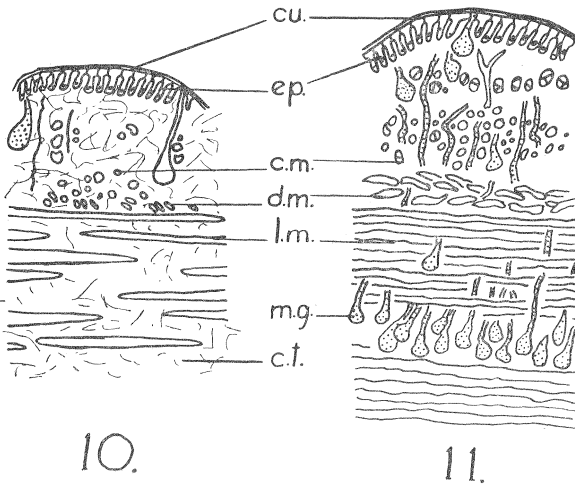
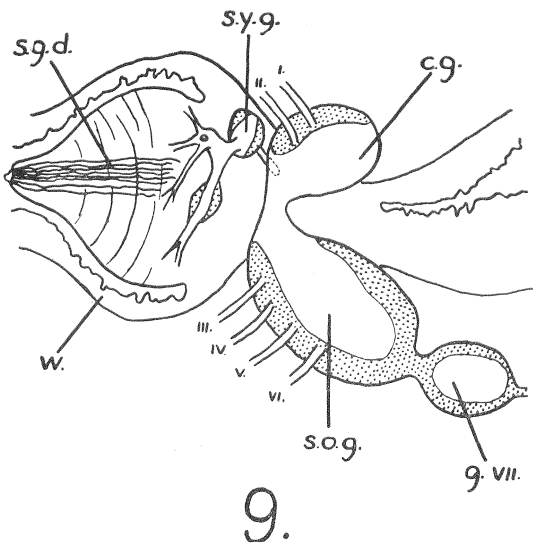
The head region is distinct and rounded. The surface is marked by a tessellated pattern corresponding to the first five annuli. Behind this, distinct annuli are clearly visible. The total number of annuli is 80.

The outer surface of the posterior sucker is tessellated, the areas being small, polygonal, and separated by deep furrows. The inner surface has a central tessellated region from which radiate muscle ridges. These are 76 in number, and are rounded. There are no papillae. The sucker is largely hidden beneath the body.

The anterior sucker is not constricted off from the body, but is a shovel-shaped depression on the ventral surface of the head. At the posterior end of the sucker is a deep buccal cavity at the base of which lies the mouth. This is provided ventrolaterally with two dentate jaws. On the dorsal surface of the head are five pairs of eyes; these belong to somites II, III, IV, V and VI. There is a precocular region constituting somite I. The eyes lie on annuli 2, 3, 4, 5 and 8. The eyes of the third pair are ill-defined, being less heavily pigmented than the others.

Annulus 6 is the first complete annulus. Together with 5, with which it is fused ventro-laterally, it forms the posterior lip of the sucker.

At the posterior end of the body the 77th is the last complete annulus; then follow two incomplete ones. The 78th extends from the ventro-lateral position across the dorsal surface; the 79th annulus is shorter, extending across the region of the auricles. The 80th annulus, on the dorso-lateral borders of which are the auricles, is complete.



Philaemon pungens R. Blanchard and *P. grandis* sp. nov.

FIG. 9.—Lateral view of the anterior ganglionic mass and the left sympathetic ganglion of *P. pungens*. The nerves are numbered I to VI.

FIG. 10.—Transverse section of the body-wall of *P. pungens*.

FIG. 11.—Transverse section of the body-wall of *P. grandis*.

c.g. cerebral ganglion; c.m. circular muscles; c.t. connective tissue; cu. cuticle; d.m. diagonal muscles; ep. epidermis; g. VII. ganglion VII; l.m. longitudinal muscles; m.g. mucous glands; s.g.d. ducts of salivary glands in the jaw; s.o.g. sub-oesophageal ganglion; sy.g. sympathetic ganglion; w. wall of pharynx.

The auricles are 3-lobed, flange-like appendages. The middle lobe is small and triangular, and the first and third are larger, with thin membranous margins. The interlobular sinuses are rounded.

The reproductive apertures are separated by $\frac{1}{2} + 3 + \frac{1}{2}$ annuli, the male being on 27, and the female on 31.

Nephridiopores are visible on the caudal borders of the first annulus in somites IX to XXIII inclusive. Thus at first sight there appear to be only 15 pairs of nephridiopores. However, from sections, two additional pairs can be distinguished, the first opening on the buccal margin between the second and third pairs of eyes, and the last opening on the posterior sucker, beneath the auricle lobes.

In living specimens, the dorsal surface of the body has a mid-longitudinal brown stripe. On either side of this are bright yellow patches which are segmentally arranged. In the mid-body region they coalesce, forming irregular longitudinal stripes. On either side of these, and taking up the greater part of the dorsal surface, are brown bands. To the naked eye these appear dark-brown, but under magnification they are seen to be mottled brown and green. The lateral margin of the body is marked by a narrow yellow stripe, which becomes a series of segmental patches in the posterior body region. The ventral surface is a uniform light-brown, as is the marginal part of the outer surface of the posterior sucker.

In preserved specimens, the ventral surface, sides of the body, the entire posterior sucker, the 80th annulus, and the auricle lobes are pale yellow. The dorsal surface of the body is brown, and it is marked by four longitudinal darker-brown stripes in the paramedian and paramarginal positions. The green pigmentation is lost on preservation.

This leech is capable of considerable extension. Three living specimens collected in a gully at Trevallyn had the following lengths (in the resting condition): 5.5 cm., 3.5 cm. and 2 cm. The largest specimen was capable of extension up to about 10 cm. The average distance between successive positions of the posterior sucker, when progressing over a flat surface (a laboratory bench), was 7.3 cm.; the leech moved in a straight line. The medium sized specimen was capable of extension up to about 7 cm., and the average length of one loop was 4.5 cm. The smallest specimen covered a distance of about 3 cm. in each loop.

The characteristic resting position of *P. pungens* is with the posterior sucker attached, either to the base or to the sides of the container, and with the rest of the body free. Specimens of *P. grandis* rarely are seen in this position but most frequently lie under any available cover on the bottom of the container.

Philaemon grandis is not an active leech, the specimens kept in a jar remaining motionless unless touched or blown upon. Unlike *P. pungens*, *P. grandis* soon relaxes into a state of inactivity again.

Internal Anatomy

(a) *Body-wall and musculature*: The body is covered externally by a thin cuticle, beneath which is a layer of columnar epidermal cells. These two together form a layer 18μ thick. Among the

epidermal cells are mucous gland cells. These are as much as twice as long as the epidermal cells, and project into the sub-epidermal connective tissue layer. Similar gland cells also are found among the muscle layers. They are very numerous in the region of the female reproductive aperture.

The musculature is very well developed. The body wall consists of three sets of muscles, an outer layer 160μ thick, of circular muscles, a middle layer 160μ thick, of diagonal fibres, and an inner layer 250μ thick, of longitudinal muscles. The muscle layers are embedded in connective tissue which extends from beneath the epidermis throughout the body between the various systems.

(b) *Circulatory system*: There are three main longitudinal vessels, one dorsal and two lateral. The dorsal vessel is thin-walled and non-muscular; it is derived from the dorsal lacuna. It gives off segmental branches.

The lateral vessels have walls thickened with rings of circular muscles. These vessels have a course which undulates laterally. The lateral vessels give off segmental capillaries, which supply the nephridia. The capillary walls are muscular proximally, becoming less so distally.

The dorsal and lateral vessels are connected anteriorly and posteriorly by capillary networks. A capillary network surrounds the intestine.

The ventral sinus lies in the midventral line. It is almost completely filled by the elements of the central nervous system. The sinus expands segmentally to accommodate the ganglia. The blood is red, and contains phagocytic amoebocytes. These have an average diameter of 8μ , and have a rounded nucleus.

(c) *Excretory System*: The excretory system consists of 17 pairs of nephridia, lying in somites VIII-XXIV. The nephridia are similar to those described by Lambert (1898, pp. 228-231) for *P. pungens*. The vesicles are very large, measuring 0.8 mm. long, 0.6 mm. wide and 0.2 mm. deep.

(d) *Alimentary Canal*: The mouth lies at the base of the buccal cavity. There are two jaws, ventrolateral in position. The jaws are covered with cuticle which is thickened at the free margin of the jaw, where it forms a row of about 50 denticles. The jaws are highly muscular structures, consisting of circular, dorso-ventral, and longitudinal muscles, the latter a continuation of those of the pharynx.

Running up the centre of each jaw are the ducts of the salivary glands, which surround the pharynx. These glands occur in four paired, ill-defined masses, which are, in relation to the pharynx, postero-ventral, postero-lateral, dorsal and antero-ventral. The ducts from each mass are bundled together and open into the pharynx in the ventro-lateral positions.

The inner surface of the pharynx is marked by three longitudinal ridges, one mid-dorsal and two ventro-lateral. In addition to circular, longitudinal and radial muscles, the pharynx has an external musculature of radiating muscles. These run from the body wall to the pharynx and hold it in position.

The muscular pharynx is succeeded in VII by the short oesophagus. This has thick glandular walls and a poorly developed musculature. The unicellular glands in the oesophageal wall of *P. pungens* are referred to by Lambert (1898, p. 225) as ramose oesophageal glands.

The oesophagus is succeeded in VIII/IX by the crop. This has an epithelial lining, 13μ thick, outside which are a few poorly developed circular muscle fibres. From the crop are given off 11 pairs of caeca, which lie laterally in IX to XIX inclusive. The last pair of caeca is elongated posteriorly, extending to XXIII.

Opening into the posterior caeca is a pair of ducts which run from the posterior or Lambertian organs. These are similar to those found in *P. pungens*, and lie in somites XXI and XXII, the right one anterior to the left. They measure 0.9 mm. long, 0.5 mm. wide and 0.4 mm. deep.

In XIX the main crop canal opens into the intestine. This is lined by a deep epithelium, 50μ thick. Closely associated with the intestinal epithelium is a rich network of blood capillaries. The lining of the intestine is somewhat folded, thus increasing the surface.

The rectum commences in XXII. It is a simple sac, and posteriorly opens to the exterior by the anus which lies behind the last annulus. The lining is an epithelium similar to that of the crop. The rectum becomes muscular towards the posterior end.

(e) *Reproductive System*: The male organs consist of 10 pairs of testes which lie intersegmentally in XIII/XIV to XXII/XXIII. The vasa deferentia pass forward and become greatly expanded as the seminal vesicles. The coils of these large thin-walled structures occupy the greater part of the body space in XI to XIII. The left vesicle, which is in XI to XII, is anterior to the right, in XII to XIII.

From the anterior ends of the vesicles, the tubes narrow and become the ejaculatory ducts. The walls of these are well supplied with circular muscle fibres, and are about 50μ thick. The diameter of the ejaculatory ducts decreases as they pass forward.

The two ducts open into the atrium of the bursa. This opens to the exterior by the slit-like male reproductive aperture in the 27th annulus. The bursa is lined by an epithelium, and has muscular walls. Surrounding the terminal portions of the male reproductive system are a large number of pear-shaped, unicellular glands. These have an average length of 30μ and a diameter of 20μ . The cytoplasm is granular, dark at the base, lighter near the duct. The nucleus lies in the dark basal region. The ducts of these glands open between the epithelium cells into the inner part of the bursa.

The female organs are a pair of ovaries lying ventrally in the posterior part of XII, between the seminal vesicles. From each ovary an oviduct passes back, the two oviducts joining in XII/XIII and continuing back as a single duct to the vagina. The duct has muscular walls and is lined by a low epithelium.

The vagina is large, extending from the middle of somite XII to XIII/XIV. In shape, it is ovoid, slightly larger anteriorly. The walls are thick and glandular.

At the anterior end, slightly ventral to the oviduct, is given off a duct which leads to the female reproductive aperture. This duct, referred to in *P. pungens* (Lambert 1898, p. 232) as the external reproductive duct, has very muscular walls, and is lined internally by a somewhat folded epithelium. Both the external reproductive duct and the oviduct are slightly coiled in XII.

(f) *Nervous System*: The anterior ganglionic mass lies above and below the pharynx, the two parts being united by connectives on each side of the pharynx. This anterior mass represents six ganglia. The ganglion of somite VII is closely united to the main anterior mass. Ganglia VIII to XXIII are widely spaced, lying in the ventral sinus, and connected by paired nerve fibres. Ganglia XXIV to XXVII have short connectives, and form an anal concentration. They are united to the caudal ganglionic mass, which consists of a fused mass of ganglia XXVIII to XXXIV.

Slightly median to the pharyngeal connectives and partly concealed by them are a pair of small ganglia located on the dorso-lateral surface of the pharynx. They are united by circumpharyngeal connectives, give off bundles of nerve fibres, and are the sympathetic ganglia.

Affinities

Philaemon grandis is closely related to *P. pungens*. A comparison of the two species is given in Table I.

The two species differ in the arrangement of pigment. *P. pungens* has a light mid-dorsal line between dark-brown lateral areas. On either side of the mid-line are light-greenish patches outlined in very dark-brown. *P. grandis* is much paler in general pigmentation and has four longitudinal dark lines.

TABLE I

Comparison of *Philaemon pungens* R. Blanchard, 1898 and *P. grandis* sp. nov.

Character	<i>P. pungens</i>	<i>P. grandis</i>
Size	12 mm. x 3 mm.— 25 x 4	36 mm. x 6 mm.
Number of rays in posterior sucker	58-60	76
Head tessellae	Few, regular	Numerous, irregular
Position of first pair of nephridiopores	Between the annuli bearing third and fourth pairs of eyes	Between the annuli bearing second and third pairs of eyes
Male accessory glands	Absent	Present
Female reproductive ducts	External reproductive duct dorsal to oviduct	External reproductive duct ventral to oviduct
Body wall muscles	Weakly developed	Very well developed

Distribution

P. grandis was first discovered at Temma on the west coast (one preserved specimen). Three other specimens were found at Trevallyn (three living), and two others have been collected but the locality not recorded.

PHILAEMON PUNGENS R. Blanchard, 1898

(Figures 3 b, 6-10)

DIAGNOSTIC FEATURES (Blanchard, 1917, p. 653)

'Somites I-III monomères; somites IV-VI trimères; somites VII-XXI normaux, tétramères; somite XXII également tétramère, les anneaux 2 et 3, se fusionnant partiellement sur les côtés de la face dorsale; somites XXIII-XXVI monomères. Nombre total des anneaux: 78. Pores sexuels séparés par quatre anneaux, l'orifice mâle percé en arrière du somite X (anneau 26), la vulve s'ouvrant en arrière du deuxième anneau du somite XI (anneau 30). Pores néphridiaux sur les parties latérales de la face dorsale. Mâchoires portant chacune environ 70 dents.'

Description

The Tasmanian specimens are very similar to those described by Lambert (1898) but show some minor differences. The relative positions of the female ducts are slightly different. In the Tasmanian specimens the external reproductive duct arises from the vagina in a position which is ventral to the point of entry of the oviduct. In the Mainland specimens it is described as being dorsal. The vagina is more anterior in the Tasmanian specimens.

The seminal vesicles are not so large in the specimen sectioned as in Lambert's specimen. This feature, however, is variable, as comparison with compressed whole mounts shows that they may attain quite a large size.

The marginal lip organs are very well-developed. Since these receive a separate nerve supply it is possible that they represent the sensory organs of a preocular somite, such as is recognized by Moore (1927) in *Haemadipsa* Tennent. If this is so, then the anterior ganglionic mass consists of 6 fused ganglia, instead of 5, making a total for the whole body of 34. This agrees with the number recognized in recent works.

In the Tasmanian specimens the anterior ganglionic mass lies further back in the body than it does in those described by Lambert. In the mainland specimens it lies in the 7th to the 9th annuli, while in the specimens before me it lies in the 12th to the 14th.

The sympathetic ganglia lie dorso-laterally on the pharynx-wall slightly anterior to the nerve fibres which pass on either side of the pharynx and unite the dorsal and ventral ganglia of the anterior ganglionic mass. From the sympathetic ganglia, which are themselves united by circum-pharyngeal connectives, nerve fibres are given off to the anterior part of the alimentary canal.

The posterior organs of the alimentary canal lie in somites XX, and XX/XXI. They measure 0.6 mm. long, 0.5 mm. wide and 0.4 mm. deep. The folded nature of the walls is difficult to see as the organs are filled with a granular secretion.

Egg Capsules: Egg capsules have been described for other members of the Haemadipsidae, but not for *Philaemon*. An egg capsule belonging to *P. pungens* was collected at Tarraleah on the 6.1.1954. In general structure it resembles that of *Haemadipsa* Tennent. The capsule is approximately spherical, measuring 7 mm. in diameter. It is pale-yellow in colour. Two regions may be distinguished, an inner capsule with a wall which is entire except for a small aperture at one end

through which the young escaped, and an outer region. The outer region is a honey-comb like structure arising from the inner capsule. It consists of about 100 polyhedral cells, open at the outer end. Many of the cells are irregularly hexagonal.

Thirteen young leeches emerged from the capsule. They were very slender, and measured about 5 mm. long. The first emerged on the 20.1.1954, and by the 4.3.1954, all had emerged. When the first emerged, there was no definite colour pattern, the young leech appearing a uniform dark-brown colour. At the end of about three months the colour pattern of *P. pungens* was evident. The young leech now measured 6 mm. long and 2 mm. wide; it was capable of extension up to 15 mm. long. No food was taken until the 11.3.1954, when the leeches were induced to suck the blood of a small frog, *Crinia signifera*.

Distribution

P. pungens is recorded by Lambert (1898, p. 211) as occurring in gullies in various parts of Victoria, N.S.W., and the Western Tiers, Tasmania. Blanchard (1917, p. 653) records it from Victoria, N.S.W., and Java. The specimens referred to in this paper were collected from the following localities in Tasmania:—

1. Ferndene, near Penguin.
2. Junction of Gould's Country and Pyengana roads.
3. Mount Wellington, several localities.

The species also occurs in the far south at Catamaran, and in the North-west, in the Denny Gorge.

Family HIRUDINIDAE

Sub-family MONISTICHODONTA

Genus *LIMNOBELLA* R. Blanchard, 1893

GENERIC DIAGNOSIS

Size medium to large. Colour pattern usually longitudinally striped, but occasionally spotted or solid. Eyes five pairs, well-developed. Somites IX-XXIII or XXIV 5-annulate and complete. Male and female gonopores very constantly at XI and XII b5/b6. Differs from *Macrobella* in lacking copulatory glands, and from *Whitmania* in that somite VI is 3-annulate. Jaws small, armed with strong teeth.

LIMNOBELLA AUSTRALIS (Bosisto, 1859)

(Figures 12-14)

Leeches referable to this species occur on the west coast of Tasmania. The specimen from which the following description of the external features was made, was collected near the Pieman River.

External Features

(a) *Size:* The total length is 52 mm. The maximum width is 5 mm. The posterior sucker is 3 mm. wide, and 2.5 mm. long.

(b) *Shape:* The body of the leech is elongated and sub-cylindrical; it is slightly depressed in the mid-body region. Here the sides of the body are sub-parallel, but converge markedly towards the ends.

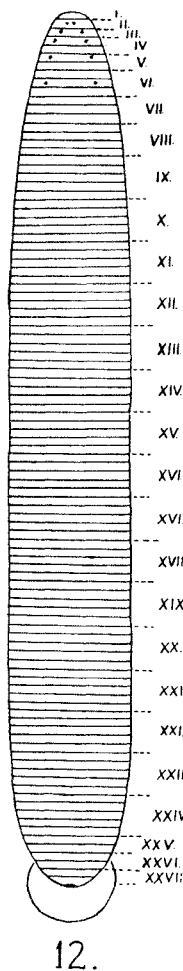
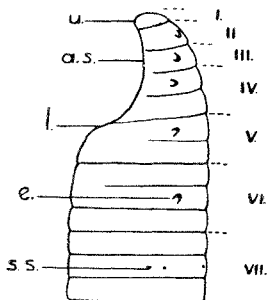
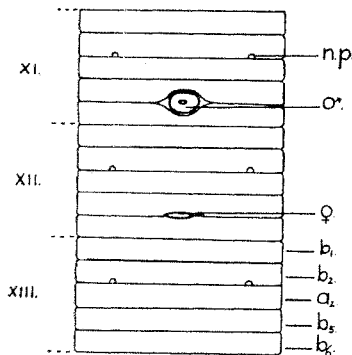


FIG. 12.—*Limnoddella australis* (Bosisto, 1859)
FIG. 12.—Dorsal view of the entire animal, showing the somite limits. The somites are numbered I to XXVII (excluding those of the posterior sucker).



13.



14.

FIG. 14.—Diagram of the ventral surface of the body in the clitellar region.

a2. sensory annuli; a.s. anterior sucker; b1, b2. presensory annuli; b5, b6. post-sensory annuli; e. eye; l. lower lip of the anterior sucker; n.p. nephridiopore; s.s. segmental sensilla; u. upper lip of the anterior sucker; ♂. male reproductive aperture; ♀. female reproductive aperture.

At the anterior end are a number of incomplete annuli which form the anterior attachment area. The mouth lies slightly behind the middle of this.

At the posterior end of the body is a small, shallow, cup-shaped sucker. It is centrally attached and has a postero-ventral aspect.

(c) *Colouration*: The specimen was fixed in Bouin's Fixative and preserved in 90 per cent alcohol. The dorsal aspect of the leech is brown, marked by a darker longitudinal streak. The ventral surface is slightly paler than the dorsal. The colour of the living leech is reported to be very similar.

(d) *Annulation*: The total number of annuli is 103. The first five of these are incomplete ventrally, and form the anterior sucker. The 6th is the first complete annulus, and, together with the 7th, with which it is fused ventrally, it forms the lower lip of this sucker. The 6th and 7th annuli are distinct dorsally, as are the 8th and 9th, which also are fused ventrally.

Three pairs of tubercles are present on the dorsum of 12, 15, 20, 25 and 30. Behind this region they are not apparent, and so are of little help in determining somite limits. The most useful structures for this are the nephridiopores, the genital apertures and the eyes.

Five pairs of well-developed eyes are present, one pair on each of annuli 2-4, 6, and 9. The eyes are on an arc at the anterior extremity.

The reproductive apertures are separated by five annuli. The male aperture is at 31/32 and the female at 36/37.

The nephridiopores lie on the 2nd annulus of the somite, there being four complete annuli between two annuli which bear pores. The nephridiopores lie in paired rows in the ventral paramarginal position. They lie near the caudal border of the annulus.

Goddard (1909, p. 480) gave the following table of annulation:—

TABLE II

Somite	Annuli	Nature
i	1	Uniannulate
ii	2	Uniannulate
iii	3, 4	Biannulate
iv	5, 6	Biannulate
v	7, 8, 9	Triannulate
vi	10, 11, 12	Triannulate
vii	13, 14, 15, 16	Tetranulate
viii-xxiii	17 . . . 96	Pentannulate
xxiv	97, 98	Biannulate
xxv	99, 100	Biannulate
xxvi	101, 102	Biannulate

Expanding this a little, we have:—

Somite	Annuli	Nature
viii	17-21	Pentannulate
ix	22-26	Pentannulate
x	27-31	Pentannulate
xi	32-36	Pentannulate
xii	37-41	Pentannulate

Now Goddard (1909, p. 482) says that the male and female reproductive apertures are at 30/31 and 35/36 respectively. This, according to the above table, means that they are in X and XI b5/b6. However, in the diagnosis of the genus to which he assigns his specimens, it is stated that the genital

pores are as in *Hirudo*, i.e., in XI and XII b5/b6. The following modification of Goddard's table, based on the recognition of a preocular somite, fits the diagnosis more closely:—

TABLE III

Somite	Annulus	Nature
i	1	Uniannulate
ii	2	Uniannulate
iii	3	Uniannulate
iv	4, 5	Biannulate
v	6, 7	Biannulate
vi	8, 9, 10	Triannulate
vii	11, 12, 13	Triannulate
viii	14-17	Quadriannulate
ix	18-22	Quinqueannulate
x	23-27	Quinqueannulate
xi	28-32	Quinqueannulate
xii	33-37	Quinqueannulate
xiii-xxiv	38-97	Quinqueannulate
xxv	98-99	Biannulate
xxvi	100, 101	Biannulate
xxvii	102, 103	Biannulate

The annulation is well defined, except on somites I-III, which are uniannulate.

