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Some digenetic trematodes from fishes of shallow Tasmanian waters

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ABBREVIATIONS USED IN TEXT FIGURES

C, cirrus; *Cs*, cirrus sac; *Cut*, cuticle; *Ec*, ecsoma; *Esv*, external seminal vesicle; *Ex ap*, excretory aperture; *Ex v*, excretory vesicle; *Gc*, genital cone; *Gp*, genital pore; *Hd*, hermaphrodite duct; *Int*, intestine; *I sv*, internal seminal vesicle; *Lc*, Laurer's canal; *Oc*, ocular pigment; *Oo*, ootype; *Oes*, oesophagus; *OS*, oral sucker; *Ov*, ovary; *P gl*, prostate gland; *Ph*, pharynx; *Pp*, pars prostatica; *P ph*, prepharynx; *Rs*, receptaculum seminis; *R su*, receptaculum seminis uterinum; *Sh gl*, shell gland; *S ph*, sphincter; *Ss*, sinus sac; *Sv*, seminal vesicle, *Tes*, testis; *Ut*, uterus; *Vas d*, vas deferens; *VS*, ventral sucker or acetabulum; *Yk d*, yolk duct; *Yk gl*, yolk gland; *Yk r*, yolk reservoir.

This contribution to our sparse knowledge of the helminth fauna of Tasmanian Fishes reports the presence of eight Trematodes, four of which are regarded as new. Apart from the taxonomic and morphological aspects, considerable interest accrues from a consideration of the significance of the presence of these particular species in Tasmanian waters.

Virtually nothing is known of the composition and distribution of the Trematode fauna of the fishes of the antarctic and southern temperate regions. Manter (1934) observes that many of the trematodes taken from deep-water fishes at Tortugas find their closest relatives in the fishes of Northern and far-distant waters rather in those of nearby shallow waters. Further, Manter remarks, 'It might even be found eventually that some species of trematodes have a continuous distribution from Arctic to Antarctic through deep-water hosts, although their shallow-water hosts might only appear in distant waters. Trematodes of the Antarctic are practically unknown and their comparison with deep-water forms of the tropics would be most interesting'.

The present paper, although limited in scope, bears out Manter's contention, e.g., *Helicometra fasciata*, herein reported from Tasmania, has been reported from both European and tropical waters. Again, *Hemiperina manteri* n.sp. finds its closest relative *(Hemiperina nicolli)* in deep waters at Tortugas, and the two members of the closely related genus *Hemipera* occur in British waters. *Derogenes crassus* has previously only been reported from deep waters at Tortugas. The occurrence of a new species of *Bivesicula* is of special interest as the three known species of this genus occur in Japanese waters. We may well expect the genus to have a continuous distribution from Northern to Southern hemispheres through the medium of deep-water tropical hosts.

Family ALLOCREADIIDAE

Sub-family *Allocreadiinae*

Helicometra fasciata (Rud.)

(Fig. 1)

Host: Neosebastes thetidis Waite.
Location in Host: Intestine, immediately beyond stomach.
Locality: Host obtained from Hobart fish market.
Frequency: Six specimens in one of six host fish examined. (March, 1945.)

Principal Dimensions

	Length mm.	Breadth mm.	Forebody mm.	Oral sucker mm.	Ventral sucker mm.	Eggs μ
1.	2·04	0·85	0·93	0·16	0·29	64 x 28
2.	2·49	1·09	0·99	0·19	0·36	88 x 28
3.	2·56	1·06	0·83	0·18	0·37	62-72 x 24
4.	2·79	1·08	1·11	0·19	0·36	72-88 x 24-28
5.	2·79	1·12	1·16	0·19	0·39	72-80 x 28-36
6.	3·63	1·45	1·58	0·28	0·46	88 x 28