In his description of *L. australis* var. *mauiensis* (originally *Hirudo mauiana*) Benham (1907, p. 185-191) did not recognise a preocular annulus; instead he counted annulus 4 as a separate somite. This method is not used by other workers.

(e) *External Openings*: These are of three kinds:—

- i. alimentary;
- ii. nephridial; and
- iii. reproductive.

1. *Alimentary*: The mouth lies near the base of the anterior sucker. Since the anterior somites are turned in, the exact nature of the mouth is difficult to determine. However, three pairs of jaws appear to be present. The anus lies on the caudal border of the last annulus.

2. *Nephridial*: In the specimen before me, 14 pairs of nephridiopores are easily visible. They are situated in two lines on the ventral surface, midway between the mid-ventral and lateral positions. The openings occur on the caudal borders of annuli 29, 34, 39, 44, 49, 54, 59, 64, 69, 74, 79, 84, 89, and 94. The three anterior pairs, i.e., those belonging to somites VIII, IX and X, are not visible.

3. *Reproductive*: The male and female reproductive systems open separately to the exterior by reproductive apertures situated in the mid-ventral line. The male pore opens between annuli 31/32, and the female, between annuli 36/37. The male aperture is distended into the form of a large rounded hole by the penis; the female aperture is a simple, transverse slit.

Distribution

Specimens of *Limnobdella australis* have been recorded, under a variety of names, from several mainland localities. The species is represented in New Zealand by the variety *mauiensis*. The previously recorded localities are as follows:—

1859	? Victoria	<i>Hirudo australis</i> Bosisto
1859	? Victoria	<i>H. medicinalis</i> Becker
1861	N.S.W.	<i>H. quinquestriata</i> Schmarida
1871	N.S.W.	<i>H. novemstriata</i> Grube
1893		<i>L. quinquestriata</i> Blanchard
1901	Australia	<i>Limnobdella australis</i> Brandes

1904	Upper Yarra, Vic.	<i>L. quinquestriata</i> Kershaw
1907	Auckland, N.Z.	<i>H. mauiana</i> Benham
1909	N.S.W., Victoria, Queensland	<i>L. australis</i> Goddard
1911	S.W. Australia	<i>H. australis</i> Johanson
1947	Australia	<i>H. (L.) australis</i> Parker & Haswell
1949	New Zealand	<i>L. australis</i> Richardson

The specimen in my possession was collected on 31.12.1953 in the region of lagoons north of the Interview River (12 miles north of the Pieman River).

Family PISCICOLIDAE

Genus AUSTROBELLA Badham, 1917

GENERIC DIAGNOSIS

'Small marine leeches with well-defined neck and body regions. The body cylindrical in the young, but much flattened in the adult. The lateral parts of the body below the clitellum bulging out and forming a shoulder-like appearance. Somite of six annuli. No pulsating vesicles, their place being taken by a continuous contractile lacuna placed on either side outside the body musculature. Dorsal and ventral median lacunae present, communicating by segmental lacunae. Three pairs of pouches present in the thick-walled intestine, a fourth pair being represented by a flexure in the gut. Testes five pairs. Eyes one pair.' (Badham, 1917.)

Type: *A. translucens*, Badham, 1917.

AUSTROBELLA BILOBATA sp. nov.

(Figures 15-22)

DIAGNOSTIC FEATURES

A. bilobata resembles *A. translucens* Badham in generic features, but shows certain specific differences. The body is cylindrical in the young, becoming flattened in the adult which has a markedly shouldered appearance posterior to the clitellum. The somite consists of three primary annuli, all of which are subdivided, giving a total of six. Pulsatile vesicles are absent, their function being performed by lateral contractile lacunae only. The crop has seven sets of paired lateral caeca, the last six pairs of which are double. The thick-walled intestine has three pairs of lateral pouches, and a fourth pair is represented by a flexure. There are no eyes. The gonopores are separated by two annuli. The female reproductive system has paired short ovaries without prolonged posterior lobes. There are five pairs of testes. The size of *A. bilobata* is, both in immature and mature forms, greater than that of other described species.

External Features

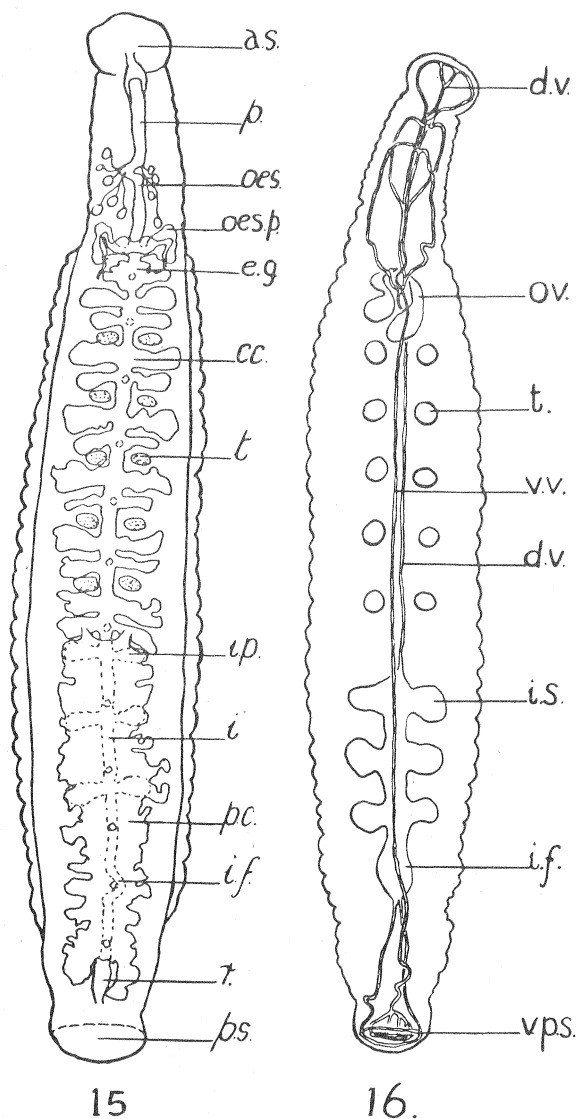
(a) *Size and Shape*: The leech is flattened in the urosomal region, and has anteriorly a more cylindrical neck or trachelosome. The distinction between these two regions is less marked in young forms, as shown in figure 19, which represents a series of outline drawings of specimens of different sizes. Table IV gives the measurements of 25 specimens.

(b) *Colouration*: The leech is strongly pigmented and shows up distinctly on the surface of the host. The most obvious pigment is dark bluish-black arising from numerous closely-packed stellate cells. This pigment is more concentrated on the dorsum and on the outer surfaces of both suckers. The ventral surface of the living animal appears almost as dark as the dorsal owing to the semi-transparent nature of the leech. However, in killed specimens it is paler. The inner surfaces of both suckers also are paler.

Scattered among the dark pigment cells, and especially along the body margins are reddish-yellow pigment cells. Eyes are lacking.

(c) *Annulation*: This is difficult to make out in the living specimen and can best be seen from compressed whole amounts and sagittal sections.

The primary number of annuli constituting a somite appears to be three but, as previously mentioned, in the urosomal region all annuli are secondarily furrowed so as to give the appearance of six annuli per somite.

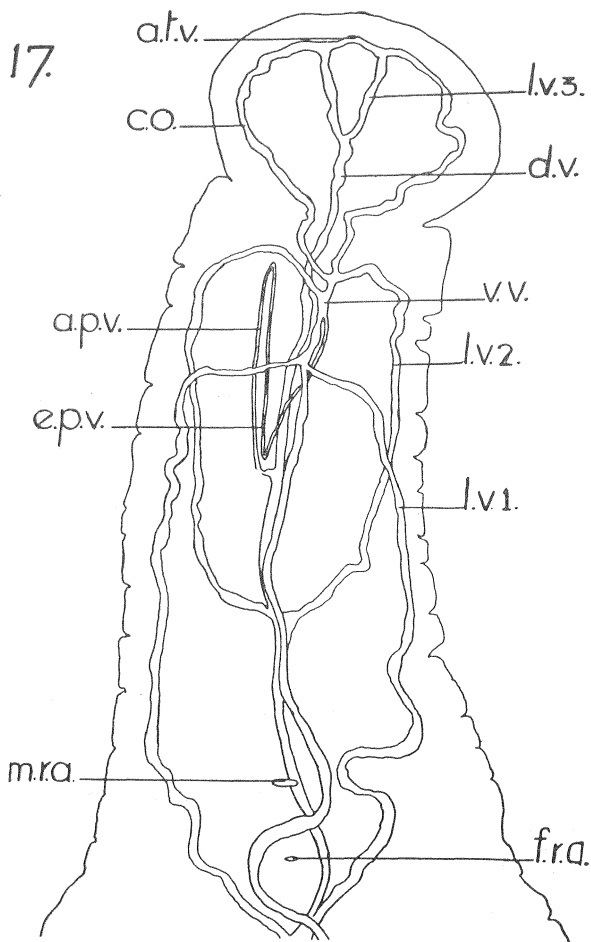


Austrobdella bilobata sp. nov.

FIG. 15.—General anatomy from the ventral surface.

FIG. 16.—Blood-vascular system from the ventral surface.

a.s. anterior sucker; c.c. crop caecum; d.v. dorsal blood-vessel; e.g. anterior endodermal gut; i. intestine; i.f. intestinal flexure; i.p. intestinal pouch; i.s. intestinal sinus; oes. oesophagus; oes.p. oesophageal pouch; ov. ovary; p. proboscis; p.c. posterior caecum of crop; p.s. posterior sucker; r. rectum; t. testis; v.a.s. blood-vessels of the anterior sucker; v.p.s. blood-vessels of the posterior sucker; v.v. ventral blood-vessel.



Austrobdella bilobata sp. nov.

FIG. 17.—Diagram showing the main blood-vessels of the tracheosome, as seen in ventral view.

a.p.v. afferent proboscis vessel; a.t.v. anterior transverse vessel, connecting the two limbs of the third pair of lateral vessels arising from the dorsal vessel; c.o. continuations of the third pair of lateral vessels around the anterior sucker to the ventral surface; d.v. dorsal vessel; e.p.v. efferent proboscis vessel; f.r.a. position of female reproductive aperture; l.v.1. first pair of lateral vessels; l.v.2. second pair of lateral vessels; l.v.3. third pair of lateral vessels; m.r.a. position of male reproductive aperture; v.v. ventral blood-vessel.

TABLE IV

Measurements in mm. of *Austrobdella bilobata* sp. nov.

Total length	Maximum width	Diameter of posterior sucker	Length of neck and clitellum	Width of neck
6	0.5	0.5	2	0.5
8	1.5	1.5	2.5	1.5*
9	2	1.5	3	1.5
9	2	1.5	2.5	1.5
9.5	2	2	3	1.5*
9.5	2.5	1.5	3	1.5
9.5	2.5	1.5	3	1.5
10.5	2	1.5	3	1.5
10.5	2	1.5	3	1.5
11	2	1.5	3	1.5
11	2.5	1	4	1.5
12	2.5	2	4	1.5
13	3	2	4	1.5
14	3	2	3.5	2
14.5	3	2	4.5	2
15	3	2	4	2
16	3	2	5	1.5
16	3	1.5	4	2*
16	3	2	5	2
16	3	1.75	4	2
16.5	3.5	2	4	2
18	3	1.5	4	2*
21	4	2	5	2
30	5	2	6	2*
32	5.5	2.25	6	2

* Indicates compressed specimen.

The secondary furrows which divide the annuli transversely at the middle are not so deep as the primary furrows. The ganglia of the nerve cord lie at about the mid-point of the original annulus.

The annulation of the preclitellum and clitellum is not the same as that described above for the urosome, but is of a reduced type. The preclitellum contains 14 primary annuli, the clitellum five, and the urosome 39 plus three incomplete annuli. Of these the last three are ventrally indistinguishable from the sucker. These annuli are nearly all double with the possible exception of the posterior ones. The five clitellar annuli are not subdivided. However, when the position of the nerve ganglia is considered, it appears that these are all primary annuli. Ganglia lie in the second and fourth annuli of the clitellum.

The male genital pore lies on the mid-ventral line between the 2nd and 3rd annuli of XI, and the female pore between the 4th and 5th annuli of XII.

Annuli 9, and 11-14 of the preclitellum are secondarily furrowed.

Internal Anatomy

(a) *Bodywall and Musculature*: The body surface is covered by a thin cuticle secreted by the columnar cells of the epidermis. The average height of the epidermal cells is 22μ and the average diameter 6.5μ . The rounded nucleus, which is situated near the base of the cells, has one spherical, usually central nucleolus. Lying among the epidermal cells are scattered gland cells which secrete mucus. These are goblet-shaped, and the main part of the gland lies beneath the epidermis.

The depth is of about 39μ , and the maximum diameter 20.8μ . Below the epidermis is a layer of connective tissue, which in turn is underlain by the two muscle layers, an outer circular and an inner longitudinal layer. There is developed in the region of the contractile lacunae, outside the body-wall musculature, a series of large unicellular hypodermal glands. Most have a large central secretion space, and in the adjacent cytoplasm, a deeply straining nucleus. The glands have diameters of up to 82μ .

(b) *Coelomic System*: *A. bilobata* lacks pulsatile vesicles, their place being taken by a pair of contractile lacunae lying laterally outside the body musculature, and extending throughout the length of the urosome. Segmentally they are connected with the rest of the coelomic system by a branch from the segmental lacuna. The normal lateral lacunae are lacking.

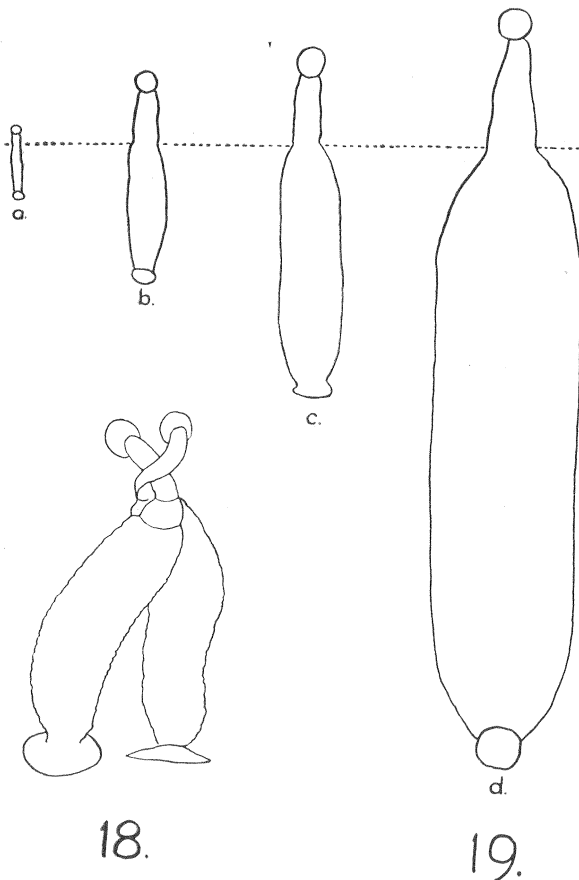
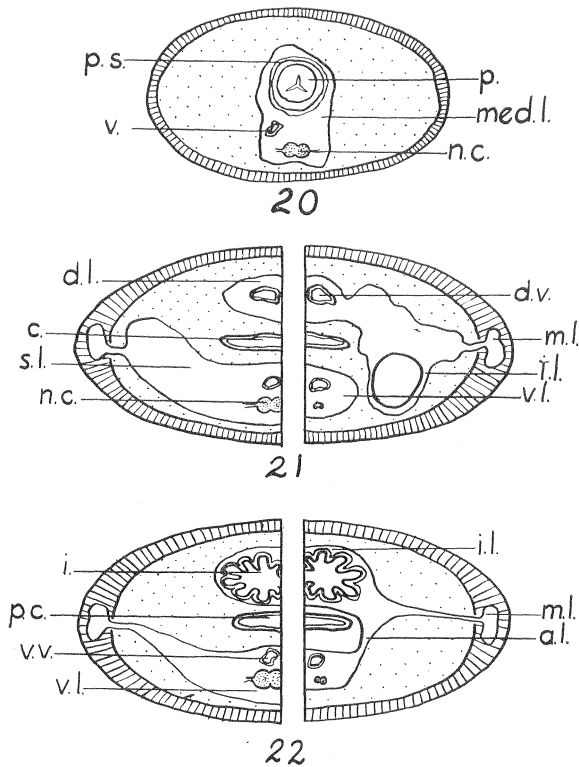
*Austrobdella bilobata* sp. nov.

FIG. 18.—Two individuals copulating.

FIG. 19.—Outline drawings of four specimens of different size. a. 3 mm. long; b. 8.5 mm. long; c. 13.5 mm. long; d. 30.5 mm. long.

The dotted line marks the division between the trachelosome above and the urosome below.



Austrobdella bilobata sp. nov.

FIG. 20.—Diagrammatic transverse section through the tracheosome. The shaded area lies outside the body-wall muscles.

FIG. 21.—Diagrammatic transverse section through the testis region of the urosome; left side segmentally, and right side intersegmentally.

FIG. 22.—Diagrammatic transverse section through the intestinal region of the urosome; left side segmentally, and right side intersegmentally.

a.l. accessory lacuna; c. crop; d.l. dorsal lacuna; d.v. dorsal blood-vessel; i. intestine; i.l. intestinal lacuna; med.l. median lacuna; m.l. marginal lacuna; n.c. nerve cord; p. proboscis; p.c. posterior crop caecum; p.s. proboscis sheath.

The dorsal lacuna is a well-developed structure. In the anterior part of the body it contains the dorsal blood vessel, and in the posterior part surrounds the intestinal sinus (i.e., the thick-walled intestine with its associated blood space).

The ventral lacuna lies ventral to the alimentary canal, and contains the ventral nerve cord and the ventral blood vessel. Anteriorly it expands, so as to enclose the proboscis and anterior ganglionic mass. It is similarly expanded in the anterior urosome, where it contains the ovaries and testes.

Segmentally both dorsal and ventral lacunae give off branches which unite laterally. From these a short branch runs out through the longitudinal and circular muscles to unite with the contractile lacuna. Dorsal and ventral capillaries are given off from the contractile lacunae.

(c) *Blood-vascular System*: The blood-vascular system is described from one of the paratypes, a compressed whole mount. The preparation was heavily overstained in alum carmine and then slowly differentiated, in 0.6% acid alcohol for a period of about eight hours.

There is a dorsal median longitudinal vessel which anteriorly gives off three pairs of lateral vessels and an unpaired proboscis branch. The posterior pair of lateral vessels arises posterior to the female reproductive aperture, and is directed initially outward, and then forwards and ventral. The second pair arises in somite X and follows a similar course. At its anterior extremity, about midway through the anterior sucker, the dorsal vessel bifurcates. The members of the anterior pair of vessels so formed run towards the edge of the sucker, where they are connected by a transverse vessel. Then they continue around the edge of the sucker and leave it ventrolaterally. These two vessels unite in the region of the anterior ganglionated nerve mass and continue as a ventral median longitudinal vessel. This receives, immediately behind the brain, the ventral anterior continuation of the second pair of lateral vessels given off from the dorsal vessel. The vessels do not enter immediately opposite one another. A short distance behind is the point of entry of the efferent proboscis vessel. The afferent proboscis vessel, after leaving the dorsal vessel, runs forward in the proboscis to about the level of the brain, then turns and continues back parallel to the forwardly directed portion. Near the original point of entry this vessel leaves the proboscis and once more becomes forwardly directed, this time ventrally as well, and unites with the ventral vessel in the abovementioned region.

A short distance posterior to this junction, are the entry points of the antero-ventral ends of the posterior pair of lateral vessels.

The ventral vessel then continues as an unbranched tube to the base of the posterior sucker. Here it splits into a number of branches which run to the more deeply situated of the two concentric ring vessels which lie in the marginal parts of the posterior sucker. This inner ring vessel is connected with the outer ring vessel by a number of short cross branches. From here paired dorso-lateral vessels arise and run forward to unite in the mid-dorsal line in the region of the intestinal flexure. Throughout the region of the thick-walled intestine, from the gut flexure posteriorly to the most anterior of the three pairs of caeca anteriorly, the dorsal vessel becomes part of a sinus which surrounds the thick-walled intestine.

Badham (1817, pp. 31-32) has described the circulation of the blood in *Austrobdella translucens*. The blood system of *A. bilobata* differs from that in the type in only minor features, mainly in the anterior region.

(d) *Excretory System*: Excretion takes place by means of 11 pairs of nephridia situated in somites XIII to XXIII inclusive. The nephridial tubules are very fine and form a network in the lateral

parts of the body. The internal opening is by a coronet of cilia-bearing cells, into the lateral parts of the ventral lacuna. A ciliated funnel and a capsule are absent.

(e) *Digestive System*: The mouth opening is in the middle of the anterior sucker, and leads to the proboscis sheath. This extends back as far as IX, and consists of a thin epithelium covering a thin layer of longitudinal and circular muscles. Within the proboscis sheath is the proboscis, covered externally by an epithelium which is continuous with that of the sheath. Beneath this are the longitudinal, radial and circular muscles of the proboscis. Between the radial muscles are found the ducts of the salivary glands, which discharge at the anterior end of the proboscis. The ducts of the salivary glands enter the proboscis at its base. These glands lie on either side of the proboscis in somites VIII to XI. On either side there are six or seven very large glands of diameter up to 328μ , and a number of smaller glands of diameter 80μ .

The proboscis is followed by a narrow, thin-walled oesophagus. Slightly posterior to the level of the male pore the two lateral ducts of the oesophageal pouches enter the oesophagus. These pouches are considerably expanded and have lobate walls; their openings into the oesophagus are narrow. The oesophagus extends back as far as XII/XIII, where it enters the crop.

This is essentially a straight tube giving rise to seven pairs of lateral caeca. The first pair of caeca, which have very wide openings into the crop, arises from the crop canal at the level of the female reproductive aperture. The pair of caeca occupying the same position in *A. transiucens* described by Badham are considered by that author to constitute a separate region, the anterior endodermal gut.

From the following region the remaining six pairs of caeca arise in somites XIV to XIX. Only the anterior two-thirds of the somite is occupied by the pouch, the posterior one-third, in somites XIV to XVIII, being the position in which the testes are found. Each individual pouch is deeply lobed, so that whereas in other recorded species of *Austrobdella* there are simply six pairs of crop caeca in this region, in *A. bilobata* there are 12. Of the two pairs of caeca arising in each somite, the anterior pair is slightly the larger. The condition is shown in figure 15.

Ventrally from the posterior pair of caeca is given off a median diverticulum; this originates as two pouches which fuse along the midline. They are separated for a short distance—about one-seventh of their length—posteriorly. There are five fenestrae.

The median crop canal passes dorsally into the thick-walled intestine. From this three pairs of simple lateral diverticula arise. A possible fourth pair is represented by a flexure in the main intestinal canal. The entire intestinal region is enveloped by the intestinal sinus, which arises from the dorsal blood vessel. The posterior end of the intestine is a straight tube, which narrows posteriorly to the rectum, and becomes directed upwards. It opens in the mid-dorsal line between the 3rd and 4th annuli from posterior end.

No digestive glands apart from the salivary glands and possibly the oesophageal pouches, are associated with the alimentary canal.

(f) *Reproductive System*: The leech is hermaphrodite, and apparently protandrous, specimens 6 mm. in length having mature testes and slightly immature ovaries.

The male reproductive organs consist of five pairs of testes alternating with the crop diverticula 2-7 and situated in the last annulus of XIV, XV, XVI, XVII and XVIII respectively. On either side they link up with a longitudinal vas deferens which passes forward to XII-XIII, where it expands and becomes the somewhat coiled ejaculatory duct. Above and lateral to the male reproductive aperture these ducts become the very much enlarged ejaculatory cornua, which unite in the midline into a short muscular spermatophore-sac opening to the exterior at the male pore. Entering the spermatophore-sac or bursa on either side are masses of unicellular "spermatophore" or accessory male glands.

The female system consists of a pair of ovaries lying in the 2nd and 3rd urosomal annuli. The ovaries are asymmetrical in position, the left one being a more or less rounded mass largely confined to two, while the right one is more elongated, extending through two and three, and is closer to the midline. This, however, is not constant, as the arrangement is not the same in all specimens. Other workers have recorded the fact that the ovaries may vary considerably in position in other leeches; so much so that they have been mistaken for hearts in living material. Anteriorly the ovaries lead into straight oviducts which unite in XIII. The single short duct so formed passes forward and opens into the enlarged and glandular chamber. The epithelial lining of this is a continuation of the general body epithelium and is thrown into folds within the pouch. This is surrounded by a cellular connective tissue, such as described by Badham (1917, p. 36) as conductive tissue in *A. transiucens*.

Clitellar glands are present within the body-wall musculature and occupy nearly all the space between it and the various systems—alimentary, reproductive and vascular. From the glands the ducts lead forward to open at the clitellum, in somites X-XII. Two kinds of glands may be distinguished. The larger (which in a specimen 18 mm. long had a diameter of 196.8μ) have a large secretion space surrounded by very granular cytoplasm. The secretion space is filled with a finely granular material which stains light-pink with eosin. The smaller glands, of average diameter 82μ , differ from the larger in the nature of their secretion, which stains a vivid pink with eosin.

The ducts are placed in four groups, two dorso-lateral and two ventrolateral.

Copulation: Fertilization takes place by means of spermatophores, which are exchanged during copulation. The process of copulation was observed about 4 p.m. on 29th June, and lasted intermittently over a period of about 10 minutes. Three leeches were involved, although only two copulated at any one time. The specimens were kept in sea water in Petri dishes. The leeches fastened themselves

by means of the posterior sucker on to the bottom of the dish. The free anterior end was then moved actively about until it came in contact with another leech. The necks of the two individuals then became mutually entwined so that the reproductive apertures were adjacent. In this position copulation occurred. The glandular vagina of the female system was at times partly extruded, probably to facilitate the deposition therein of the spermatophore. Strong muscular contractions were observed in the clitellar region. These appeared to have their origin in the ejaculatory corona, which were considerably swollen, so as to make their outlines clearly visible in macroscopic view.

For some time preceding and following copulation, the leeches were very restless, and agitation of the container caused them to move about actively.

Egg Capsules: These were deposited by a number of leeches kept in sea-water in a glass jar at ordinary room temperature, during the periods 16th-31st March, 11th-13th May, and 25th-30th June, 1954. As soon as the leeches started depositing the capsules, one leech was isolated and kept from 17th March-31st March in a separate container. Over this period it produced 67 capsules, more than half (about 40) being deposited during the first week. The egg capsules were always produced at night, and were deposited on the bottom and sides of the container.

Capsules were deposited by leeches collected on the 15th March, 1954, 7-10th May, 1954, and 25th June, 1954. Five specimens collected on 30th August, 1954, failed to produce any capsules.

The capsules are small (0.8 mm. x 0.65 mm. x 0.50 mm.) translucent amber-yellow structures, which become darker as development proceeds. The lower or attachment surface is flattened and the upper dome-shaped. The wall of the capsule resembles chitin and is slightly elastic. Only one leech hatches from each egg-capsule, and it is about 3 mm. in length when it emerges.

In no case were the egg capsules observed attached to flounders. Under natural conditions the leech probably leaves its host in order to deposit the capsules.

The young *A. bilobata* take 3-4 months to emerge from the capsule. The young leech is semi-cylindrical with both anterior and posterior suckers well-developed. It is but lightly pigmented, the pigment being a light pink as contrasted with the very dark bluish-black of larger specimens.

(g) **Nervous System:** This shows no important differences from that described for *A. translucens* by Badham. The ganglia are large and well-developed.

Habits (including Relation to Host)

Austrobdella bilobata is a hardy animal, and can withstand adverse conditions with no apparent disadvantage.

A catch of flounders was made on the 20th June, 1954; some flounders from this catch were placed in a large tub. There was no water in the tub and the fish soon died. Several hours after the death of the fish the leeches adhering to them were

found to be still alive and firmly attached. When removed to jars of sea-water they lived for several weeks.

The living leech exhibits several kinds of movements, the most obvious being:—

- (1) respiratory;
- (2) crawling; and
- (3) swimming.

(1) **Respiratory movements:** Respiration is performed by the pair of lateral pulsatile lacunae, which take the place of the pulsatile vesicles of *Branchellion*. When the living leech is observed, waves of undulations can be seen passing along either side of the body, throughout the post-clitellum. A single complete pulsation consists of a wave of contraction starting immediately behind the clitellum and finishing slightly in front of the posterior sucker. When one complete wave is finished, another begins. The contractions take place simultaneously on either side. The rate of contraction is about 19 per minute. When observed in the natural state *A. bilobata* appears very inactive, spending the greater part of the time attached (very firmly) by the posterior sucker to the side of the container, the anterior end of the leech remaining free or loosely attached. If watched closely, the sides of the body are seen to be in continual movement, of the type described above.

(2) **Crawling movements:** When disturbed, the leech moves with a somewhat uncertain looping motion for a short distance. Much time appears to be required for relaxing and renewing the hold of the suckers, especially that of the posterior sucker. When attached to the host, the leech rarely moves from its position.

(3) **Swimming movements:** These were observed only rarely, notably when a leech was detached and released in the water near the top of the tank. The leech, as it sank through the water, exhibited violent rhythmic muscular contractions, which propelled it slowly forward as it sank. It seems probable that such movements would occur only rarely in the natural state for the association of the leech with the flounder is apparently semi-permanent. The leeches remain firmly attached to the flounder even when the latter has been removed from water and is dead. However, the ability to swim is well-developed, even in newly hatched specimens.

Occurrence of *A. bilobata* on its host

Leeches were found on flounders (*Rhombosolea tapirina* Gunther) taken at Pittwater, Tasmania, during April and May, 1954. From a total catch of 296 flounders, 51 specimens of *A. bilobata* were collected. The following table indicates the number of leeches found on each fish.

TABLE V
Occurrence of *A. bilobata* on flounders

No. of Flounders	No of Leeches per Fish
261	0
25	1
8	2
1	3
1	7

With the exception of one leech found on the lower surface near the mouth, all were on the upper surface (i.e., right side morphologically) of the flounder, above the body cavity. It is possible that the specimen on the lower surface was a new infection and that the leech was making its way to the more usual position.

Badham (1917, p. 2) says *A. translucens* which parasitizes the Australian Sand Whiting (*Sillago ciliata*) occurs . . . on the fins—pectoral, pelvic, dorsal and caudal; their presence also was noticed around ulcerated patches on the sides of the fish, and a few were found in the proximity of, but not on, the gills'.

The region above the body cavity, as mentioned above, appears to be the only normal site for *A. bilobata*; its presence has never been noticed on the fins. Scars similar to those mentioned for the sand whiting occur above the body cavity in the flounder. They are present even in small specimens of the host.

No host relationships are given for *A. anoculata* Moore.

Relation to Existing Species

A comparison of *A. bilobata* with the two existing species is given in Table VI.

TABLE VI
Comparison of *Austrobdella* spp.

	<i>A. translucens</i> Badham	<i>A. anoculata</i> Moore	<i>A. bilobata</i> sp. nov.
Maximum length	13 mm.	6.8 mm.	35 mm.
Minimum size recorded	1.5 mm. in length	(No young stages)	2.5-3 mm. in length on emergence from egg capsule
Transparency	Transparent	Semi-transparent	Translucent to opaque
Pigmentation	Pigmentation by means of stellate reddish-brown cells and a number of smaller cells of shades of purple	No natural colour remains, but the type is stained a uniform green, which may be due to preservation in a copper tank	Blue-black, darker dorsally than ventrally with some amber-yellow pigment cells. Pigment cells stellate
Eyes	1 pair present	Absent	Absent
Number of annuli in mid-body normal somite	(3) 6	3 (6)	(3) 6
Division of body into trachelosome and urosome	Marked in adult	Marked in adult	Marked in adult
Oesophageal pouches	Present	Apparently absent	Present
Anterior endodermal gut	Trilobed	Not distinguished	Trilobed
Crop caeca	6 pairs, somewhat lobed distally	Similar to <i>A. translucens</i>	12 pairs, equivalent of the 6 in other species
Separation of posterior caecum	About 1/7th of total length free behind	About 1/5th of total length free behind	About 1/7th of total length free behind
Intestinal caeca	3 pairs	2 or 3 pairs	3 pairs
Intestinal flexure	Present	Absent; place taken by an expanded region	Present
Ovaries	With prolonged posterior lobes	Without prolonged posterior lobes	Without prolonged posterior lobes
Oviducal horns	Large	Absent	Absent
Testes	5 pairs	5 pairs	5 pairs
Nephridia	11 pairs	Not recorded	11 pairs
Host	Australian sand whiting, <i>Sillago ciliata</i>	Not recorded	Southern or common flounder, <i>Rhombosolea tapirina</i> Gunther
Location of parasite on host	The parasites were found on the fins—pectoral, pelvic, caudal and dorsal; present also around ulcerated patches on the sides of the fish	Not recorded	On the upper (right) side of the fish, above the body cavity, where they produce ulcerated patches and extensive scars. Never on the fins

Genus TRACHELOBDELLA Diesing, 1850

GENERIC FEATURES

The body is elongated, and divided into two regions, an anterior trachelosome and a posterior abdomen. The former is short and cylindrical, and may bear lateral non-pulsatile vesicles. At its posterior end it becomes slightly expanded as the clitellum. The abdomen is long and may be somewhat depressed. Along its sides are 11-13 pairs of pulsatile vesicles. There are two suckers, both usually rather small, the diameter of the posterior one rarely exceeding the maximum body width. The normal mid-body somite has three primary annuli, each of which is subdivided by a transverse furrow so as to form six. A posterior crop caecum is present. There are five pairs of testes, and the bursa is large and folded. Members of this genus are found, with rare exceptions, as ectoparasites on marine fishes.

Type: *T. mülleri* Diesing, 1850.

A Tasmanian leech which may be assigned to this genus has been found on the gills of the conger eel (*Leptocephalus conger* (Linnaeus)). Table VII gives a comparison of this species with others

assigned to the genus, from which it appears to be distinct. The specific name *leptocephali* is proposed for it.

TRACHELOBDELLA LEPTOCEPHALI sp. nov.

(Figures 23-28)

DIAGNOSTIC FEATURES

The body is of moderate size, much larger in the urosome than in the trachelosome. The urosome has 13 pairs of lateral pulsatile vesicles. Of these, the anterior ones are the largest, and the size decreases towards the posterior end of the body, so that one or both of the last two pairs may be practically indistinguishable in macroscopic view. The anterior sucker is about equal to the neck in width, and bears two or four pigmented patches which may be eyes. The posterior sucker is strongly contracted so as to be of lesser diameter than the body. The bursa is large, as are the male ducts. There are five pairs of testes. The ovaries are small. There is no copulatory area and no conducting tissue. Large clitellar glands are present. Posterior crop caeca are present and are almost completely fused together.

TABLE VII
Comparison of species of *Trachelobdella*

	Size in mm.	Annuli/ somite	Number of pulsatile vesicles	Annuli male/female pores	Eyes	Suckers	Host
<i>T. lubrica</i> (Grube, 1840)	50 long	(3) 6	12 pairs	3	None	Medium	Ectoparasitic on marine fish
<i>T. mülleri</i> Diesing, 1850	11 x 4-5	(3) 6	11-12 pairs	2	None	Medium	Parasitic on gills of Acantho- terygians
<i>T. sinensis</i> R. Blanchard, 1896	18 x 7	(3) 14	11 pairs	2	None	Small	? freshwater fishes
<i>T. australis</i> R. Blanchard, 1900	13 x 4	(3) 6	11 pairs	3	None	Medium	Parasitic on marine fish (usually tele- osts)
<i>T. turkestanica</i> Segelev, 1912	16.5 x 6		11 pairs	2	Present	Small	
<i>T. carajibica</i> Dequal, 1917	75 x 15				None		
<i>T. okae</i> Moore 1924	110 x 22	5	13 pairs		Present	Small	Marine fish
<i>T. aralensis</i> Dogiel and Bychowski, 1939	30 x 8	? (3) 6	11 pairs	? 2	None	Contracted	<i>Barbus brachy- cephalus</i>
<i>T. ludertzi</i> Augener, 1936	4-7.5 x 1.5	(3) 4	11 or 13 pairs	2	None	Medium	
<i>T. leptocephali</i> sp. nov.	18 x 4	(3) 6	13 pairs	2	None	Small	Gills of <i>Lepto- cephalus conger</i>

External Features

The body is divided distinctly into two regions, an interior trachelosome and a posterior urosome. The trachelosome is short and sub-cylindrical, becoming wider at the clitellar region. There are 12 primary annuli in the pre-clitellar trachelosome, and three primary clitellar annuli. All the pre-clitellar annuli are subdivided by transverse furrows. These furrows also cross the clitellar annuli, but are not complete.

The anterior sucker is excentrically attached. In the centre of its inner face is a small raised area on which the mouth opens. On the dorsal surface of the anterior sucker there are usually two elongated pigmented patches, which in one specimen appear as four separate eye-like spots, arranged approximately at the corners of a square. No ocellar units were seen in section. Also visible on the outer surface of the sucker are five or six very fine concentric striations.

The urosome is considerably larger than the trachelosome. Its sides are sub-parallel throughout most of its length, but converge posteriorly. In distended specimens the posterior part of the urosome may be larger than the anterior. In section the urosome may be cylindrical or slightly depressed. Along the sides of the urosome are 13 pairs of pulsatile vesicles. Of these the anterior pairs are quite large and hemispherical, but the size diminishes towards the posterior end of the body, so that the last one or two pairs may not be apparent except in section. The pulsatile vesicles lie on the middle of the three primary annuli of the somite.

Each normal mid-body somite consists of three primary annuli, each of which is subdivided by a transverse furrow. The primary inter-annular furrows are deeper than the secondary ones. There

are about 41 primary annuli visible on the urosome. Somites XIII-XXV inclusive are 3-annulate, and XXVI and XXVII are 1-annulate.

The anal region and posterior sucker are smaller than the mid-body region. Wrinkling is irregular here and so the exact number of annuli is difficult to determine. The sucker is tightly contracted so that its sides are parallel, and its edges wrinkled. If expanded it would be about equal to the body width in diameter.

Measurements of eight specimens are given below:—

TABLE VIII

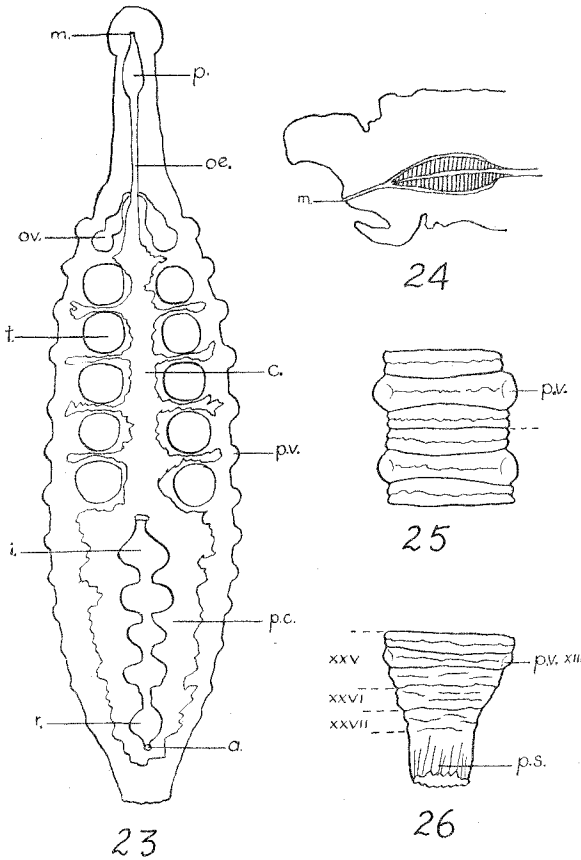
Measurements in mm. of eight specimens of
Trachelobdella leptocephali sp. nov.

Specimen Number	Total Length	Maximum Width	Length of Neck
1	19	4	5
2	20	2	5.5
3	15	3.5	4.5
4	13.5	2	4
5	18	2	4.5
6	10	2.5	4
7	12	3.5	4
8	15	3	3.5
9	12	2	3

Internal Features

(a) *Bodywall and Musculature:* The epidermis is made up of closely packed columnar cells forming a layer about 20 μ in thickness. This is covered by a very thin cuticle. The nuclei of the epidermal cells lie towards the base.

Beneath the epidermis is a well-developed connective tissue layer, about 30 μ thick. Scattered throughout this layer are hypodermal gland cells, and stellate pigment cells. The pulsatile vesicles and capillaries of the coelomic system lie in the connective tissue layer.



Trachelobdella leptocephali sp. nov.

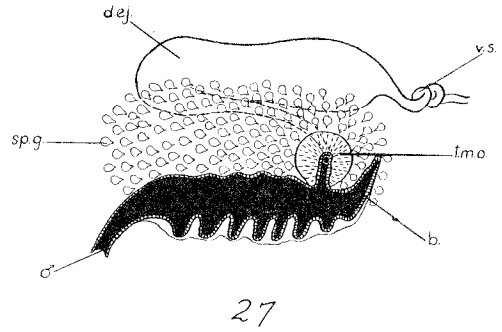
FIG. 23.—General anatomy in dorsal view.

FIG. 24.—Diagrammatic longitudinal section through the anterior sucker, showing the position of the mouth.

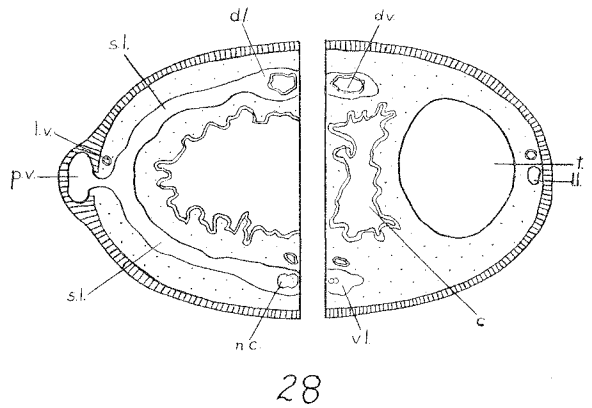
FIG. 25.—Two mid-body somites, showing annulation.

FIG. 26.—Posterior part of urosome.

a. anus; c. crop; i. intestine; m. mouth; oe. oesophagus; ov. ovary; p. proboscis; p.c. posterior crop caecum; p.s. posterior sucker; p.v. pulsatile vesicle; r. rectum; t. testis.



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28

Trachelobdella leptocephali sp. nov.

FIG. 27.—Diagrammatic reconstruction of the right half of the male reproductive ducts and associated structures, viewed from the left side.

FIG. 28.—Diagrammatic transverse section through the testis region of the urosome showing the main coelomic elements. Left side segmental, right side intersegmental.

b. bursa; c. crop; d.ej. ejaculatory duct; d.l. dorsal lacuna; d.v. dorsal blood-vessel; l.l. lateral lacuna; l.v. lateral blood-vessel; n.c. nerve cord; p.v. pulsatile vesicle; s.l. segmental lacuna; sp.g. spermatophore gland; t. testis; t.m.o. terminal muscular organ; v.l. ventral lacuna; v.s. vesicula seminalis; ♂. male reproductive aperture.

The muscles of the body-wall form a layer about 100 μ in thickness. Of this, about 80 μ is made up of longitudinal muscle fibres, whilst the outer layers of diagonal and circular fibres make up the rest.

Both the anterior and posterior sucker are well supplied with small unicellular glands. Lying in the intestinal part of the urosome immediately inside the body-wall muscles and apparently associated with the posterior sucker, are a few very large unicellular glands. These are largely confined to the dorsal part of the body, and have an average diameter of 250 μ . The nucleus is lobed and has several nucleoli. The ducts, which have a diameter of about 12 μ , leave the glands near their posterior margin, and appear to open on the inner surface of the posterior sucker. Their exact function is not known.

(b) *Coelom and Vascular System*: The main coelomic elements are dorsal, ventral, and lateral lacunae, with their segmental communications. The ventral lacuna lies beneath the gut, and contains the ventral nerve cord. At its interior end the ventral lacuna is greatly expanded, and envelops the proboscis and the anterior ganglionic mass. The dorsal lacuna lies above the gut, and contains the dorsal blood vessel. Anterior to the clitellar region the dorsal lacuna is not a separate structure but is united with the ventral lacuna and forms the median lacuna. In the urosome the dorsal and ventral lacunae are united segmentally by paired connectives. These are formed by dorsal and ventral branches given off from the dorsal and ventral lacunae respectively. These branches unite laterally with the lateral lacunae (figure 28). These are longitudinal coelomic vessels which lie near the lateral line among the longitudinal muscles. From the lateral lacuna, at the level of the segmental connective, a short transverse canal is given off, and passes out through the body-wall muscles to open into the pulsatile vesicle of that somite. Accessory segmental communications do not appear to be developed.

Coelomic capillaries are given off from the pulsatile vesicles, and ramify throughout the connective tissue layer.

One of the distinguishing features of leeches belonging to the genus *Trachelobdella* is the presence of non-pulsatile vesicles on the trachelosome. In this species the presence of these is doubtful, no definite vesicles being found.

The dorsal blood vessel lies within the dorsal lacuna, where it occupies most of the available space. The ventral vessel lies within the lacuna in the anterior part of the body, but leaves it about somite XIII. From here back to the beginning of the posterior ganglionic mass, the ventral blood vessel lies above the ventral lacuna. Paired lateral blood vessels are present, and lie dorso-laterally to the lateral lacunae.

(c) *Excretory System*: As in most piscicolids, excretion takes place by means of plectonephridia. The tubules are very fine (diameter 7μ) and ramify through the urosomal region.

(d) *Digestive System*: The mouth opening lies at the top of a small mound which is centrally placed in the oral sucker (figure 24). It leads into the proboscis sheath, which is short, extending only as far back as VII/VIII. The proboscis is short and muscular. On either side of the proboscis in somites VII to IX lie a number of large unicellular salivary glands. These have an average diameter of 100μ . The cytoplasm is granular, and the centrally placed nucleus is large, irregular in shape, and has more than one nucleolus.

The proboscis opens into the oesophagus, which extends back to XIII/XIV. Its walls are folded and are lined with a thick epithelium. There are no oesophageal pouches. The oesophagus is slightly expanded near its posterior end, where it is succeeded by the crop. This is a thin-walled structure, the main canal of which extends back to XX. It has six pairs of segmental expansions in XV to XX inclusive; sometimes a small anterior expansion occurs in XIV. From the posterior pair

is given off a single, large posterior caecum, which extends, ventral to the intestine, back to the posterior end of the body just anterior to the anus. There is a possible fenestra in XXV, but this is not clearly defined. Throughout its entire length, the walls of the crop are greatly folded, thus providing room for considerable expansion.