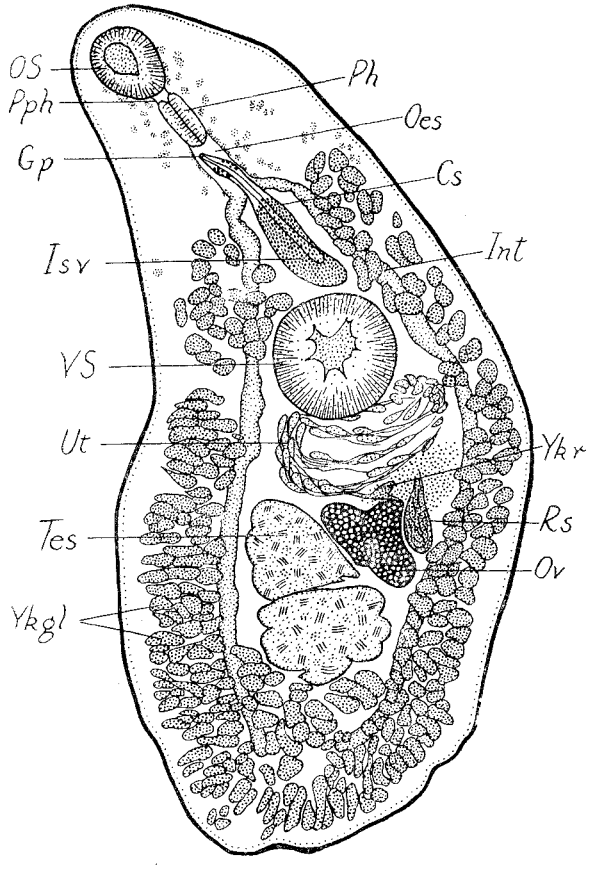

FIG. 1.—*Helicometra fasciata*, whole mount from the ventral aspect.

(For abbreviations used on figures, see beginning of paper.)

Minor differences occur between these specimens and descriptions of forms taken from different fishes in other regions, but there seems every reason to include them in *H. fasciata*. This species is one of the most widely distributed of digenetic trematodes, having been previously reported from the Atlantic and Mediterranean Oceans, Tortugas, Florida, and Mexico. This is the first record of its occurrence in Southern waters. Its presence here is of interest as its occurrence is now known to be from distant Northern to Southern waters, in cold and in tropical seas over a wide range of longitude.

Helicometra bassensis Woolcock

(Fig. 2)

Host: Platycephalus bassensis.
Location in host: Intestine.
Locality: Derwent Estuary.
Frequency: Four specimens in one fish examined. (Feb., 1945.)

Principal Dimensions

	Length mm.	Breadth mm.	Forebody mm.	Oral sucker mm.	Ventral sucker mm.	Eggs μ
1.	2·17	0·36	0·72	0·19	0·28	60 x 28
2.	2·25	0·51	0·47	0·21	0·34	56 x 28
3.	2·59	0·49	0·68	0·23	0·33	60 x 28
4.	3·31	0·56	0·83	0·24	0·37	60-70 x 28

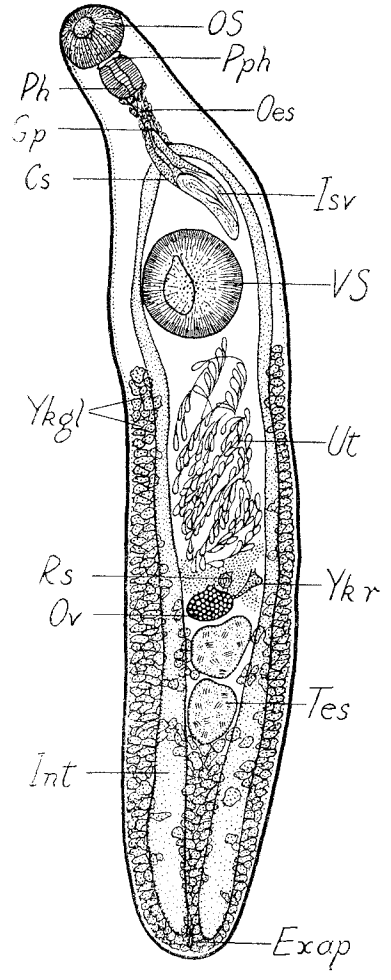

FIG. 2.—*Helicometra bassensis*, whole mount from the dorsal aspect.

There is no doubt that these trematodes represent *Helicometra bassensis*, but the specimens are worthy of note as the body is more slender and the testes are proportionately smaller than in Woolcock's specimens. The host is the same as that in which this species occurs in Victorian waters.

Family OPECOELIDAE

Sub-family *Opecoelinae*

Opecoelus tasmanicus n.sp.

(Figs 3-5)

Host: Latridopsis forsteri Castelnau.
Location in Host: Rectum.
Locality: Host obtained from Hobart fish market.
Frequency: Eight specimens from one of two hosts examined. (March, 1946.)