The intestinal canal arises dorsally from the crop in XX. There is a slight anterior projection of the main intestinal canal ventral to this point. The intestinal epithelium is about three times as deep as that of the crop. There are four pairs of intestinal caeca, in somites XX to XXIII. The entire intestinal region is enclosed in a coelomic lacuna—the intestinal lacuna.

In XXIV the intestine opens into the rectum. This is a short expanded region which opens to the exterior at XXVI/XXVII.

(e) *Reproductive System*: Male organs: there are five pairs of testes lying intersegmentally in XIV/XV to XVIII/XIX. The testes are large rounded bodies which occupy the greater part of the body space. The vas efferens leaves the testis near the antero-ventral border, and passes up and out to open into the vas deferens, which is situated dorso-laterally. The vas deferens of each side passes forward to XIII, where it becomes expanded into a thin-walled, coiled seminal vesicle. The coils of this extend forward in the dorso-lateral position to about XII, where they pass into the glandular ejaculatory ducts. These are enormously enlarged bodies which extend forward to IX. Their walls are made up largely of polygonal gland cells and their ducts, which open into the narrow lumen. In IX the ejaculatory ducts become bent back and enter a loose mass of spermatophore glands. As they pass back through this mass the ducts decrease in diameter and converge. Near their ends they become surrounded by the exceedingly numerous ducts of the spermatophore glands, and together with these ducts, become united into a solid structure by an enveloping sheet of circular muscle fibres. The ejaculatory ducts unite into a common duct within this structure, and into this open the ducts of the spermatophore glands. This terminal glandulo-muscular organ in turn opens into the bursa on the postero-dorsal side of the latter structure. The bursa is a greatly enlarged sac which extends back from the male aperture in XI almost to XIII. Its walls, especially that of the ventral surface, are folded and muscular, and it is lined with a deep epithelium. A muscular organ of the bursa is also present in *Calliobdella*, but from the figures given by Johansson (1898, p. 591) it appears that the ejaculatory ducts and the muscular organ open separately into the bursa, whereas in *T. leptocephali* the ducts open into the bursa after uniting inside the muscular organ (figure 27). Attached to the sides of the bursa are retractor muscles which are inserted in the lateral body wall. It seems probable that the bursa is capable of protrusion as in some other piscicolid leeches, and serves as a copulatory organ.

Female Organs: the ovisacs are small, and lie in the ventro-lateral parts of XIII/XIV. The oviducts pass forward and unite in XII to form a

short muscular vagina which opens to the exterior at the female pore. A copulatory area and conducting tissue appear to be absent.

A number of mucous glands are present in the ventral part of the body immediately behind the clitellum, on the ventral surface of which they open. They probably have a lubricating function. Smaller ones surround the male aperture.

The clitellar glands are present throughout the urosome, where they form a layer immediately inside the body-wall musculature. The glands are small, having an average diameter of 50μ . Their ducts open at the clitellum. Clitellar glands are not present in the trachelosome. The clitellar glands have an average diameter of 50μ . The nucleus is large (about 25μ in diameter), central, lobed, and with several nucleoli. The ducts of the clitellar glands open on the clitellum. Also in the urosome, in somites XX to XXV, are a number of very large unicellular glands. These have an average diameter of 200μ although many are elongated parallel with the long axis of the body. The centrally placed nucleus has a diameter of about 80μ , and is markedly lobed. The function of these glands is not known, but they resemble the clitellar glands in the nature of the cytoplasm and nucleus. However, their ducts open on the posterior sucker.

(f) *Nervous System*: The nervous system agrees in general with that found in other piscicolids. The anterior ganglionic mass is short and compact, and ganglion VII is closely joined to it. Ganglia VIII to XI are fairly close together, then a long connective unites XI and XII. Ganglia XII and XIII are again close together; XIII to XXIV are fairly widely spaced; then follow three closely spaced ganglia and then the short broad posterior ganglionic mass.

Relation of the Leech to Its Host

Nine specimens of *Trachelobdella leptocephali* were taken from the gills of the common conger eel (*Leptocephalus conger* (Linnaeus)). The tightly constricted, almost tubular posterior sucker appears well adapted for attachment to the gill filaments.

"*ICHTHYOBDELLA*" *PLATYCEPHALI* sp. nov.

(Figures 29-34)

DIAGNOSTIC FEATURES

Members of this species are small leeches parasitic on the flathead, *Platycephalus bassensis* Cuv. and Val. The body of the leech is indistinctly divided into trachelosome and urosome. Two well-marked suckers, both attached excentrically, are present. There are no eyes. Lateral pulsatile vesicles are not visible externally; however, in section there are seen to be segmental expansions of the lateral lacunae. True vesicles are not formed, as these expansions do not occur outside the body-wall musculature. The complete somite is 14-annulate. In the male reproductive system there are five pairs of testes; the ejaculatory bulbs are long, and the atrial cornua short; there is a large bursa. An area of conducting tissue is present in the female system, and lies in somites XII/XIII. Oesophageal pouches are present in X/XI. The posterior caecum of the crop is completely unified. There are four pairs of intestinal caeca. Ten pairs of nephridia are present.

External Features

(a) *Size*: Only two specimens of this leech were available. The following measurements were made on the larger specimen:—

	Length	Width	Depth
Anterior sucker	2 mm.	2 mm.	
Neck	3 mm.	1.5 mm.	1 mm.
Clitellum	1.5 mm.	1 mm.	
Urosome	15.5 mm.	2.5 mm.	1.5 mm.
Posterior sucker	3.5 mm.	3.5 mm.	
Total length	23 mm.	2.5 mm.	(excluding suckers)

The smaller specimen, from which the internal anatomy was studied by means of serial transverse sections, had a maximum length of 10.5 mm.; the width in the neck region was 0.33 mm., and in the urosome, 0.71 mm.; the depth in these two regions was 0.35 mm. and 0.52 mm., respectively.

(b) *Shape*: The body is subcylindrical in the smaller, and only moderately depressed in the urosomal region of the larger leech. It is divided, but not distinctly, into an anterior trachelosome and a posterior urosome. The clitellum is slightly constricted.

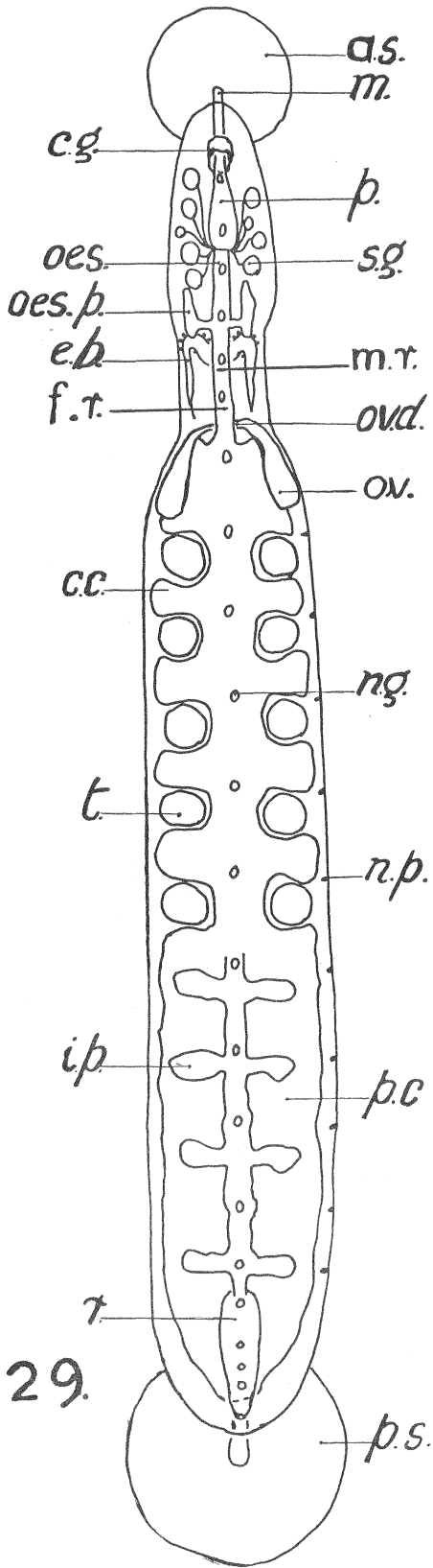
The oral sucker is disc-like, excentrically attached, and has an entire margin. The mouth opening is centrally situated on its inner face. The posterior sucker is almost twice the size of the anterior, disc-like when expanded, otherwise somewhat cup-shaped. The point of attachment of the posterior sucker is slightly excentric, the dorsal free edge being slightly longer than the ventral (2 : 1.5 mm.).

(c) *Colouration*: The outer surface of the anterior sucker has two conspicuous transverse dark bands. The more posterior of these is the darker and may conceal ocellar units although these were not found in section.

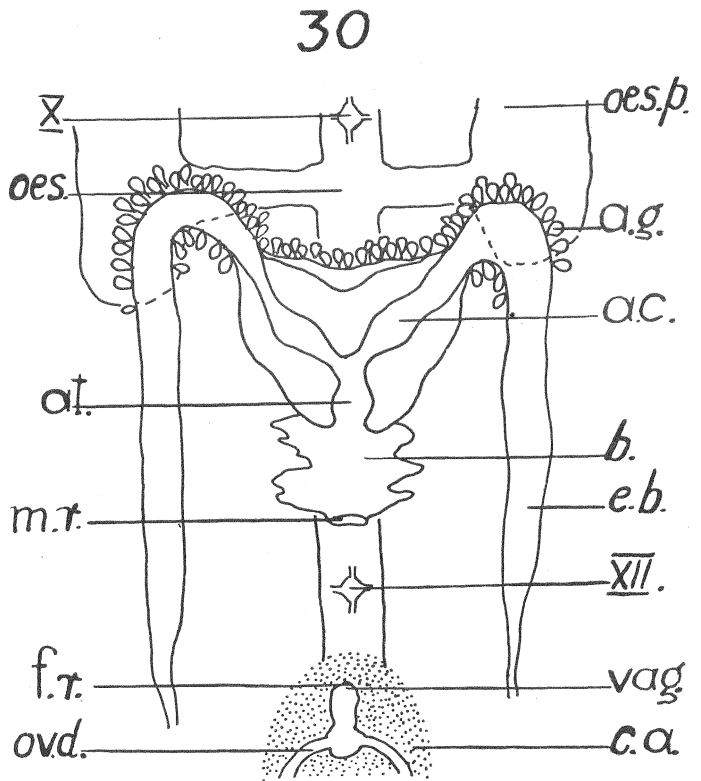
The dorsum and sides of the body are brown, and are marked by three pairs of longitudinal light bands dorsally, and with a fourth pair in the ventrolateral position. One pair is in the inner paramedian position, one, indistinct and discontinuous, in the outer paramedian position, and one is dorsolateral. The latter is expanded segmentally, each expansion extending through about four annuli.

The outer surface of the posterior sucker is irregularly mottled. The ventral surface of the body is pale, as are also the inner surfaces of the suckers.

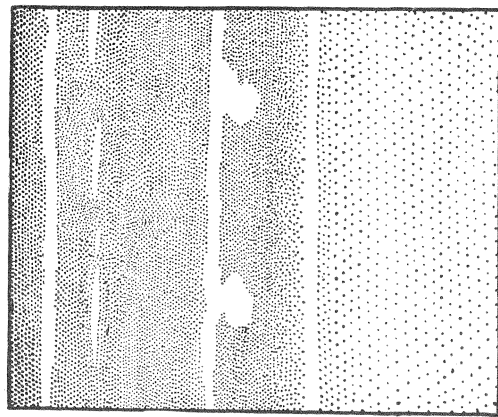
(d) *Annulation*: To the unaided eye the skin appears to be smooth; under magnification, however, there is seen to be a large number of very small annuli. There appear to be about 30 annuli in the preclitellar region, comprising, together with the oral sucker, somites I to IX/X. The annulation of the clitellum is irregular and incomplete. There are three complete furrows, the anterior of which is oblique, and probably marks the posterior limit of X. This is followed by a dorsally incomplete groove, and then by a complete one. Slightly posterior to this and on the ventral side is the male reproductive aperture. Then follows a depression with a series of incomplete furrows, which may mark the posterior limit of XI. This is succeeded by a region crossed by one



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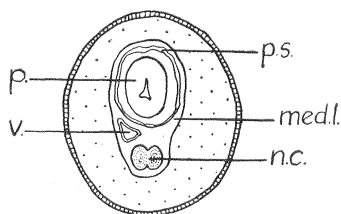
Ichthyobdella *platycephali* sp. nov.

FIG. 29.—General anatomy in dorsal view.

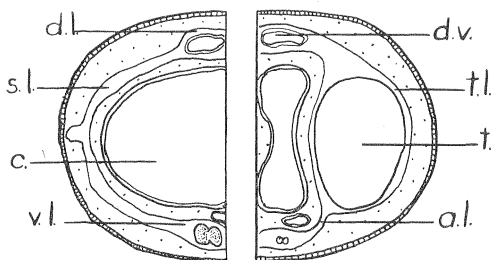
FIG. 30.—Diagram of male reproductive ducts in ventral view.

FIG. 31.—Diagram of the dark and light banding in the colour pattern, from the mid-dorsal position on the left of the figure, to the mid-ventral on the right.

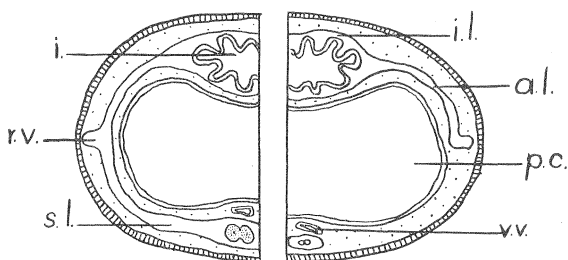
a.c. atrial cornua; a.g. male accessory gland; a.s. anterior sucker; a.t. atrium; b. bursa; c.a. copulatory area; c.c. crop caecum; c.g. cerebral ganglion; e.b. ejaculatory bulb; f.r. female reproductive aperture; i.p. intestinal pouch; m. mouth; m.r. male reproductive aperture; n.g. nerve ganglion; n.p. nephridiopore; oes. oesophagus; oes.p. oesophageal pouch; ov. ovary; o.v.d. oviduct; p. proboscis; p.c. posterior caecum of crop; p.s. posterior sucker; s.g. salivary gland; r. rectum; t. testis; vag. vagina; X, XII, ganglia X and XII.



32.



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"Ichthyobdella" platycephali sp. nov.

FIG. 32.—Diagrammatic transverse section of the trachelosome, showing the main elements of the coelom. The shaded area lies outside the body-wall musculature.

FIG. 33.—Diagrammatic transverse section through the testis region of the urosome; left side segmental, right side intersegmental.

FIG. 34.—Diagrammatic transverse section through the intestinal region of the urosome, left side segmental, right side intersegmental.

a.l. accessory segmental lacuna; c. crop; d.l. dorsal lacuna; d.v. dorsal blood-vessel; i. intestine; i.l. intestinal lacuna; med.l. median lacuna; n.c. nerve cord; p. proboscis; p.c. posterior caecum of crop; p.s. proboscis sheath; r.v. rudimentary vesicle; s.l. segmental lacuna; t. testis; t.l. testis lacuna; v. blood-vessel; v.l. ventral lacuna.

complete and by a ventrally incomplete furrow. A slight swelling, which may mark the position of the female pore is present immediately posterior to the complete furrow. The two furrows which mark the anterior and posterior limits of the clitellum are deeper than the other furrows.

The urosome consists of about 180 very short annuli. These, if the laterally placed light spots are segmental in arrangement, are arranged in groups of 14 to a complete somite.

Traces of annulation are also visible on the outer surface of the posterior sucker as fine concentric grooves.

Internal Anatomy

A series of transverse sections was made from the smaller specimen. As it was somewhat contorted the orientation of the sections was not always transverse, but was sufficiently so for the main anatomical features to be worked out. The sections were stained in Heidenhain's Iron Haematoxylin, according to the method given by Pantin (1946, pp. 39-40).

(a) *Body Wall and Musculature*: The outer layer of the body wall is a thin cuticle secreted by the one-layered epidermis. The epidermal cells are flattened, about 3.9μ in depth, and 9.1μ in width. The nucleus, which contains a nucleolus, lies near the base of the cell.

The connective tissue layer beneath the epidermis is very narrow; scattered throughout it are hypodermal gland cells which have a large secretion space.

The muscle layers are not strongly developed, the circular and longitudinal together forming a layer only 13μ in thickness. This fact, taken together with that of the poor development of dorso-ventral muscles indicates that the leech was probably not an active swimmer.

In the connective tissue within the musculature are found the clitellar glands. These have a diameter of 26μ - 39μ . They appear to have no special orientation. There is a very large secretion space occupying almost the entire cell and enclosed by a thin layer of densely granular cytoplasm. Towards one end of the cell this layer is thickened and contains the nucleus. The clitellar glands are present in both pre- and post-clitellar regions. Those in the pre-clitellum are found almost as far forward as the anterior ganglionic mass. The ducts are gathered into two longitudinal bundles, dorso-lateral in position.

In the post-clitellar region the glands are found in greatest abundance between the crop expansions; where the testes occupy the greater part of the lateral space the glands are clustered dorsally and ventrally. The ducts of the post-clitellar glands are gathered into six bundles. These are dorso-lateral (2) and ventro-lateral (2) and dorsal (2).

The ducts of the clitellar glands open on the clitellum.

The tissue of the posterior sucker contains well-developed sucker glands, which lie nearer the outer surface. They are found throughout the sucker except for the point of attachment and a marginal band.

(b) *Respiratory System*: No specialized respiratory structures, such as branchiae or pulsatile vesicles are developed. However, the lateral sinuses have segmental expansions which may be the rudiments of lateral canals connecting up with vesicles (figs. 33-34).

(c) *Digestive System*: The mouth is a small opening centrally situated in the anterior sucker. It leads to the proboscis, which lies within the proboscis-sheath and extends back to VIII/IX, where it enters the long thin-walled oesophagus. The salivary glands lie on either side of the proboscis and anterior part of the oesophagus. The salivary glands are large, having an average diameter of 0.1 mm. The secretion space is large and is enclosed within vesicular cytoplasm. The nucleus is a large triangular body with numerous nucleoli. The ducts, 6μ in diameter, of the salivary glands enter the base of the proboscis and then continue their course inside the proboscis to open at its anterior end. Inside the proboscis they are represented by six large longitudinal ducts.

Between X/XI the oesophagus gives off paired oesophageal pouches. These have a narrow opening into the oesophagus but expand forward ventrally and laterally. Although the crop was well-filled with food, these pouches were quite empty. It has been suggested that, such pouches, in other Piscicolid leeches, are glandular in function, or that they contain symbiotic bacteria (Autrum, 1932-34, p. (8) 301).

The oesophagus enters the crop slightly behind XIII. This is a large thin-walled structure, the main canal of which extends back to XIX where it enters the intestine. The crop has a series of six segmental expansions. From the last of these is given off a single median caecum which extends back to XXVII. There are four very small fenestrae in XIX, XX, XXI, and XXII. The intestine, which is given off from the crop in XIX and lies dorsal to the caecum, has four pairs of lateral pouches in XIX/XX, XX/XXI, XXI/XXII and XXIII. In XXIV the intestine enters an expanded rectal chamber, which terminates at the anus.

(d) *Reproductive System: Male Organs*: There are five pairs of testes situated in XIV/XV, XV/XVI, XVI/XVII, XVII/XVIII and XVIII/XIX, between the crop expansions. On either side a vas deferens passes forward, and about the level of XIII, expands into an elongated seminal vesicle or ejaculatory bulb. The two bulbs continue forward almost to X, where they turn ventroposteriorly and enter the muscular ejaculatory cornua. These are short and unite a short distance behind and ventral to XI. The short muscular atrium opens into a well-developed bursa with folded walls. This opens at the male aperture between XI and XII.

The anterior parts of the ejaculatory bulbs are covered with a mass of unicellular spermatophore or prostate glands. In the midline, immediately above the union of the ejaculatory cornua is a reservoir by way of which many of the central glands open into the atrium.

Female organs: There is a single pair of ovaries lying laterally in XIII-XIV. They gradually pass anteriorly into narrow oviducts which converge towards the midline ventrally and unite to form a short vagina. This is directed antero-ventrally and opens at the female pore in XII-XIII.

Associated with the female part of the reproductive system is an area of conducting tissue. This extends longitudinally from XII to XIII/XIV; transversely it occupies about half the ventral surface. In this region, the epidermis becomes thickened (39μ) and has a folded appearance. It is widely separated from the underlying musculature by the development within the connective tissue, of a mass, 52μ in thickness, of glandular tissue. Such tissue in other leeches has been referred to as "leitendes Gewebe" or "tissu vecteur". (Brumpt, 1901.)

(e) *Nervous System*: The central nervous system lies within the ventral lacuna. Its ganglia are extremely large and well-developed. The general structure is the same as for other Piscicolid leeches. The position of the ganglia is shown in figure 29.

(f) *Coelom and Vascular System*: The coelomic system consists of the following parts: median, dorsal, ventral, and segmental lacunae.

Median lacuna: this occurs in the trachelosome, where it contains the proboscis and related structures. In the urosome it splits and gives rise to the dorsal and ventral lacunae. In addition to the proboscis the median lacuna contains the ventral nerve cord, the anterior ganglionic mass, and associated blood vessels.

Dorsal lacuna: this consists of two parts—a testicular portion and an intestinal portion. The former lies above the gut and contains the dorsal blood vessel. From it arise two sets of segmental lacunae, the main and the accessory communications, lying in the middle and posterior parts of the somite respectively. In the intestinal region the dorsal lacuna is expanded and surrounds the intestine.

Ventral lacuna: lies beneath the gut and contains the ventral nerve cord. The ventral blood vessel does not lie within the ventral lacuna, but slightly above it. The ventral parts of the segmental lacuna arise from the ventral lacuna. The ventral lacuna is quite small.

Segmental lacunae: these are of two kinds—main and accessory. The main communication of the testis region forms a complete ring around the gut, and is made up of dorsal and ventral branches arising from the dorsal and ventral lacunae respectively. These branches unite, near the lateral line and in this region the lacuna becomes expanded. The structure so formed resembles the "rudimentary vesicle" figured by Moore (1952, fig. 7a) in his description of *Johanssonia abditovesicula*. The accessory communication of the testis region consists also of a complete ring, which is widely expanded and contains the testes. The main communication in the intestinal region resembles that of the testis region in that it is a complete ring. The accessory communication however, lacks the ventral part. It consists of a curved branch running from the dorsal lacuna to the lateral line.

In this region the swollen part of the main segmental lacuna gives off a very fine canal which passes back along the lateral line and unites with the lateral end of the accessory communication. This canal does not appear to be present in the testis region.

There are no lateral lacunae and no pulsating vesicles such as occur in *Johanssonia* Selensky, 1914.

(g) *Excretory System*: There are 10 pairs of nephridia lying laterally in somites XIV-XXIII. The main body of the nephridium lies anterior to the nephridiopore, which opens immediately behind the level of the ganglion of its somite. The nephridium commences laterally, then pursues a somewhat convoluted course towards the dorsal part of the body, where it changes direction and passes down to the ventral part. Here it again turns and passes dorsally and posteriorly till it reaches the mid-lateral line. Then the nephridium becomes constricted before expanding into a bulb opening on the surface. No trace of internal funnels was found.

Affinities

In 1914 Selensky (1914a) described a leech parasitic on a pantopod, and gave it the provisional name of "*Ichthyobdella*" *pantopodum*. Later in the same year he (Selensky, 1914b) described a leech from *Anarrhichas lupus* (Linn.) and erected a new genus *Johanssonia* to accommodate this species, which he named *J. kolaensis*. He then assigned his earlier "*Ichthyobdella*" *pantopodum* to his new genus. In 1952, Moore described a leech from *Tetraodon hispidus* Linn. which he

called *Johanssonia abditovesicula*, noting however that it differed quite markedly from the description of *Johanssonia kolaensis* given by Selensky (1914b), from which the following is taken:—Small leeches with well-formed suckers of less diameter than the body; both somewhat excentric. Body cylindrical and not distinctly divided into trachelosome and urosome. Skin smooth. Lateral lines marked by the presence of 11 pairs of lateral vesicles; of these the last pair may be reduced or absent. No eyes. Normal mid-body somite made up of 14 (16) annuli. Posterior crop caecum with five fenestrae. Ciliated organs present in the nephridial system. Six pairs of testes. Male system has no "Johansson's organ" in the long bursa; however, the common part of the ejaculatory ducts is provided with a glandular muscular groove which projects into the bursa. Conducting tissue and a copulatory area are present.

Table VIII gives a comparison of the three species assigned to the genus *Johanssonia*, and also includes the Tasmanian species which appears to be related quite closely to *J. abditovesicula*. As Moore recognized, his species does not lie with certainty in the genus *Johanssonia*, and it seems possible that when more material becomes available the systematic position of both *J. abditovesicula* and "*Ichthyobdella*" *platycephali* may be determined more precisely.

Distribution

Two leeches were collected from flathead at Catamaran, south Tasmania.

TABLE VIII

Comparison of species of *Johanssonia* and "*Ichthyobdella*" *platycephali* sp. nov.

	<i>Johanssonia kolaensis</i> Selensky, 1914	<i>Johanssonia pantopodum</i> (Selensky, 1914)	<i>Johanssonia abditovesicula</i> Moore, 1952	" <i>Ichthyobdella</i> " <i>platycephali</i> sp. nov.
Maximum length	23 mm. +	20 mm.	15 mm.	23 mm.
Annuli/somite	14 (16)	14	14	14
Eyes	None	None	None	None
Skin	Smooth, with small lateral vesicles	Smooth, with small lateral vesicles	Smooth	Smooth
Shape	Body cylindrical, imperfectly divided into 2 regions	Body cylindrical, imperfectly divided into 2 regions	Body divided into 2 regions, but not markedly	Body cylindrical narrower, anteriorly and imperfectly divided into 2 regions
Pulsatile vesicles	11 pairs	11 pairs	No true vesicles	No true vesicles
Oesophageal pouches	Not mentioned	Not mentioned	Not mentioned	Present
Posterior crop caecum	United, with 5 fenestrae	United, with 5 fenestrae	United, ? with 2 fenestrae	United, ? with 2 fenestrae
Nephridia	With ciliated funnels	With ciliated funnels	Not mentioned	10 pairs, without funnels
Female system	With copulatory area and conducting tissue	With copulatory area and conducting tissue	Not mentioned	With copulatory area and conducting tissue
Male system	With glandulo-muscular organ of bursa	With glandulo-muscular organ of bursa	Ejaculatory cornua surrounded by male accessory glands	Ejaculatory cornua surrounded by male accessory glands
Testes	6 pairs	6 pairs	5 pairs	5 pairs
Ventral blood vessel	Outside ventral lacuna	Outside ventral lacuna	Outside ventral lacuna	Outside ventral lacuna
Host	<i>Anarrhichas lupus</i> (Linn.)	<i>Nymphon strömii</i> Kröyer	<i>Tetraodon hispidus</i> Linn.	<i>Platycephalus bassensis</i> C. & V.

Genus **BRANCHELLION** Savigny, 1820

GENERIC FEATURES

Posterior body-region two or three times as broad as the anterior, flattened, and with paired lateral leaf-like appendages on almost all rings. Members of the genus are entirely marine.

Type: *Branchellion torpedinis* Savigny, 1820.

A table comparing the chief features of the different species assigned to this genus is given hereunder (table IX). Richardson regards the presence of tubercles as one of the characters in which *B. australis* differs from *B. parkeri*, and Moore (1952, p. 43) refers to ". . . tubercles, which are conspicuously developed in *B. australis*." However, in the original description of *B. australis*, Leigh-Sharpe (1916, p. 46) made no mention of tubercles, but said, "There are on the dorsal surface . . . very conspicuous patches where the pigment is absent, giving to the unaided eye the appearance of whitish spots." These spots are apparently regarded by both Richardson and Moore as tubercles, or at least indicating the presence of them. It was hoped to be able to determine the nature of the spots by reference to the type specimen, but this is no longer available, and appears to have been lost.

A species of *Branchellion* which occasionally is found on certain Tasmanian Elasmobranchs, appears to be identical with the New Zealand form, *B. parkeri*. The following description is based on an examination of both young and adult specimens.

The specimens were preserved in 5 per cent formalin.

BRANCHELLION PARKERI Richardson, 1949

(Figures 35-44)

? *B. raiæ* Parker, 1892.

B. parkeri Richardson, 1949; 1953.

DIAGNOSTIC FEATURES

Branchellion parkeri is a branchiate leech, usually 2-4 cm. in length, but occasionally attaining a length of 7 cm. Externally it has 31 pairs of branchiae borne laterally on the abdominal annuli. At the base of the branchiae on every third annulus is a pulsatile vesicle; in all, these comprise 10 pairs. There are four post-branchiate annuli, the last two of which are post-anal. Eyes and ocelli are lacking. The body is smooth and without tubercles. The dorsal surface of each annulus is marked by the presence of four, six or eight white spots arranged in a transverse row.

The crop has six pairs of lateral caeca, from the last of which is given off ventrally a posteriorly directed median diverticulum. The intestine has four pairs of lateral caeca. The female reproductive organs are a pair of ovaries which pass anteriorly into paired oviducts. These unite to form a short vagina, opening at the female aperture in the clitellum. Behind the ovaries lie five pairs of testes in somites XIII-XVII. The male reproductive aperture is situated in front of the female pore; there is a short blunt, ornamented penis.

External Characters

(a) *Size*: Adult Tasmanian specimens of *B. parkeri* range in total length from 17 mm.-75.5 mm. and in the total width (including the branchiae) from 3 mm.-12.5 mm.

TABLE IX
Comparison of recognised species of *Branchellion Savigny*

Feature	<i>B. parkeri</i>	<i>B. australis</i>	<i>B. borealis</i>	<i>B. ravenelii</i>	<i>B. torpedinis</i>	<i>B. orbiculus</i>	<i>B. lobata</i>	
No. of gills	31 pairs	31 pairs	31 pairs	31 pairs	33 pairs	33 pairs	31 pairs	
Tubercles/spots	No tubercles, 4 white spots on each annulus (Richardson, 1953)	Tubercles on all annuli of the neck, and 4, 6, or 8 on the abdominal annuli (Richardson, 1949) Leigh-Sharpe (1916) mentions only white spots in the above positions	The 1st annulus of the 3-annulate segments of the neck has 4 white dorsally, as also the 1st annulus of the clitellum.	No tubercles	1st annulus of each segment has 6 white spots dorsally and 4 ventrally	No warts on the pre-clitellum. 4 longitudinal rows of white spots on the neck on each annulus and 6 on the dorsal and 4 on the ventral surface of the abdomen on the 1st annulus of each somite	No tubercles	No tubercles
Pulsatile vesicles	10 pairs	11 pairs	11 pairs	11 pairs	11 pairs	11 pairs	11 pairs	
Post-branchiate annuli	4	6	6	4	4	5	5	
Post-anal annuli	2	3	3	1	1	2	2	
Testes	5 pairs	3	3	5 pairs	5	5	5	
Eyes	None	None	None	1 pair, asymmetrical longitudinally	6 eyes on the 5th segment of the anterior sucker	Circular	Expanded, disc-like	
Shape of anterior sucker	Sub-circular hooded	Hoodlike	Circular	Cup-shaped	Black pigment dispersed	Black pigment dispersed	Black pigment dispersed	
Pigmentation of anterior sucker	2 transverse black pigment patches, one on either side of the midline	8 or 9 large black pigment spots	Sucker dark, 2 darkest areas with 4-5 light spots	

N.B.—*B. intybijotikum*, *B. lineare*, *B. punctatum* and *B. imbricatum* are inadequately described.

TABLE X

Measurements in mm. of 27 specimens of *B. parkeri* from Tasmanian waters.

Total Length	Width of Body including Gills	Total Length	Width of Body including Gills
5	0.5	17	3
6	0.5	17	3
7	1	24	4
7	2	26	6
8	0.5	31	9
9	1	32	6
9	1	32	6
10	1	32	8
10	1.5	32	8
11	1.5	35	9
12	1.5	43	7
13	2	54	10.5
15	2	75.5	12.5
15	3		

A series of measurements made on specimens of this leech from Tasmanian waters is given in Table X.

(b) *Shape* (figure 35): The body of the adult leech is divided into two clearly defined regions, the trachelosome and the urosome. In small immature forms the trachelosome is not so sharply constricted off from the urosome, there being a gradual development from the cylindrical form of the young to the shape of the adult, which has a marked shouldered appearance, and in which, although the trachelosome is still sub-cylindrical, the urosome is dorso-ventrally flattened. Two distinct disc-shaped suckers are present.

(c) *Colouration*: The ventral surface of the entire animal is very pale and shows no definite pattern. The inner surfaces of the two suckers are similarly lacking in dark pigmentation. A few scattered brown pigment spots are present in both regions.

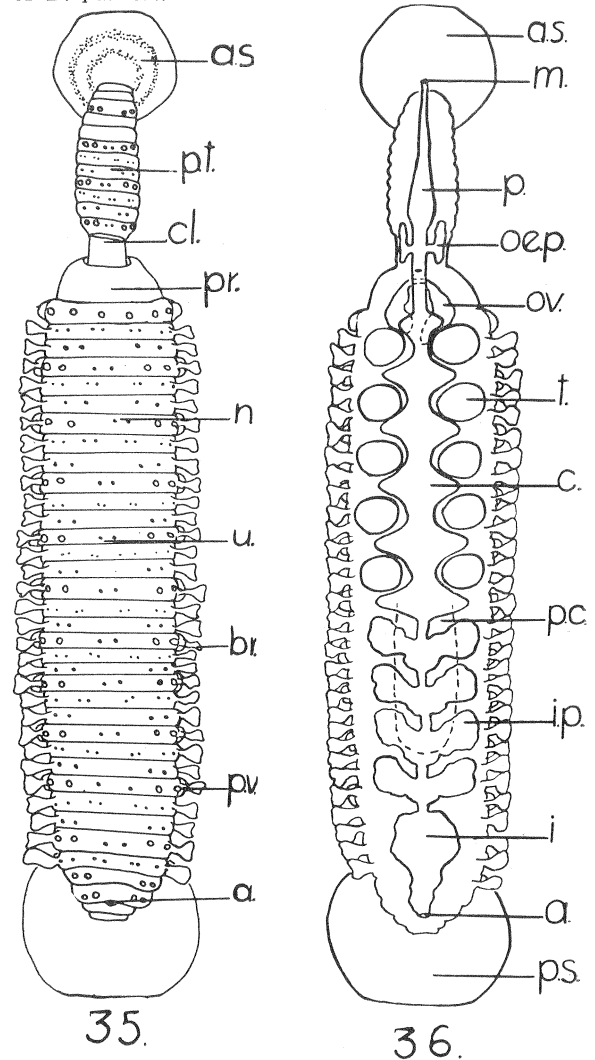
The dorsum of the anterior sucker is pigmented light brown and bears two conspicuous concentric bands of darker pigmentation; these are more clearly defined in young forms with lighter body pigmentation. In larger specimens they tend to merge with one another and form a darkly pigmented region over the entire proximal part of the sucker. The dorsum of the neck, abdomen (with the exception of the last two annuli) and the posterior sucker are coloured dark-brown by numerous melanophores. The neck is, in general, paler than the rest of the dorsum; similarly, there are fewer melanophores on the distal edges of the gills and on the pulsatile vesicles. The margin of the posterior sucker is similarly lacking in pigmentation.

The dorsum of both body and posterior sucker has a pattern of creamy-yellow spots, the arrangement of which is described below.

In general, young specimens up to about 12-15 mm. long are lighter in colour, and show very little differentiation between dorsal and ventral surfaces. As a result, the pigmentless patches on

the dorsal surface are more difficult to distinguish; however, they appear to have the same arrangement, described below, as in the larger and darker specimens. In no case are the light spots raised up as tubercles.

Richardson has described both patterned and colourless phases among the New Zealand specimens of *B. parkeri*.

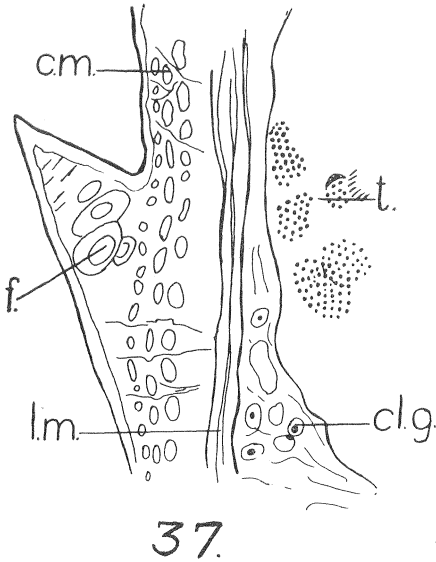


Branchellion parkeri Richardson, 1949.

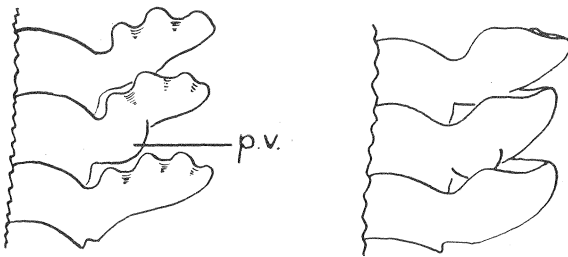
FIG. 35.—External features, dorsal view.

FIG. 36.—General anatomy, dorsal view.

a. anus; a.s. anterior sucker; br. external branchial appendage; c. crop; cl. clitellum; i. intestine; i.p. intestinal pouch; m. mouth; n. neural or sensory annulus characterized externally by the presence of four large and two medium-sized light spots, and by a pair of lateral pulsatile vesicles; o.e.p. oesophageal pouch; ov. ovary; p. proboscis; p.c. post-caecum of crop; pr. prepuce; p.s. posterior sucker; p.t. preclitellar trachelosome; p.v. pulsatile vesicle; t. testis.



37.



38.

39.

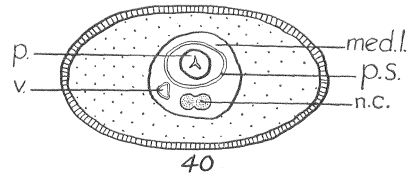
Branchellion parkeri Richardson, 1949.

FIG. 37.—Longitudinal section of part of the ventral body-wall of *B. parkeri* showing the position of the fat cells.

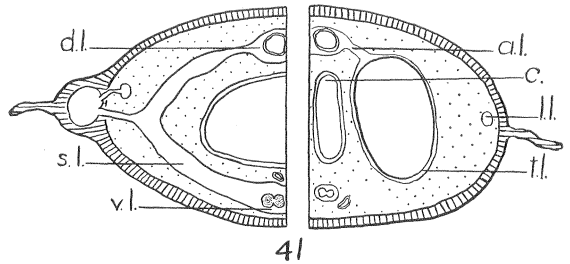
FIG. 38.—Ventral view of three branchiae of a New Zealand specimen of *B. parkeri*.

FIG. 39.—Ventral view of three branchiae of a Tasmanian specimen of *B. parkeri*.

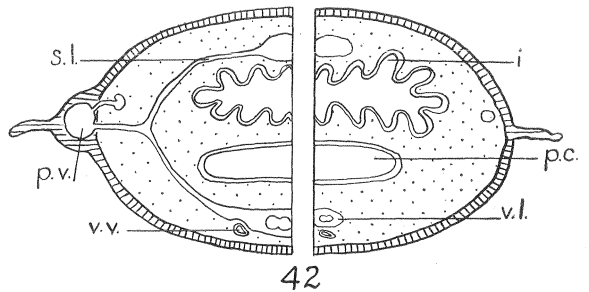
c.m. circular muscles; cl.g. clitellar gland; f. fat cell; l.m. longitudinal muscle; p.v. pulsatile vesicle; t. testis.



40



41



42

Branchellion parkeri Richardson, 1949.

Diagrammatic transverse sections through the body showing the main coelomic elements. The shaded area lies outside the body-wall musculature.

FIG. 40.—Trachelosome.

FIG. 41.—Testis region of the urosome; left side segmental, right side intersegmental.

FIG. 42.—Intestinal region of the urosome; left side segmental, right side intersegmental.

a.l. accessory segmental lacuna; c. crop; d.l. dorsal lacuna; i. intestine; l.l. lateral lacuna; med.l. median lacuna; n.c. nerve cord; p. proboscis; p.c. posterior caecum of crop; p.s. proboscis sheath; p.v. pulsatile vesicle; s.l. segmental lacuna; t.l. testis lacuna; v. blood-vessel; v.l. ventral lacuna; v.v. ventral blood-vessel.

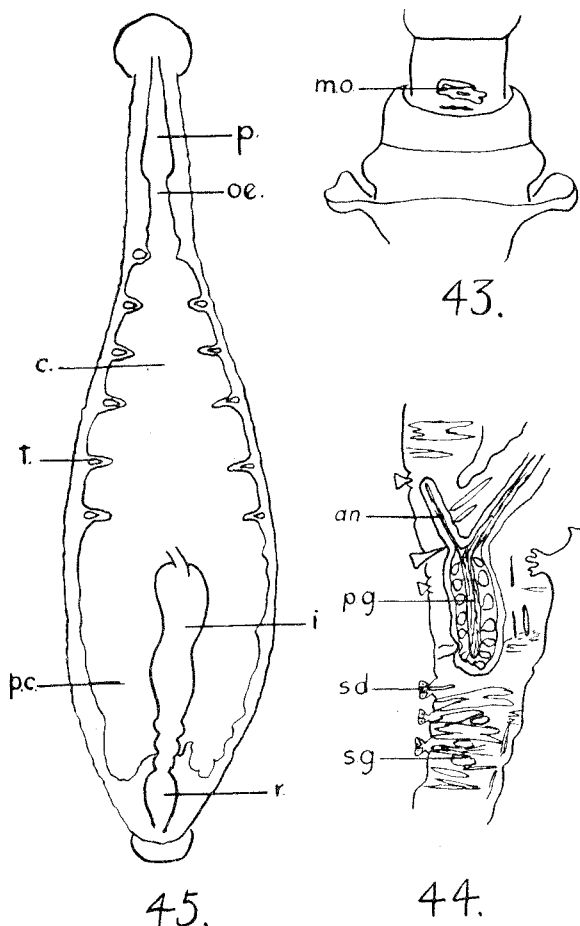


FIG. 43.—Ventral view of clitellar region of *B. parkeri* showing the partly protruded male organ.

FIG. 44.—Diagrammatic longitudinal section of part of the posterior sucker of *B. parkeri*.

FIG. 45.—Dorsal view of digestive system of *P. tasmanica*. a.n. anterior nerve branch in sucker; c. crop; i. intestine; m.o. male organ; oe. oesophagus; p. proboscis; p.c. posterior caecum of crop; p.g. posterior ganglionic mass; r. rectum; s.d. sucking disc; s.g. sucker gland; t. testis.

With the possible exception of some of the small specimens, all the Tasmanian examples belong to the patterned dark phase. However, the lack of colour in the small specimens may be due to the action of the preservative on the initially weaker pigmentation.

There are minor differences in the arrangement of the spots in the Tasmanian and New Zealand specimens. Three types of spots may be distinguished by differences in size; they may be classed as large, medium and small. In all the Tasmanian examples these spots have the following arrangement (see Table XI).

In the abdominal region the spots occur on the anterior half of the annulus. The arrangement of the spots is shown in fig. 35. As can be seen, it is very similar to that given by Leigh-Sharpe for *B. australis*. However, *B. parkeri* differs from the latter species in having only 10 pairs of pulsatile vesicles, and only five pairs of testes.

(d) *Annulation* (fig. 35): In the specimens before me the neck region exhibits only 12 of the 13 annuli mentioned by Richardson, only two of the three very small anterior annuli being present. These two are fused ventrally. The 3rd annulus is larger than normal and incompletely divided by a dorsal furrow. In contrast to the condition found in the abdomen, the spots on this annulus are situated posterior to the furrow. Immediately behind the neck, the body is constricted into a clitellar region, the greater part of which is hidden by the prepuce—an anteriorly reflected fold of the body-wall. Behind the prepuce the body appears to consist of 37 annuli.

TABLE XI
Patterning of *B. parkeri* from Tasmania.

Position	Spots		
	Large	Medium	Small
Pre-clitellar			
Trachelosome			
Annulus:			
1	0	0	0
2	0	0	0
3	4	0	0
4	0	0	0
5	0	0	0
6	4	2	0
7	0	0	0
8	0	4	0
9	4	2	0
10	0	0	8
11	0	4	0
12	4	2	0
Clitellum somites XI, XII	Unpigmented		
Urosome			
somite: annulus:			
XIII		Unpigmented	
a ₁			
a ₂	6	0	0
a ₃	0	0	8
XIV-XXIII			
a ₁	0	4	0
a ₂	4	2	0
a ₃	0	0	8
XXIV	4	0	0
XXV	4	0	0
XXVI	0	0	0
XXVII	0	0	0

The 1st two apparent annuli of the abdomen are non-branchiate, the 1st is larger than most of the succeeding ones, and the 2nd, a sensory annulus, bears laterally a pair of pulsatile vesicles. The following 3-33 inclusive, bear laterally-projecting, foliaceous outgrowths (branchiae). These are expanded distally and have simple margins. The

furrows which incompletely divide the dorsum of each abdominal annulus are less conspicuous in the Tasmanian specimens than in those from New Zealand.

There are 10 pairs of pulsatile vesicles, one pair being borne on every 3rd (i.e., sensory) annulus. Behind the last pair of pulsatile vesicles are four branchiate annuli. The pulsatile vesicles are situated laterally, at the base of the branchiae. Behind the last branchiate annulus are four non-branchiate rings. The anus is situated in the mid-dorsal line between the 2nd and 3rd of these.

The ventral surface of the abdomen is marked by forwardly-projecting extensions of the annuli arising at the interannular furrows. Laterally these flanges are in direct communication with the branchiae.

The prepuce forms a collar completely encircling the clitellum and ventrally may cover the reproductive apertures (but see below). These are close together, the male lying slightly anterior to the female. In the clitellar region no annulation is evident.

The anterior sucker is subcircular, becoming somewhat hoodlike in the larger specimens, but never as much so as in *B. australis* (Leigh-Sharpe, 1916, pp. 44-45, figs. 1 and 2); the posterior sucker is larger and flatter, and quite circular. Well-developed radial and circular muscles are visible in the tissue of the suckers. In the anterior, the circular, and in the posterior, the radial muscles predominate. The inner surface of the posterior sucker is covered with small attachment discs.

Internal Anatomy

The internal anatomy was studied by means of longitudinal sections stained with Heidenhain's Iron Haematoxylin. Some sections were counter-stained with eosin, according to the method given by Pantin (1946, pp. 39-40).

(a) *Body-wall and Musculature*: The epidermis consists of a single layer of cells having their nuclei towards their bases, and is covered externally by a thin cuticle which, on the dorsal surface, is thicker than on the ventral surface.

The epidermal cells have an average height of 21μ , and an average width of 8μ . The nuclei contain a darkly staining nucleolus. Among the epithelial cells are goblet-shaped gland cells which secrete mucus. These are slightly larger than the epithelial cells and are granular in appearance.

Beneath the epidermis is a connective tissue layer. This has an average thickness of 26μ . Beneath the connective tissue lie the muscle layers. These are arranged in an outer circular and an inner longitudinal series. There are three layers of circular muscles, the innermost of which, especially on the ventral surface of the body, is the most strongly developed. The circular muscle layer lies in connective tissue and forms a layer about 0.026 mm. in thickness. There appear to be two layers of longitudinal muscles, which however, for the most part, are so closely united as to be practically indistinguishable from one another.

The average thickness of the longitudinal muscle layer is 0.052 mm. A series of dorso-ventral muscles pass between the gut pouches in the posterior part of the body. In transverse sections the muscles have a lobed appearance.

In this genus, as in *Austrobdella*, clitellar or cocoon glands lie between the subdermal musculature and the alimentary canal. In the Tasmanian specimens, the region occupied by the clitellar or cocoon glands extends from the posterior limit of the clitellum to the anal region. The glands are in the form of unicellular structures, usually rounded but occasionally somewhat angular. Their average dimensions are: length = 0.0531 mm. x width = 0.0388 mm. x height = 0.0319 mm. The main body of the gland consists of dense but finely granular cytoplasm. The nucleus, a somewhat flattened, darkly staining body, is situated within this. The secretion space, at one end of the gland cell, also is enclosed in the cytoplasm. The space contains scattered granules. From the secretion space, the duct of the gland passes forward. The ducts are gathered into eight bundles. Laterally two such bundles, one dorsal and the other ventral, lie inside the musculature. About the level of somite XIV, they unite to form a median lateral bundle. Anteriorly this bends towards the midline where it unites with the rest of the clitellar gland ducts. These are in paired dorsal and ventral bundles. The openings of the ducts are in the clitellar region within the prepuce.

In the Tasmanian specimens of *B. parkeri* fat cells are associated with the ventral, forwardly projecting flanges of the body-wall (fig. 37). Within each flange, a number of cells form a band transverse to the long axis of the body. They are entirely confined to the ventral surface of the body. This arrangement is similar to that in *B. torpedinis*.

The fat cells are rounded, elongated dorso-ventrally. The long axis has a dimension of about 39μ ; the intermediate axis is parallel with the long axis of the body and has an average dimension of 34μ ; and the shortest axis is parallel with the transverse axis of the body, and has an average length of 30μ . The cytoplasmic cell body is densely granular. It stains moderately with haematoxylin and very darkly with eosin. The nucleus is centrally placed, and is somewhat irregular in shape. Several nucleoli are present. They appear black when stained with haematoxylin and also when counterstained with eosin.

In addition to the general musculature of the body, strongly-developed muscle bands are found in the posterior sucker (fig. 44). The sucker is lined throughout with epidermis covered with cuticle. The actual attachment is by means of small disc-like structures arranged quincunxially. These are covered with epidermis and set in a socket of connective tissue. A muscle strand extends vertically into the disc. In between the muscle bands of the sucker are large numbers of rounded unicellular glands, with long ducts which open to the exterior through pores on the ventral surface of the small suckers. The glands are aggregated into large glandular masses, and are called "sucker-glands". Scriban and Autrum (1932-34) describe the appearance of these in *B.*

torpedinis Savigny on pages (8) 126, and (8) 146. These glands lie near the inner surface and are present throughout the entire tissue of the sucker (fig. 44). The ducts of these glandular aggregates open in the centre of the sucking discs, which have a slight central depression.

(b) *Respiratory System*: Respiration takes place by means of branchiae and pulsatile vesicles (fig. 35). The branchiae are 31 pairs in number. The vesicles are situated at the base of the branchiae on the sensory annuli.

The pulsatile vesicles are 10 pairs in number. The vesicle, which is covered by epidermis, is largely composed of connective tissue, except for a central space. Medially this becomes constricted, and leads by a very narrow canal to the lateral longitudinal vessel within the body (figs. 41-42, see also (c) *coelom*, below).

Richardson (1949 *a*, p. 10) gives a full description of the mode of respiration in the New Zealand specimens.

(c) *Coelom and Vascular System*: The coelom, which is greatly reduced, consists of four main longitudinal elements—a dorsal, a ventral, and paired lateral sinuses. The dorsal and ventral sinuses are connected segmentally by connecting sinuses. Laterally from the connecting sinuses a transverse vessel is given off to the lateral sinuses. The dorsal, ventral and connecting sinuses are thin-walled, but the lateral sinuses have muscular walls and are contractile. As mentioned above, paired branches, leading to the pulsatile vesicles, are given off from the lateral sinuses in the middle annulus of somites XIII-XXII. Two vessels enter each pulsatile vesicle, one from the contractile lateral sinus, and one from the segmental lacuna. The former vessel opens into the vesicle in a position dorsal to that of the segmental lacuna.

The dorsal sinus contains the dorsal blood-vessel. In the intestinal region the dorsal blood-vessel gives rise to the intestinal sinus. This is essentially a close network of fine blood-vessels which ramify over the surface of the intestine. A single all-enveloping sinus, such as is found in other leeches is not present. A ventral blood vessel lies in the connective tissue beneath the ventral sinus. The central nervous system and the ovaries lie within the ventral sinus.

(d) *Excretory System*: This consists of 11 pairs of plectonephridia, segmentally arranged in somites XIII to XXIV. These are best seen in partly macerated and compressed preparations. The nephridia appear as a series of segmental tubules arising from paired longitudinal vessels in the intermediate ventral position. Only one pair of nephridiopores appears to be present—those of somite XXIV. There are no funnels and no capsules.

This very primitive nephridial system is similar to that described by Bourne (1884, pp. 481, 486) for *Branchellion torpedinis*. In that species also there is apparently only one pair of nephridiopores, opening ventrally on somite XXIV.

(e) *Digestive System* (figure 36): In the specimens before me the mouth opens at the base of the anterior sucker and leads into the proboscis sheath. The sheath extends back as far as the 8th ganglion in the ventral nerve cord (i.e., the 2nd free ganglion behind the cerebral mass). The proboscis is straight and strongly muscular. The ducts of the salivary glands enter at the base of the proboscis. The glands are arranged in a cluster of about 20 on either side of the proboscis.

Behind the proboscis is the narrow, thin-walled oesophagus. This, from lying centrally in the cylindrical neck region, becomes curved dorsally in an arc above the nerve cord and reproductive apertures. In X, the ducts of a pair of large thin-walled oesophageal pouches enter the oesophagus. The oesophagus extends back as far as ganglion XII, where it is followed by the crop, which is provided with six pairs of lateral pouches, placed respectively in somites XIII, XIV, XV, XVI, XVII and XVIII. The 1st and 6th pairs of pouches differ from the intervening ones. The 1st are of much smaller lateral extent, and the 6th gives off posteriorly, a large-sized diverticulum lying in the mid-ventral line. This extends back as far as the 3rd pair of intestinal diverticula which lie above it. It is perforated by five fenestrae.

The crop diverticula have simple walls.

Above ganglion XVIII the crop passes into the intestine, lying above the median crop diverticulum. The intestine consists of a median tube which gives off four pairs of lateral pouches, in somites XIX, XX, XXI and XXII. Unlike those of the crop caeca, the walls of these are plentifully supplied with small accessory pouches and are highly vacular. Behind the pouched region, the intestine is an unbranched tube with similar wall structure, lying above ganglia XXIV-XXVI. It passes posteriorly into a short rectal chamber which swings upward, to open at the anal aperture in the mid-dorsal line. The inner wall of the entire intestinal region differs from that of the crop and rectum in being thickened.

(f) *Reproductive System*: *B. parkeri* resembles *B. ravenelii* in having five pairs of testes. These lie in XIII/XIV, XIV/XV, XV/XVI, XVI/XVII and XVII/XVIII. From the testes on either side, a vas deferens passes forward. The two vasa deferentia are situated dorso-laterally within the longitudinal muscles. They have very thick walls. The vessels are 18 μ in diameter and have a lumen with a diameter of 9 μ . Paired vasa efferentia leave the testes on their median side and pass up and out to unite with the vasa deferentia. The seminal vesicle recorded by Richardson (1949 *a*, p. 9) as being present in the New Zealand specimens appears to be absent in some of my specimens. This appears to be due to a difference in degree of dilation, as in some it is quite large, while in others it is merely a narrow tube.

Anteriorly, the vas deferens becomes a much convoluted tube, lying lateral and dorsal to the gut. It leads to the muscular ejaculatory duct, extending as far forward as IX, where it turns towards the ventral surface and becomes greatly expanded to form the ejaculatory horns, in which the sperma-

tophores are produced. The horns unite and open by a short blunt penis into the atrium lying in IX/X. In a specimen taken on *Dasyatis* sp. from Pittwater (November, 1950), the penis is partly protruded (fig. 43) and is seen to have a frilled margin. Dorso-ventral retractor muscles are attached to the terminal part of the male system.

The ovaries are paired and lie close to the midline in XIII, above the ganglion of that somite. Anteriorly each gives off an oviduct which runs into a short common muscular vagina in XII, which opens by the female pore situated mid-ventrally in this somite. The walls of the oviducts are surrounded by conductive tissue.

(g) *Nervous System*: There is a ventral nerve cord with ganglia segmentally arranged along its length, except that the ganglia of the 1st six and last seven somites are aggregated into masses. Both cord and ganglia are double.

The ganglia of somite I lie dorsal to the proboscis in the 3rd and 4th free annuli, and constitute the cerebral ganglia. These are connected by periproborescival connectives with the main ganglionic mass lying beneath the proboscis sheath. This mass contains the fused ganglia of somites II to VI. Close behind lie the ganglia of somites VII and VIII. The ganglia of somites IX, X, XI and XII lie on an arc above the reproductive apertures and below the alimentary canal. Ganglion XIII is ventral in position. Then follow ganglia XIV to XXIII, each lying in the middle annulus of its somite. Ganglia XXIV-XXVII lie close together, owing to the reduction in annulation of these four posterior somites. The posterior grouping is characteristic of *Branchellion*. Extending from segment XXVII into the posterior sucker is found the terminal ganglionic mass. This contains seven paired ganglia belonging to the seven somites (XXVIII-XXXIV) which constitute the posterior sucker. At the antero-ventral end of this ganglionic mass is given off a thick nerve branch which supplies the lower surface of the sucker (see fig. 44).

Habits

Richardson (1949 a, p. 9 and 1953, p. 292) is the only author who has published observations on the living animal. He describes *B. parkeri* as being for the most part an inactive leech, capable, however, of swift but erratic movement when roughly treated.

Unfortunately no live material from Tasmanian waters is available.

Richardson remarks that the inability of *B. parkeri* to swim is probably one of the most important factors in limiting its host range to bottom-dwelling forms.

In New Zealand waters *B. parkeri* occurs on *Raia nasuta*, *Mustelus antarcticus*, *Callorhynchus milii* and certain skates. In Tasmania, specimens are found on *Raia lemprieri*, *Pristiophorus* sp. and *Dasyatis* sp.

With the exception of *Pristiophorus* and *Mustelus*, all these hosts spend a large part of their time on the bottom, mainly feeding on shell fish. It would, therefore, not be difficult for the *Branchellion* to attach itself to any one of these fish.

The occurrence of *Branchellion* on *Pristiophorus* presents a different problem. *Pristiophorus* is largely a fish feeder (Whitley, 1940, p. 154) and spends considerable part of its time actively swimming after its prey. However, since it is a ventrally flattened animal, it is fairly safe to assume that it spends some time on the bottom and may even feed on bottom-dwelling fish.

Similarly, the occurrence of *Mustelus* as a host for *Branchellion*, at first sight appears strange as it belongs to a family of sharks however, it has adopted a bottom-dwelling life and a diet which includes molluscs. To this end its teeth have become crushing plates (Young, 1950, p. 177).

Distribution

Up to the present this species has been recorded from New Zealand. The localities are as follows:—

- Richardson, 1949 a: *B. rajae* is common on dogfish in Cook Strait.
- Richardson, 1949 b: *B. rajae* on *Raia nasuta* (no locality given). *B. parkeri* on *Mustelus antarcticus* from the vicinity of Wellington.
- Richardson, 1953: *B. parkeri* on a skate, off Dunedin; also some trawled off Cape Campbell.

In Tasmanian waters, *B. parkeri* has been obtained from the following new hosts and new localities:—

- on *Raia lemprieri* Richardson, 1845, North West Bay; and Port Sorell.
- on *Pristiophorus* sp., Port Sorell.
- on *Dasyatis* sp., Pittwater.

Comparison with New Zealand Specimen

A comparison of the Tasmanian form with a specimen of *B. parkeri* from *Raia nasuta*, Cook Strait, New Zealand, revealed several interesting features. In addition to the differences in patterning, the form of the gills (figs. 38 and 39) differed in the specimens from the two localities. In *B. parkeri* from New Zealand the gill margins showed more folding than in those from Tasmania; in the latter they are only slightly wavy, whereas in the former they appear frilled.

Genus PONTODELLA Leach, 1815

GENERIC FEATURES

Marine leeches, ectoparasitic on skates and rays. Body long and cylindrical, without pulsating vesicles or branchiae, covered by papillae which usually project as conspicuous spiny or warty protuberances but may be partly or entirely retracted. Anterior sucker discoid and excentrically attached, posterior sucker centrally attached and campanulate. Without eyes. Complete somite formed of 3, 4 or 5 rings, the number being constant within the species.

Type: *P. verrucata* Leach, 1815.

PONTOBELLA TASMANICA (Hickman, 1942)

(Figure 45)

DIAGNOSTIC FEATURES

Pontobdella tasmanica belongs to the 3-annulate species of *Pontobdella*. It closely resembles *P. loricata* Harding in having 12 tubercles on each a_1 and a_2 , and 8 on a_3 , but has only 5 clitellar annuli. The mid-dorsal tubercles on a_1 and a_2 in *P. tasmanica* are smaller than those on the rest of the annulus.

A leech, attached to a piece of *Ulva* and referable to this species was collected by J. L. Hickman, 13.10.1952, on Kingston Beach. From it the following observations were made. The body is cylindrical, 12 mm. long and has a maximum breadth of 1.5 mm. in the mid-body region and of 0.5 mm. in the neck region. Two suckers are present and are clearly marked off from the rest of the body. The anterior sucker is excentrically attached, and the posterior one centrally. There are 57 annuli in the body between the two suckers, and they are arranged in 3-annulate somites (with the exception of I-VI anterior sucker, XI, XII, XXV, XXVI, XXVII and XXVIII-XXIV posterior sucker). The alimentary canal, as seen in a compressed whole mount, shows a general resemblance to that of *P. benhami* Richardson, 1950.

In the specimen of *P. tasmanica* under examination the proboscis extends back to IX. From here a thin-walled oesophagus extends back to XII, where it expands into the wide simple crop. Intersegmentally this is constricted into seven compartments, the last of which ends at XIX. From here, a median ventral caecum extends back to about XXV, although its posterior limit is difficult to determine, and probably varies with the state of engorgement. Dorsally at the posterior end of XIX, the simple intestine, which is of smaller diameter than the crop, is given off. This is constricted off in XXII/XXIII from a somewhat beaded region with three compartments, the posterior of which is constricted off from the bulbous rectum in XIII/XXIV.

The male reproductive system contains six pairs of testes situated intersegmentally between the crop expansions. Paired ejaculatory cornua unite to form the atrium which opens to the exterior by the male reproductive aperture, situated in XI a_2/a_3 .

A 2nd and much larger specimen of *P. tasmanica* was collected by Mr. A. M. Olsen. It had the following measurements:—

Total length: about 80 mm.
Maximum width: 10 mm.
Maximum thickness: 10 mm.
Width of neck: about 4 mm.
Diameter of anterior sucker: 2.5 mm.
Diameter of posterior sucker: 5.5 mm.

Distribution

This species has previously been recorded from Sandy Bay, Hobart (Hickman, 1942) as previously mentioned; the small specimen described above was collected at Kingston, Tasmania. The large specimen was collected from a skate from Brig Rocks, King Island, on 2.4.1951.

Family GLOSSIPHONIIDAE

Sub-family GLOSSIPHONIINAE

Genus GLOSSIPHONIA Johnson, 1816

GENERIC FEATURES

Small to moderately large glossiphoniids with two or three pairs of eyes. The complete somite is 3-annulate. The crop has six pairs of lateral caeca, the last of which is elongated and posteriorly directed. Seminal vesicles and ejaculatory ducts form a long open loop. The male and female reproductive apertures are either united or separated by one or two annuli. Salivary glands are diffuse.

Type: *Hirudo complanata* Linnaeus, 1758.

Four species of *Glossiphonia* have previously been recorded from Australia; they are:—

- G. australiensis* Goddard, 1908. Oberon, N.S.W. Goddard, 1908.
- G. heteroclita* (Linnaeus, 1758). Gosford N.S.W. Goddard, 1909.
- G. inflexa* Goddard, 1908. Waverley, Sydney. Goddard, 1908.
- G. intermedia* Goddard, 1909. Fairfield, N.S.W. Goddard, 1909.

A comparison of these species is given in table XIII. Goddard (1908, p. 321) recorded a *Glossiphonia* from Tasmania, but from his text, it is not clear to which of the above species he is referring. Since *G. australiensis* is the species most widely distributed, it is probably this.

The specimens of *Glossiphonia* at my disposal were collected at two localities: Lake Dulverton, and a small creek running into the Curryajong Rivulet at Antill Ponds. The leeches from the two different localities represent two species. That from the latter appears to be new, and the specific name *G. tasmaniensis* is proposed for it.

TABLE XIII

Comparison of species of *Glossiphonia* previously described from Australia

	<i>Glossiphonia australiensis</i> Goddard	<i>G. heteroclita</i> (Linn.)	<i>G. intermedia</i> Goddard	<i>G. inflexa</i> Goddard
Average size	10 mm. x 5 mm. 15 mm. long extended	8.8 x 2.6 mm.	33 mm. extended 14 x 4.6 contracted	14 x 4.5 mm.
Colour of body	Body flesh coloured	Usually amber-yellow with paired median black dots	Anterior half blue-grey posterior yellow crop caeca green	Pale sage green
Transparency of body	Body opaque	Body clear and gela- tinous	Body translucent-trans- parent	Body semi-translucent
Number of eyes	3 pairs on annuli 2, 3	3 pairs on 5 (6) 7, 8, or 4, 5, 6 (Goddard)	2 pairs on 5, 6	None
Number of annuli	70	68-72 (70)	70	?
Number of annuli on anterior sucker	Anterior sucker consti- tuted by 7 annuli		Posterior lip formed by annulus 8	
Nature of body surface	Body surface rough and devoid of papillae in macroscopic view; in section it is seen to be covered by a large number of papillae	Smooth and without sense papillae	Sense papillae small white tubercles on every 3rd annulus behind 21, 4 on each, the 2 para- medians being the larger	Sense papillae in mid- body on every 3rd annulus
Position of anus	1 post-anal ring	No post-anal rings (?)	2 post-anal rings	Anus dorsal on last annulus
Reproductive apertures	Male and female aper- tures separated by 1 very narrow annulus	Male and female aper- tures united in furrow between XIi/XIii	Male/female: apertures separated by 1 annulus (28)	Reproductive apertures united on the 28th annulus
Crop caeca	6 pairs, the last pair extending from 44-60, and carrying 11 small lateral branches	6 pairs of caeca, simple, except for the 6th, which has 5 secondary diverticula.	Crop with 6 pairs of caeca of which the 6th is larger and has 3-4 side branches	?
Intestine	Intestine with 4 pairs of auriform caeca	4 pairs	4 pairs of elongated auriform sacs	?
Number of testes	6 pairs of testes	6 pairs	6 pairs	?

GLOSSIPHONIA TASMANIENSIS sp. nov.

(Figures 46-49)

DIAGNOSTIC FEATURES

G. tasmaniensis is small, lanceolate in outline, colourless and transparent. The alimentary canal, when containing food, is visible through the body wall. Three pairs of eyes are present, one pair on each of annuli 6, 7, and 8. The total number of annuli is 70. Between the last two of these is the anus. Each member of the 6th pair of crop caeca has 4-5 small side branches. In the male reproductive system the number of testes varies from 4-5 pairs, one or both of the first two pairs normally present in species of *Glossiphonia* being absent. The ejaculatory ducts are long and muscular; they unite, and the duct so formed opens into the common genital space. One pair of elongated ovaries is present, extending from XIII to XVII. The oviducts unite to form a short vagina which forms a collar round the nerve cord. The vagina opens into the common genital space. This opens to the exterior at 28/29.

External Features

(a) *Size*: The leech is small, being 7-10 mm. long and 3-4 mm. wide.

(b) *Shape*: In outline it is lanceolate, pointed anteriorly, rounded posteriorly. The body is depressed, somewhat rounded dorsally and flat or

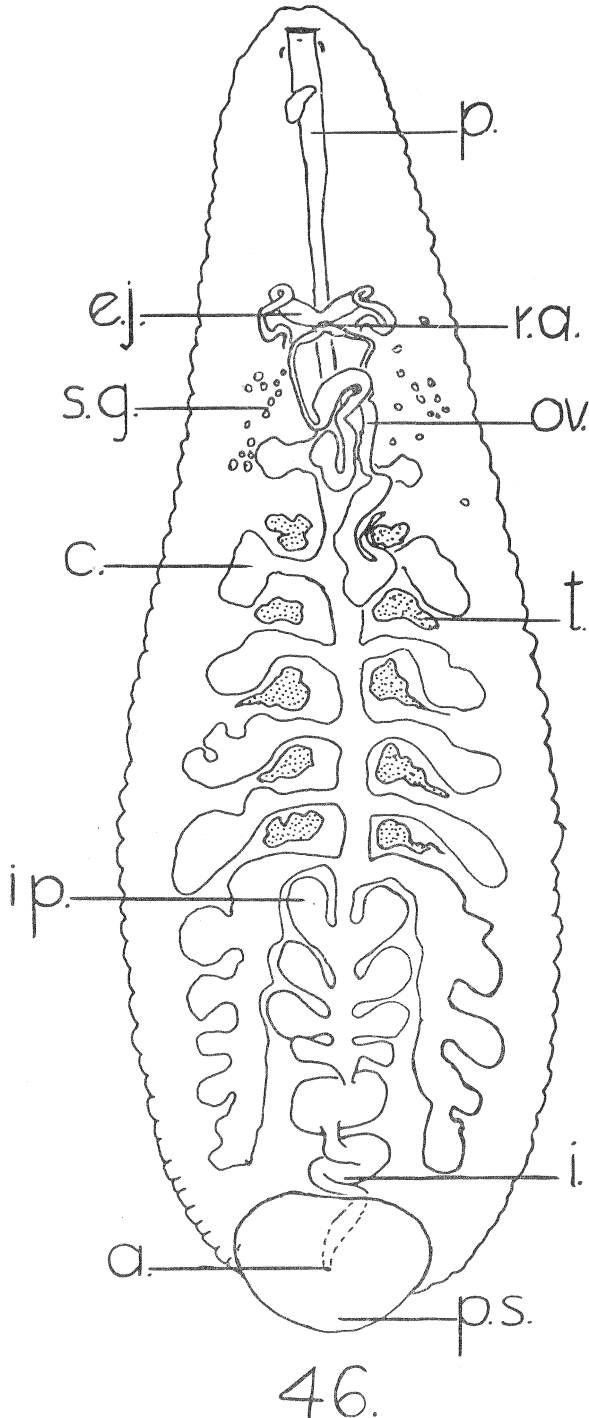
concave ventrally. The oral sucker is not divided off from the body, but is a slightly concave region surrounding the mouth on the anterior ventral surface. This anterior attachment area extends over annuli 1-5, the 6th being the first complete annulus ventrally.

A distinct disc-like posterior sucker, slightly less than half the maximum body width in diameter, is present. It is little wider than long; the sucker is terminal, centrally attached and ventral in aspect.

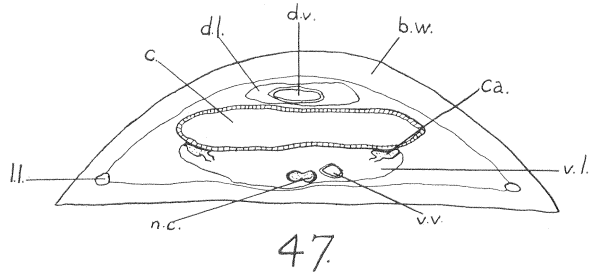
There are three pairs of eyes on annuli 6, 7 and 8. The first pair is small, close to the midline, and but lightly pigmented. The 2nd and 3rd pairs are wider apart and darker; often there appears to be but a single eye on either side.

The total number of annuli is 70. The reproductive apertures are united at 28/29, and the anus opens between 69/70.

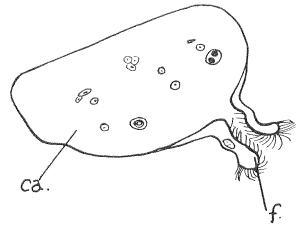
(c) *Pigmentation*: In the living state the leech is a small transparent mass of almost colourless to greyish-white jelly, which could pass unnoticed



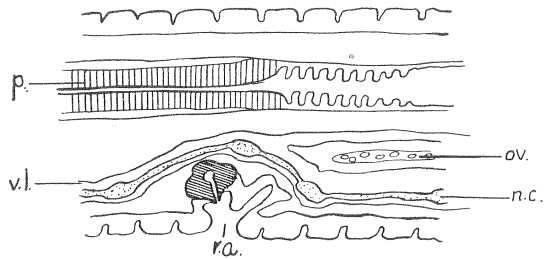
46.
Glossiphonia tasmaniensis sp. nov.
FIG. 46.—Whole animal, showing the main systems.
a. anus; c. crop; ej. ejaculatory horn; i. intestine; i.p. intestinal pouch; ov. ovary; p. proboscis; p.s. posterior sucker; r.a. reproductive aperture; s.g. salivary gland; t. testis.



47.



48.



49.

Glossiphonia tasmaniensis sp. nov.

FIG. 47.—Diagrammatic transverse in the mid-body region, showing the position of the main organs.

FIG. 48.—Nephridial capsule and ciliated funnel.

FIG. 49.—Diagrammatic longitudinal section in the mid-line, showing the reproductive aperture.

b.w. body-wall; c. crop; ca. nephridial capsule; dl. dorsal lacuna; dv. dorsal blood-vessel; f. ciliated funnel of the nephridium; ll. lateral lacuna; n.c. nerve cord; ov. ovary; p. proboscis; r.a. reproductive aperture; v.l. ventral lacuna; v.v. ventral blood-essel.

against the dark surface of the stones under which it is found, if it were not for the crop diverticula. These, because of the food which they contain, appear almost black.

When killed, and fixed in Bouin's Fixative, the leeches lose their transparency.

Internal Anatomy

This was studied by means of compressed whole mounts stained in alum carmine, and also by means of longitudinal and transverse sections stained in Heidenhain's Iron Haematoxylin; the transverse sections were counter-stained in eosin.

(a) *Bodywall and Musculature*: The body is covered by a thin cuticle secreted by the epidermis. The epidermal cells are very small, columnar in shape, and have their nuclei towards their base. The thickness of the cuticle and the epidermis together is 7.8μ . Essentially epidermal in nature, but projecting into the sub-epidermal region are numerous goblet-shaped gland cells. These have a granular secretion which stains deeply with haematoxylin but is unaffected by eosin. Each gland opens by a narrow duct on the middle of the annulus. The average size of these gland cells is $30\mu \times 10\mu$. The glands are much more numerous on the dorsal than on the ventral surface. The connective tissue layer is thin.

The longitudinal and circular muscles are well-developed, especially the latter. They together form a layer about 80μ in thickness.

In addition, dorso-ventral muscles are present, mainly in the posterior body region, where they are found between the paired diverticula of the alimentary canal.

The musculature of the posterior sucker is composed mainly of oblique fibres which enter the sucker from the body. At the junction between the body and the sucker a network of fibres is developed.

(b) *Coelom and Vascular System*: The coelom is represented by dorsal, ventral and lateral lacunae. Throughout the greater part of the body the dorsal lacuna contains the dorsal blood-vessel. In the intestinal region this blood-vessel becomes greatly enlarged and envelopes the intestine and its caeca as the intestinal sinus.

The ventral lacuna is much larger than the dorsal and contains the ventral nerve cord, the ventral blood-vessel and the ovaries. Anteriorly the lacuna becomes expanded to enclose the proboscis and related nervous structures. The two main longitudinal sinuses are connected by segmental commissures. In the testis region these are enlarged as the testicular lacunae and contain the testes.

The lateral longitudinal lacunae lie in the lateral angle of the body and are connected with the segmental lacunae by a short transverse branch.

(c) *Excretory System*: The excretory organs are nephridia. These occur in somites VIII-XXIV. The nephridia of the 1st and of the last two somites lack the ciliated opening into the ventral lacuna. In the clitellar somites no nephridiopores are present.

The nephridium opens to the exterior from a vesicle at the nephridiopore. This is situated on the ventral surface midway between the mid-ventral and lateral lines. The diameter of the vesicle is 31μ .

Internally, the nephridium opens by a ciliated neck into the ventral lacuna. The openings are situated dorso-laterally. The neck is about 39μ in length and leads into a large bladder (having a diameter of up to 90μ), which is frequently filled with intra-capsular leucocytes. The neck is lined with cilia which are directed towards the bladder.

(d) *Digestive System*: The mouth lies about the middle of the oral sucker and leads to the proboscis sheath; this contains the hollow muscular proboscis. The lumen of the proboscis is 3-cornered in section. The proboscis is long, extending back to XII, and it can be protruded for a distance equal to half the length of the body. It is succeeded by the short oesophagus, which is lined internally by a thick columnar epithelium. The oesophagus is succeeded in XIII by the crop, the two being separated by a constriction. Six pairs of caeca are given off from the sides of the crop. They lie in XIV, XIV/XV, XV/XVI, XVI/XVII, XVII/XVIII, and XIX-XXVI. The anterior pair is the smallest, and the succeeding pairs become larger. The 6th pair arises in XIX, and becomes elongated and directed posteriorly. Each of the members of this pair bears four to five accessory side-branches.

The central crop canal ends in XIX, where it is separated by a constriction from the following intestinal region. The anterior part of this bears four pairs of auriform caeca; these are found in XX, XXI, XXII and XXIII. The caeca are directed slightly forwards and those of the anterior pair are the largest.

The posterior part of the intestine consists of two expanded chambers, followed by the rectum. The anterior of these chambers in XXIII/XXIV, is very large, and ventral in position. It is closely constricted off on its postero-dorsal aspect from the 2nd chamber. This is followed by the rectum which opens mid-dorsally between 69/70.

Associated with the oesophagus is a paired mass of unicellular salivary glands, which extends through several segments. The ducts of these glands open into the base of the proboscis. The glands have a large secretion space and the nucleus lies in the cytoplasm at one side of this. The average diameter of the glands is 80μ .

(e) *Reproductive System*: In most other species the male and female apertures are separate, but in *G. tasmaniensis* they show the comparatively unusual feature of being united.

Male Organs: There are only four or five pairs of testes. The four pairs usually present lie between crop caeca 2/3, 3/4, 4/5, and 5/6; i.e., in somites XV, XVI, XVII and XVIII. If a 5th pair is present it is between caeca 1/2; i.e., in somite XIV. Sometimes only one member of the anterior pair is present; this was on one occasion found anterior to the 1st pair of crop caeca.

Anteriorly the paired longitudinal vasa deferentia become enlarged and muscular to form the ejaculatory ducts. The duct on each side is somewhat convoluted, and extends forward as far as X, where it turns ventro-posteriorly. The left and right ducts converge and unite in XI. The atrium opens into the common genital space.

Female System: The female organs are a pair of elongated and somewhat convoluted ovaries, extending back as far as XVII/XVIII. Anteriorly in XIII they pass into paired oviducts, which unite above and below the nerve cord to form a short muscular vagina, in the form of a collar encircling the ventral nerve cord. The vagina opens into the common genital space. The collar-like structure around the nerve cord is also known from *G. complanata* (L.) (Lameere, 1931, p. 196).

(f) *Nervous System and Segmentation:* The central nervous system consists of a double median ventral ganglionated chain. There are 21 free ganglia in addition to the anterior and posterior concentrations of six and seven ganglia respectively.

The macroscopically visible sense organs are three pairs of eyes in annuli 5/6, 7 and 8. The 1st pair lies close to the midline and is poorly developed. The pigmentation of this pair is paler than that of the two larger succeeding pairs. The 2nd pair of eyes is wider apart, darkly pigmented, and has an antero-lateral aspect. The eyes of the 3rd pair lie very close to those of the 2nd pair; they are also darkly pigmented and have a postero-lateral aspect.

Habits

These glossiphoniids, collected on the under surface of stones in a small creek at Antill Ponds, are very sensitive to light and spend most of their time under any cover that is available. This habit may be correlated with their lack of pigmentation.

Specimens of *G. tasmaniensis* were kept in fresh-water in Kilner jars. By changing the water regularly and providing a few small fresh-water snails as food from time to time, no difficulty was experienced in keeping the leeches alive for several weeks. The leeches devoured the snail, leaving an empty shell.

Affinities

G. tasmaniensis appears to be closely related to the *G. heteroclita*-*G. weberi* group, and in fact may be a variety of *heteroclita* (table XIV). However, in the literature concerning the latter species I have been able to find only one reference to individuals possessing fewer than six pairs of testes, that being in Johansson's paper (1918, p. 376) where he records five pairs. Other workers do not appear to confirm this. This may be due to the number that is most commonly present being given. In no case was the variation in the number of testes shown by the Tasmanian specimens due to immaturity.

TABLE XIV
Comparison of species of *Glossiphonia* which show similar features.

Character	<i>Glossiphonia heteroclita</i> (Linn.)	<i>G. weberi</i> Blanchard	<i>G. novae-caledoniae</i> Johansson	<i>G. tasmaniensis</i> sp. nov.
Size	9.5 mm. x 5 mm.	6-12 mm. x 3-55 mm.	5.5 mm. x 3 mm.	7-10 mm. x 3-4 mm.
Colour	Body amber-yellow at times grey-white never brown or brightly coloured. Sometimes with a median row of black spots	Ground-grey to orange, usually with 5 longitudinal rows of dark spots	Grey-white with median segmentally arranged spots	Grey-white
Eyes, 1 pair on each of annuli	5 (6), 7, 8 (varies)	6, 7, 8 (varies)	5, 7, 8	5, 7, 8
Total number annuli	70	70	70	70
Lower lip of oral sucker	5 and 6	5 and 6	4	5 and 6
Nature of body surface	Almost smooth	5 rows of papillae	No papillae median dorsal ridge present	Surface very finely granular. No segmental papillae
Post-anal rings	0	1	0	1
Position of reproductive aperture	United between 28/29	United: 27/28 or 28/29	Male: 26/27 Female: 27/28	United: 28/29
Number of testes	6 pairs	6 pairs	5 pairs	4 or 5 pairs

Only one other species of *Glossiphonia* has been described as having fewer than six pairs of testes, and that is *G. novae-Caledoniae* Johansson (1918, p. 376) where the number given is five pairs. This species, however, differs quite markedly from the Tasmanian specimens in that it has a low median dorsal ridge and the reproductive apertures are separated by one annulus (table XIV).

Distribution

Specimens of *G. tasmaniensis* were collected at Antill Ponds. They were taken from the under surface of stones in the creek running into the Curryjong Rivulet in this locality. The collection was made on 10th March, 1954. At this season, a large percentage of the leeches were carrying young.

GLOSSIPHONIA AUSTRALIENSIS Goddard 1908

(Figures 50-54)

DIAGNOSTIC FEATURES (after Autrum, 1936, p. 14).

The body is flesh-coloured and opaque; it resembles *G. heteroclitia* in general appearance. There is a pair of eyes present on each of annuli 2, 3 and 4, those of the 1st pair are smaller than the succeeding ones and are closer together; the eyes of the 2nd pair are very close to those of the 3rd. The posterior sucker is small. Altogether there are 70 annuli, one of which is post-anal. Papillae are not macroscopically visible. The mouth-opening lies slightly in front of the middle of the oral sucker. There are six pairs of crop caeca, the last of which extend from ring 44-60, and bear numerous (11) side-branches. There are four pairs of auriform intestinal caeca. Six pairs of testes are present; coiled seminal vesicles (in the ventral lacuna) are lacking. Ovisacs have a lateral diverticulum on either side of the union with the oviduct. Male and female apertures are separated by one annulus, which, however, is so short that outwardly the reproductive apertures appear to be united; male: 28/29; female: 29/30. Leeches 10 mm. long x 5 mm. wide.

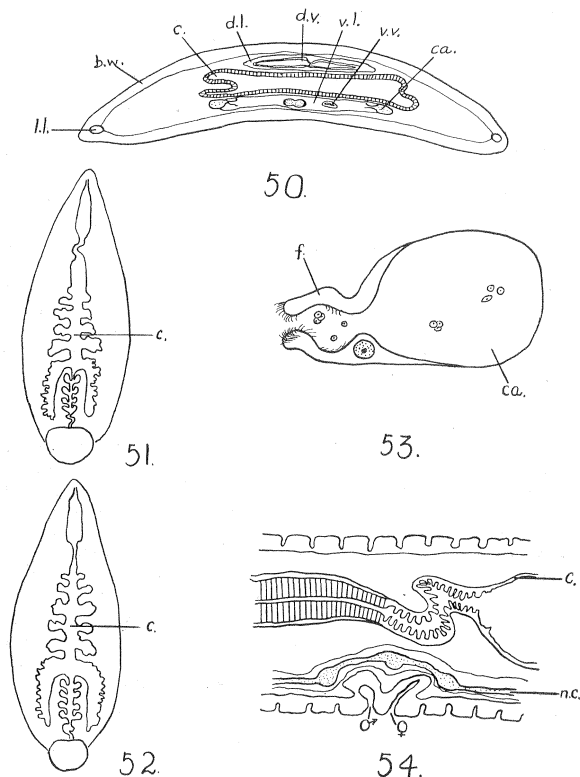
*Glossiphonia australiensis* Goddard, 1908.

FIG. 50.—Diagrammatic transverse section in the mid-body region, showing the position of the main organs.

FIG. 51.—Immature individual with only five pairs of crop caeca.

FIG. 52.—Mature individual with the normal six pairs of crop caeca.

FIG. 53.—Nephridial capsule and ciliated funnel.

FIG. 54.—Diagrammatic longitudinal section in the mid-line, showing the reproductive apertures.

b.w. body-wall and muscles; c. crop; ca. nephridial capsule; d.l. dorsal lacuna; d.v. dorsal blood-vessel; f. ciliated funnel of the nephridium; l.l. lateral lacuna; n.c. nerve cord; ♂. male reproductive aperture; ♀. female reproductive aperture; v.l. ventral lacuna; v.v. ventral blood-vessel.

R.S.—15.

The Tasmanian specimens show some slight variation from the above. The reproductive apertures are clearly distinct, and are separated by a well-defined annulus. The male aperture may be surrounded by swollen lips.

External Features

(a) *Size*: This leech is capable of considerable extension and contraction and so the average size is difficult to determine. The larger specimens are, when at rest, about 15 to 20 mm. in length, and 4 to 5 mm. in width. They are, however, capable of extension in length to 35 mm. Measurements of 100 individuals are given in Table XV. Most of the specimens below 8 mm. in length are immature, and are usually attached to the parent.

TABLE XV

Length and width measurements of 100 specimens of *G. australiensis* Goddard.

Number of Specimens	Length in mm.	Width in mm.	Number of Specimens	Length in mm.	Width in mm.
1	2.5	0.5	1	11.0	5.0
3	3.0	0.5	1	11.5	4.5
4	3.0	1.0	1	12.0	4.0
1	3.5	1.0	1	12.0	5.0
7	4.0	1.0	1	13.0	6.0
2	4.0	1.5	1	14.0	3.0
1	4.5	1.5	1	15.0	5.0
1	4.5	1.5	1	17.0	3.0
1	5.0	1.0	1	17.0	4.0
1	5.0	1.5	1	17.0	5.0
4	5.0	2.0	2	18.0	4.0
1	5.0	2.5	1	18.0	4.5
1	5.5	1.5	2	18.0	5.0
2	5.5	2.0	1	19.0	4.0
9	6.0	2.0	1	19.0	6.0
2	7.0	2.0	1	19.0	7.0
4	7.0	2.5	1	20.0	5.5
3	7.0	3.0	2	20.0	6.0
2	7.5	3.0	1	21.0	5.0
1	8.0	2.5	1	21.0	5.5
3	8.0	3.0	1	22.0	6.0
1	9.0	3.0	1	22.0	7.0
1	9.0	4.0	1	23.0	5.5
1	9.5	3.5	2	23.0	7.0
1	10.0	3.5	1	24.0	6.0
3	11.0	4.0	1	25.0	8.0
5	11.0	4.0	1	26.0	7.0
1	11.0	4.5	1	27.0	7.0
			1	39.0	10.5

Nine specimens carrying young had the following measurements:—

10.0 x 4.0	21.0 x 5.5
17.0 x 5.0	22.0 x 7.0
18.0 x 4.0	27.0 x 7.0
19.0 x 7.0	39.0 x 10.5
20.0 x 5.5	

(b) *Shape*: This is typically glossiphoniid.

(c) *Annulation*: The external annulation of the body comprises 70 annuli, which are sub-equal in size, except for the smaller anterior ones. Six annuli are incorporated in the anterior sucker, the posterior lip of which is formed by the 7th and 8th annuli, which are fused ventrally.

Eyes are present on annuli 2, 3 and 4. Those of the anterior pair are small and close to the mid-line; those of the 2nd and 3rd pairs are larger and more widely separated transversely, but are close to one another longitudinally.

The reproductive apertures are separated by a single annulus, the 29th. There is one post-anal annulus.

(d) *Pigmentation*: The ground colour of the body is light brownish, sometimes having a greenish tinge, especially in larger specimens. There is no conspicuous patterning. Segmental papillae are absent.

Internal Anatomy

(a) *Body-wall and Musculature*: The body-wall consists of a cuticle secreted by the one-layered epidermis, the cells of which are columnar. The cuticle and epidermis are raised up into a number of very fine papillae which give the surface a granular appearance in macroscopic view. Among the epidermal cells are goblet-shaped gland cells. These have the same appearance as those described by Goddard for specimens of *G. australiensis* collected in a creek near Oberon, N.S.W., by Dr. Hill.

Beneath the epidermis is a very narrow layer of connective tissue. The narrowness of this layer appears to be a feature in which the Tasmanian specimens differ from those described by Goddard (1908, p. 326) who, in giving an account of the body-wall of the mainland specimens says:

"The dermis is of considerable thickness, and consists of a matrix in which occur numerous cells with a large nucleus . . . The cells mentioned above as occurring in the matrix constitute the 'excretophores' of other species of *Glossiphonia*."

In the Tasmanian specimens, these "excretophores" have a large, clear secretion space, and their average diameter is 10 μ .

Beneath the connective tissue layer lies the musculature. The outer layer of circular muscles is 10-15 μ thick, while the longitudinal muscles, which are very well-developed, form a layer about 60 μ thick. Within the longitudinal muscles is well-developed botryoidal tissue.

(b) *Coelom and Vascular System*: The main coelomic elements are the dorsal, ventral and lateral sinuses. Of these, the ventral sinus is the most extensive. In it are found the ventral nervous system, the ventral blood-vessel, the ovaries and the testes. In addition, the ciliated funnels of the excretory system open laterally into the ventral sinus. The dorsal sinus is largely occupied by the dorsal blood-vessel.

These two sinuses are connected segmentally by dorso-ventral connectives. Laterally from these connectives, a branch is given off and passes out to the lateral sinus. This connecting system forms the intermediate lacunae. The lateral sinuses lie among the longitudinal muscles.

(c) *Excretory System*: Goddard (1908, p. 336) says:—

"*Nephridia*.—These are very much reduced and inconspicuous structures. No traces of the nephridial funnels have been seen in section, and no well-marked nephridiopores. The exact number of nephridia I have been unable to determine."

In the specimens before me, nephridia are present in somites IX to XXV. They are large conspicuous structures situated on either side of the alimentary canal, and when fully developed possess two apertures. The external opening on each side is an inconspicuous nephridiopore lying on the ventral surface mid-way between the mid-ventral and lateral positions. The inner opening is a well-developed ciliated funnel. This opens laterally into the ventral sinus at the level of the nerve ganglion, i.e., slightly anterior to the corresponding nephridiopore. This organ has the structure typical for the genus. Not all the nephridia possess this internal ciliated opening, it being absent from somites VII to XIV and XXV. In the lateral expansions of the ventral sinus in which lie the ovaries, the ciliated organs open laterally to these. Since the testes are intersegmental in position, they do not affect the position of the ciliated organs.

(d) *Digestive System*: The mouth opening lies about the centre of the anterior sucker, and leads into the proboscis sheath. This contains the proboscis, which extends as far back as XIII/XIV.

The ducts of a number of unicellular salivary glands enter the base of the proboscis, and run longitudinally within it, to open at its anterior extremity. These salivary glands are situated laterally in XI to XVI. They have an average diameter of 100 μ . There is a large secretion space filled with finely granular material which stains pink with eosin. The finely granular material is surrounded by the densely granular cytoplasm. The nucleus, which has several nucleoli, is situated within this cytoplasm, and to one side of the secretion space.

The proboscis is followed by a short oesophagus, which in turn leads into the crop. This is a large thin-walled region, normally provided with six pairs of lateral pouches (fig. 52); however, in immature forms, only the posterior five pairs of pouches are present (fig. 51). In such cases the anterior part of the crop canal is wide. The five pairs of pouches which follow arise in somites XVII, XVIII, XIX and XX. The last two pairs, and more especially the last pair, are much longer than the preceding ones. They are directed posteriorly, and the last pair extends back to somite XXVII. This pair is provided with 11 side-branches.

One of the diagnostic features of the genus *Glossiphonia* is the presence of six pairs of crop caeca. Thus at first glance, these specimens having only five pairs of caeca, appear to belong to a different genus. However, the development of the 6th (anterior) pair takes place with age. As the leech grows indications of the presence of the anterior pouches appear, often asymmetrically, so that only one member of the pair may be present in early stages. Large Tasmanian specimens of the leech always have the six pairs of caeca. Goddard noted this feature in specimens of *G. australiensis* from the mainland (1908 a, p. 329). In the Lake Dulverton specimens, indications of the 6th pair of caeca may be lacking in individuals of up to 10 mm. in length.

Immediately behind the origin of the last pair of caeca, the canal is constricted off from the following region, the thick-walled intestine. Arising from the main intestinal canal are four pairs of intestinal caeca. These are auriform in shape, and lie in somites XXII, XXIII, XXIV and XXV. The intestinal canal then opens into a large intestinal chamber in XXVI. The entire intestinal region is enveloped in a rich vascular sinus arising from the dorsal blood-vessel. The intestine is succeeded by the rectum, which opens to the exterior at the anus, between annuli 69/70.

Most specimens seen alive have the crop filled with dark material and the intestine with light, a change which is probably due to the processes of digestion.

(e) *Reproductive System*: This for the main part agrees with the condition found by Goddard in the mainland specimens. In the male system there are six pairs of testes lying intersegmentally in XV/XVI, XVI/XVII, XVII/XVIII, XVIII/XIX, XIX/XX and XX/XXI, between the crop caeca. The testes are united to paired vasa deferentia which anteriorly become the thick-walled ejaculatory ducts. These are slightly coiled, and extend forward to about XI. Here they turn in a ventro-posterior direction and converge to the mid-line, uniting in XI/XII. The terminal portions of the ducts form the spindle-shaped ejaculatory horns. The system opens at the male pore, which has fleshy lips in XI/XII.

The female organs are a pair of ovaries lying close to the mid-line. They pass anteriorly into oviducts and converge to open by a short vagina at the female aperture.

The species is protandrous. In a specimen 8.5 mm. in length (lacking the anterior pair of crop caeca) the testes are ripe, but the ovaries are very immature. The female ducts from the reproductive aperture to the anterior extension of the ovaries are filled with a mass of connective tissue. This is apparently present until the first eggs are laid.

(f) *Nervous System*: The Tasmanian specimens show no difference from the condition described by Goddard (1908, p. 336) for the mainland specimens.

Habits and Relation to the Hosts

G. australiensis is quite active in captivity, moving about the container with a characteristic looping movement. Those with young, when disturbed, roll themselves round their progeny in the typical glossiphoniid manner. When resting normally, the adult leech frequently attaches itself by both suckers and gently undulates the body, probably to ensure efficient aeration of the young attached to the ventral surface.

The members of this species prey on fresh-water snails and are therefore predators rather than parasites.

Comparison with Mainland Specimens

The Tasmanian specimens of *G. australiensis* differ slightly from the mainland type. These differences are chiefly in size, nature of the nephridia, and in the male reproductive aperture.

As shown in table XV there is considerable variation in size, mature specimens being up to four times as large as Goddard's type.

As mentioned above under *Excretory System* the nephridia are well-developed in the Lake Dulverton specimens. In his specimens from N.S.W., Goddard was unable to find any trace of ciliated nephridial funnels. In the Tasmanian specimens these are quite apparent in transverse section, although difficult to distinguish in longitudinal sections.

In the Tasmanian specimens, as contrasted with those of Goddard, the connective tissue layer is very thin.

As regards the genital apertures, Goddard (1908, p. 324) says:—

“When first examining the species I was inclined to regard the genital apertures as united On making a closer examination with the aid of sections, I found the apertures were distinct but separated by a single annulus—the 29th—which is much diminished in importance. The two apertures open into a depression with tumid lips which lies behind a clitellum-like swelling on the ventral surface between the 28th and 30th annuli. Probably one would be enabled to see these apertures if an examination were made of a perfectly extended organism.”

In the larger Tasmanian specimens the male reproductive aperture has thickened lips, and the female aperture is visible as a transverse slit behind the male aperture. In smaller specimens the lips of the male aperture are not so prominent. In no case is the 29th annulus so narrow that the apertures appear to be united.

Distribution

G. australiensis was originally described from specimens collected in a creek near Oberon, N.S.W. (Goddard, 1908). The species was also recorded from Tasmania (?). The specimens described above were collected on 10.3.54, from the underside of stones and pieces of wood in Lake Dulverton, Oatlands.

Sub-family HAEMENTERIINAE

Genus HAEMENTERIA de Filippi, 1849

DIAGNOSTIC FEATURES

Body broadly elliptical to lanceolate. Head region at times expanded and set on a neck-like constriction. Mount-opening always at the front of the sucker, on, or lying immediately behind, the upper lip, never in the centre of the sucker. Usually one pair of eyes, at times two, three or four pairs; rarely without eyes. Normal segment of three rings; in many species a_1 and a_2 are secondarily furrowed ventrally. Dorsum with papillae, which are seldom lacking; many species with pointed tubercles. Proboscis powerful, straight. Salivary glands usually in compact masses. Crop with 7 or 10 pairs of caeca. Reproductive apertures separated by two annuli.

Type: *H. (Haementeria) ghilianii* de Filippi, 1849.

Sub-genus **Placobdella**

Species of *Haementeria* having seven pairs of crop caeca and one pair of macroscopically visible eyes, or without eyes.

Type: *H. (P.) costata* (Fr. Müller, 1846).

A species of *Placobdella* occurs in Tasmania on the lamprey, *Geotria australis* Gray, and appears to be closely related to a species recorded from New Zealand by Benham (*P. maorica* Benham, 1907). The specific name *bdellae* is proposed for the Tasmanian species, in reference to the host animal.

PLACOBDELLA BDELLAE sp. nov.

(Figures 55-61)

DIAGNOSTIC FEATURES

P. bdellae is a small leech, leaf-like in outline. The body is practically colourless and translucent. One pair of macroscopically visible eyes is present on annuli 3/4. The total number of annuli is 70. There is 1 post-anal annulus. The reproductive apertures are in 27/28 (male) and 29/30 (female). Complete somites are 3-annulate. The salivary glands lie in two groups dorso-lateral to the proboscis in X/XI. Surrounding the region where the oesophagus passes into the crop in XII/XIII are a number of unicellular glands. The seven pairs of crop caeca are lobed distally. Six pairs of testes are present, alternating with the crop caeca in position.

The seminal vesicles and ejaculatory ducts form long loops lying in the ventral lacuna, and extending back to somite XX. Sixteen pairs of nephridia are present. Members of this species parasitize the pouched lamprey *Geotria australis* Gray.

External Features

The body is elongate, broader posteriorly, and somewhat compressed. When the leech is contracted, the shape becomes ovate, broader posteriorly, tapering sharply towards the anterior end. The leeches range in size from 11 mm. x 3 mm. to 15 mm. x 4 mm.

The total number of annuli is 70. Each complete somite is 3-annulate, and the middle (a_2) annulus is slightly larger than the 1st (a_1) and 3rd (a_3). Towards the anterior end of the body, the size of the annuli decreases.

Due to the presence of a large number of papillae, the dorsal surface of the body is rough. These papillae are particularly noticeable on every 3rd annulus (i.e., on the middle annulus of the somite) from the 8th to the 65th and on the 67th and the 69th, where they occur in four distinct longitudinal rows. In the mid-body region a median row is also present. In addition, there are numerous small papillae, which, however, do not form definite rows. The ventral surface of the body is smooth.

There is one pair of strongly pigmented eyes in somite III (annuli 3/4). They lie close to the midline and are directed antero-laterally.

The male and female reproductive apertures are separated by two annuli, the male opening between 27/28, and the female between 29/30. The anus lies behind the 69th annulus. The annulation of *P. bdellae* and of the closely related *P. maorica* is shown in table XVI.

TABLE XVI

Comparison of the annulation of *P. maorica* Benham and *P. bdellae* sp. nov.

Somite	Nature of Somite	
	<i>P. maorica</i>	<i>P. bdellae</i>
I	uniannulate	uniannulate
II	uniannulate	uniannulate
III	uniannulate	biannulate
IV	biannulate	biannulate
V	biannulate	triannulate
VI	triannulate	triannulate
VII-XXIII	triannulate	triannulate
XXIV	triannulate	triannulate
XXV	triannulate	biannulate
XXVI	uniannulate	uniannulate
XXVII	uniannulate	uniannulate
	69 + 2 or 3	70

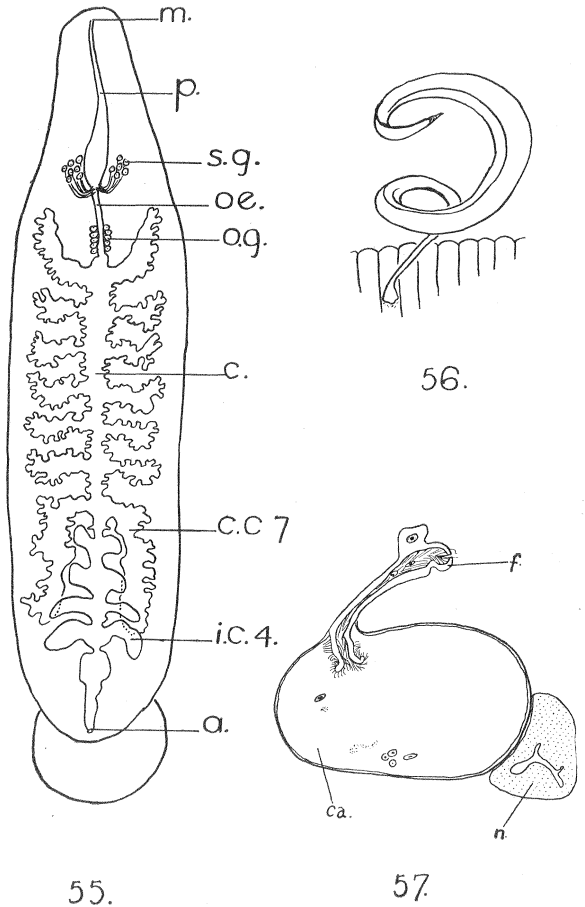
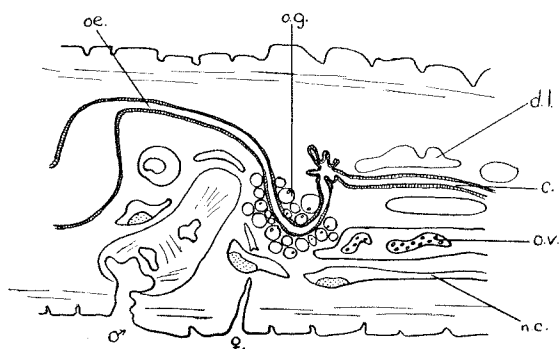
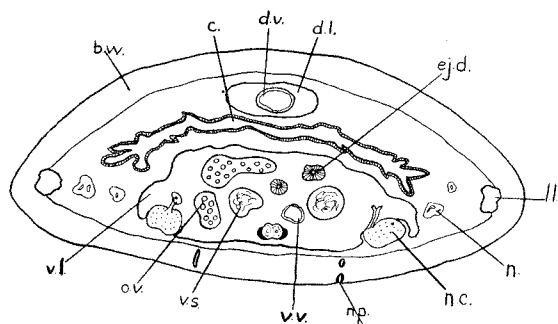


FIG. 55.—Entire animal, showing the alimentary canal.
 FIG. 56.—Spermatophore, attached to the body of the leech.
 FIG. 57.—Diagram of the nephridial capsule and ciliated funnel.
 a. anus; c. crop; ca. nephridial capsule; c.c.7, seventh pair of crop caeca; f. ciliated nephridial funnel; i.c.4, fourth pair of intestinal caeca; m. mouth; n. glandular part of nephridium; oe. oesophagus; o.g. glands surrounding the junction of the oesophagus and the crop; p. proboscis; s.g. salivary gland.



58.



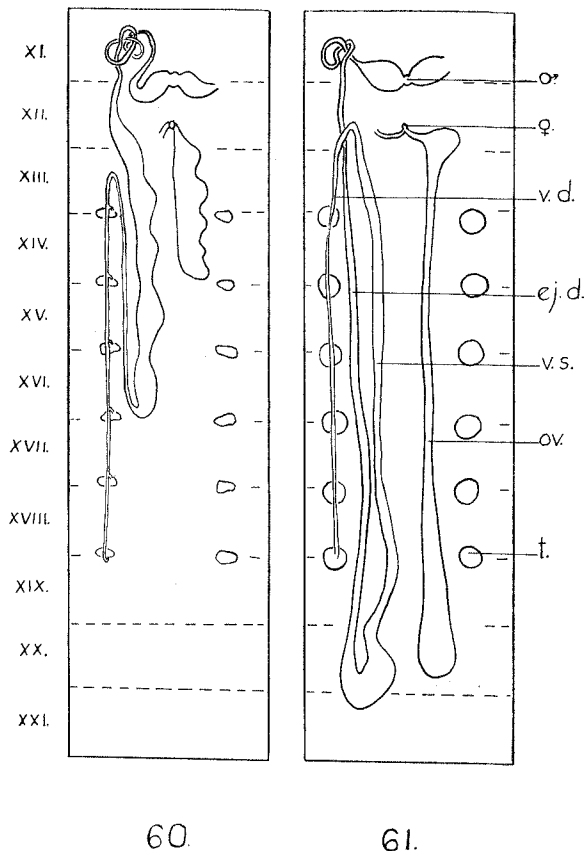
59.

Placobdella bdellae sp. nov.

FIG. 58.—Diagrammatic longitudinal section through the median line in the region of the reproductive apertures, showing the glands surrounding the junction of the oesophagus and crop.

FIG. 59.—Diagrammatic transverse section of the mid-body region, showing the position of the main organs.

b.w. body-wall and muscles; c. crop; d.l. dorsal lacuna; d.v. dorsal blood-vessel; ej.d. ejaculatory duct; l.l. lateral lacuna; n. nephridial tubule; n.c. nerve cord; n.p. nephridiopore; oe. oesophagus; o.g. glands surrounding the junction of the oesophagus and crop; ov. ovary; ♂. male reproductive aperture; ♀. female reproductive aperture; v.l. ventral lacuna; v.s. seminal vesicle; v.v. ventral blood-vessel.

*Placobdella maorica* Benham, 1907, and *P. bdellae* sp. nov.

Comparative diagrams of the reproductive systems.

FIG. 60.—*P. maorica*, after Benham, 1907.FIG. 61.—*P. bdellae*.

ej.d. ejaculatory duct; ♂. male reproductive aperture; ♀. female reproductive aperture; ov. ovary; t. testis; v.d. vas deferens; v.s. seminal vesicle; XI-XXI. somites XI-XXI.

Internal Anatomy

(a) *Body-wall and Musculature*: The outer layers of the body-wall consist of a cuticle and an epidermis. Together these form a layer 15μ in thickness. Beneath the epidermis is a layer of connective tissue, 20μ in thickness. In the middle annulus of each somite the greater part of the connective tissue layer is obliterated by the very well-developed hypodermal lacunae. Beneath the connective tissue layer lies the body musculature, consisting of an outer circular layer, and an inner longitudinal layer. These have thicknesses of 13μ and 100μ respectively.

Inside the musculature is more connective tissue. This is well-developed and as a consequence the coelom is reduced. In the connective tissue layers

surrounding the alimentary canal are numerous fat cells. These have a centrally placed, somewhat lobed nucleus.

(b) *Coelom and Vascular System*: The main coelomic elements are the four longitudinal lacunae. These are dorsal, ventral, and the right and left lateral lacunae. Anteriorly the dorsal and ventral lacunae unite in the region of XII, and a single anterior median lacuna is formed. A similar union takes place posteriorly in the anal region. The dorsal lacuna contains the dorsal blood-vessel. In the region of the intestine, this expands and envelops the intestine and the intestinal caeca as the intestinal sinus. The ventral lacuna contains the ciliated funnels of the nephridia, the central nervous system, the ventral blood-vessel and part of the reproductive system. The ventral blood-vessel lies above the nerve cord. The ovaries and the male reproductive ducts lie in the ventral lacuna, dorso-lateral to the nerve cord. They extend from somite XII to XX. The seminal vesicles and the ejaculatory ducts are dorsal to the ovisacs.

In addition to the four main lacunae, intermediate, segmental and hypodermal lacunae are present.

The intermediate lacunae form an irregular system of coelomic spaces on either side of the alimentary canal. They are particularly well-developed in the posterior body region, where they occupy nearly all the space between the intestine and the body musculature.

The segmental lacunae connect the dorsal, ventral and lateral lacunae. The hypodermal lacunae are given off from the lateral lacunae in the middle annulus of each somite, and extend through the sub-epidermal connective tissue layer on both dorsal and ventral surfaces.

Attached to the walls of the dorsal, ventral and especially the intermediate lacunae are cells which have an average size of 24μ by 15μ . The cytoplasm is alveolar in structure. There is a rounded nucleus, with a single excentrically placed nucleolus. These cells appear to agree in structure and position with the chloragogenous cells described by Scriban and Autrum (1932-34, pp. (8) 188-191), as occurring in various other species.

(c) *Excretory System*: The function of excretion is performed by 16 pairs of nephridia. These lie in somites VIII to XXIII. The nephridiopores lie on the ventral surface, mid-way between the mid-ventral and lateral lines. They have a very small vesicle. The nephridial tubules themselves are very well-developed. In longitudinal sections cut slightly medial to the lateral body-wall, the cut ends of the ascending and descending loops occupy a large portion of the lateral body space.

The nephridia, with the exception of those in XI and XII, open into the ventral coelom by large ciliated funnels and capsules. The capsules have an average diameter of 180μ and the funnels a length of about 120μ .

(d) *Alimentary Canal*: The mouth lies near the anterior end of the oral sucker in somite II. It leads to the proboscis sheath which contains the thick muscular proboscis. This extends back

to XI. The diameter of the proboscis increases posteriorly so that in X it is about twice as wide as it is anteriorly. The posterior end of the proboscis is bent.

Entering the proboscis at its base are the ducts of two groups of unicellular salivary glands. These lie in X/XI, dorso-lateral to the proboscis. The ducts pass back and then forward and down to enter the base of the proboscis in XI. The proboscis opens into the short S-shaped oesophagus, which extends back to XIII. Internally the oesophagus is lined with a thick epithelium. From the base of the proboscis the oesophagus takes an S-shaped course—down and forwards, then up and back—to somite XIII, where it enters the crop.

Surrounding the S-shaped region where the oesophagus passes into the crop are a number of unicellular glands. Their ducts open into the alimentary canal in this region. The glands resemble the salivary glands but their cytoplasm is not alveolar. Similar glands have been described for *P. maorica* Benham (1907), in which species they occur around the anterior part of the crop. In *P. bdellae* the lining of these two regions is very similar, making it difficult to fix the boundary between oesophagus and crop. The glands appear to be oesophageal.

Behind the glandular region, the crop is essentially a straight tube lying dorsal to the ventral lacuna, and extending from XIII to XX. In each of somites XIII to XIX it gives off laterally a pair of diverticula. The anterior pair is directed forwards, and extends into XI/XII. The 2nd to the 6th pairs are directed laterally, and the 7th posteriorly, extending to XXV.

In XX the crop enters the intestine. The anterior part of this bears four pairs of lateral caeca in XX, XXI, XXII and XXIII. Behind the pouched region, the intestine is expanded and somewhat coiled. It passes into a short rectal chamber which opens dorsally at the anus in 69/70.

(e) *Reproductive System*: The male reproductive organs consist of six pairs of testes situated inter-segmentally in XIII/XIV, to XVIII/XIX. The testes of each side are connected to a longitudinal vas deferens which passes forward to XIII where it turns and becomes expanded to form an elongated seminal vesicle. The seminal vesicle of each side extends back to somite XX, where it turns and becomes once more anteriorly directed. At about somite XVII, the seminal vesicles pass into the ejaculatory ducts. These are of smaller diameter and are lined with a thick glandular epithelium which practically obliterates the lumen of the duct.

Anteriorly the ejaculatory ducts develop muscular walls. They extend forward to X/XI, and then turn back in a postero-ventral direction, as the spindle-shaped ejaculatory horns. These unite in the midline, and the short bursa opens to the exterior by the male pore in XI/XII.

The greatly elongated seminal vesicles and ejaculatory ducts are very conspicuous. Throughout their entire length they lie above the ovaries in the ventral lacuna.

The ovisacs are a pair of elongated structures extending from XIII to XX. They are expanded posteriorly and again near the anterior end by masses of ova. From the anterior expansions there is a short oviducal horn or forwardly projecting region on either side. The oviducts are short and unite to form a median vagina which also is short. This passes through the body-wall to open at the female aperture in XII a_2/a_3 .

Spermatophores: Two specimens of *P. bdellae* had spermatophores attached to them; the positions were as follows:—

1. dorso-lateral on the right side, slightly anterior to the level of the male reproductive aperture;
2. similar in position, but on the left side of the body.

In *P. bdellae* the spermatophore is about 3 mm. in length. Two-thirds of this consists of the swollen sperm-filled region, and one-third of the narrower stalk leading to the attachment area or pedicel. The two tubes are cemented together for their entire length.

The spermatophores are whitish in colour, so apparently had not long been deposited when the leeches were killed. One spermatophore is straight, the other is coiled.

Habits

The leeches were first observed inside the buccal cavity of a pouched lamprey (*Geotria australis* Gray). This unusual locality did not appear to have any adverse effects on the leeches. Some time later the leeches left the host and were collected whilst crawling freely on the bottom of the aquarium tank in which the lamprey was kept.

The host of the closely related *P. maorica* Benham, 1907, is not known.

Affinities

Up till the present time, about 40 species have been assigned to the sub-genus *Placobdella*. Of these, 11 are doubtful species, and the internal anatomy of a further eight is undescribed. When compared with the remaining species, many of which are inadequately described, *P. bdellae* appears to be most closely related to *P. maorica* Benham, 1907. These two species are the only ones in which the glandular mass surrounding the alimentary canal in XII/XIII has been described.

The chief similarities and differences between the two species are summarised in Table XVII. The other Australian species *P. bancrofti* shows few points of similarity with *P. bdellae* and so is not included in the table.

TABLE XVII

Comparison of *P. maorica* Benham 1907, and *P. bdellae* sp. nov.

Character	<i>P. maorica</i> Benham	<i>P. bdellae</i> sp. nov.
Size	9 mm. x 4 mm.	11 mm. x 3 mm.—15 mm. x 4 mm.
Number of annuli	70 (? + 2)	70
Position of mouth	Probably in annulus 2	In somite II
Number and position of eyes	1 pair in annulus 3	1 pair in annulus 3/4
Position of reproductive apertures	Male: 25/26 Female: 27/28	Male: 27/28 Female: 29/30
Position of anus	On annulus 69	Between annuli 69/70
Dorsal papillae	4 longitudinal rows	5 longitudinal rows in the mid-body, 4 elsewhere
Posterior limit of proboscis	IX/X	XI
Salivary glands	Paired lateral masses in XI	Paired dorso-lateral masses in X/XI
Posterior limit of oesophagus	Short	S-shaped, extending to XIII
Crop caeca	7 pairs. The first is directed anteriorly and is sacculated, the 2nd to the 6th are each confined to 1 somite, and the 7th is directed posteriorly through about 4 somites and is also sacculated	7 pairs. The 1st is directed anteriorly, the 2nd to 6th are each confined to 1 somite, and the 7th is directed posteriorly to XXV. All are lobed distally
Anterior glands	Surrounds the crop in XI	Surrounds the alimentary canal in XII/XIII
Intestinal caeca	4 pairs	4 pairs
Ovaries	1 pair, sacculated in XIII/XIV	1 pair, elongated, extending from XIII to XX
Testes	6 pairs, intersegmental in XIII/XIV to XVIII/XIX	6 pairs, intersegmental in XIII/XIV to XVIII/XIX
Male ducts	Vesiculae seminales and ducti ejaculatorii form loops extending posteriorly to XVI	Vesiculae seminales and ducti ejaculatorii form loops extending posteriorly to XX/XXI
Nephridia	Funnels typical; total number not enumerated	16 pairs, in somites VIII/XXIII inclusive; large funnels present in all somites except XI and XII; nephridiopores are absent from XI and XII

ACKNOWLEDGEMENTS

The writer wishes to express her appreciation to Mr. A. M. Olsen, Mr. D. E. Kurth and Mr. W. D. Jackson for collecting specimens of some of the species described in this paper; to Professor L. R. Richardson of Wellington, New Zealand, for reprints, and for a specimen of *B. parkeri* from New Zealand waters; and to Professor Hickman for assistance and advice. For their help, the writer also is indebted to the members of the Zoology Department.

This work was carried out whilst the author was in receipt of a Research Grant from the University of Tasmania.

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