Principal Dimensions

	Length mm.	Breadth mm.	Forebody mm.	Oral sucker mm.	Ventral sucker mm.	Eggs μ
1.	2·74	0·86	0·73	0·24	0·39	—
2.	2·99	0·77	0·83	0·24	0·39	52 x 32
3.	3·34	0·86	1·06	0·27	0·42 x 0·39	60 x 32

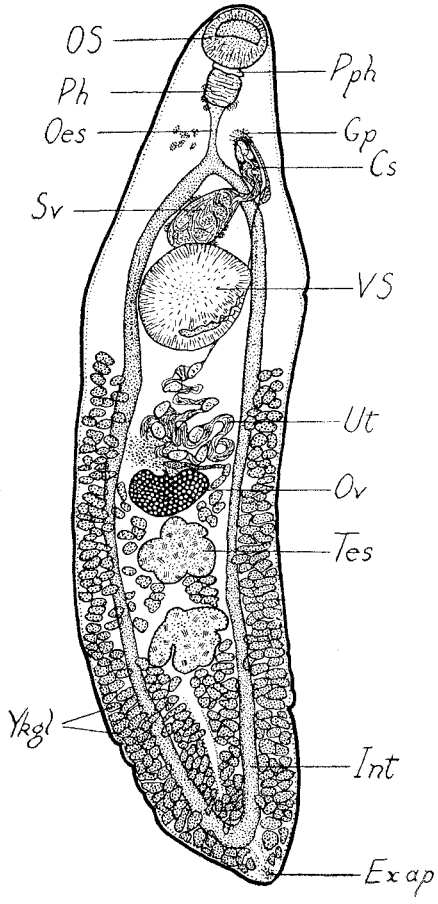

FIG. 3.—*Opecoelus tasmanicus*, n. sp., whole mount from the ventral aspect.

External features: The elongate body is broadest at the level of the testes. It tapers sharply towards the anterior end and is bluntly roundly tapered posteriorly. In section the worms are quite flat. The oral sucker is sub-terminal and is not preceded by a lip. The ventral sucker is situated at the junction of the first and middle thirds of the body length. It is slightly elongated transversely and opens by a transverse aperture, the lips of which are produced into five or six blunt papillae. The ventral sucker is not pedunculate. In this respect it differs from most species of Opecoelus. The common genital aperture is situated to the left of the oesophagus mid-way between the pharynx and the intestinal fork. The excretory pore is at the posterior tip of the body. A further aperture, the anus, occurs on the ventral surface just anterior to the excretory pore. The cuticle is smooth and spineless.

Alimentary System: The oral sucker is separated from the pharynx by a short thin-walled prepharynx. The pharynx measures 0·14 mm. long by 0·09 mm. in diameter, and is followed by a muscular oesophagus leading to the intestinal fork. The cuticle does not appear to extend into the gut beyond the pharynx. The two rami diverge and run backwards on either side of the body some little distance from the lateral margins. Posteriorly they unite into a continuous arc which runs parallel with the posterior border of the body. A blunt caecum from the middle of the posterior arc passes backwards to meet an invagination of the body wall forming a connecting tube between the intestine and the anus. The gut wall lacks conspicuous muscle fibres and is lined throughout by a flattened epithelium containing numerous ovoid nuclei.

Excretory System: There is a median excretory bladder which extends forwards as far as the ovary, lying dorsal to the testes. Anteriorly the vessel gives off a pair of slender vessels which diverge and run forward below the gut rami into the neck region.

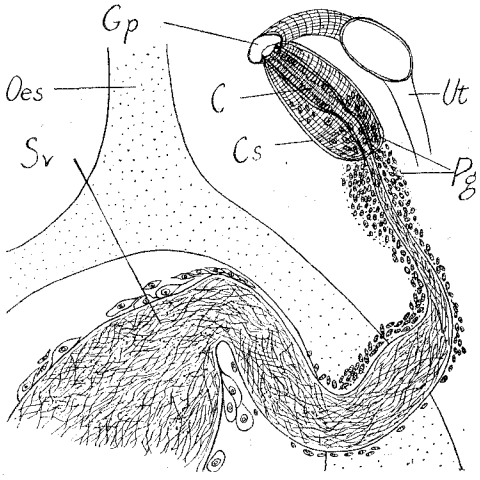

FIG. 4.—*Opecoelus tasmanicus*, n. sp., details of male terminal organs.

Reproductive System: i. *Male:*—The two testes are irregularly rounded lobed bodies lying one behind the other, between the rami, in the third quarter of the body length. They are elongated transversely and measure from 0·27 x 0·21 mm. to 0·52 x 0·39 mm. The anterior testis lies immediately behind the ovary and is

separated from the second by a short space which may be occupied to a more or less degree by yolk follicles. The vasa deferentia arise on the anterior borders of the testes and run forward above the ovary into the uterine region. They pass over the ventral sucker side by side and enter the base of the seminal vesicle. In the " in toto " mounts the vesicle lies obliquely in front of the ventral sucker, but in the contracted uncompressed specimens sectioned, the vesicle is seen to lie in the mid-line and to extend backwards for a considerable distance above the ventral sucker. The vesicle has the form of an elongated sac which tapers anteriorly as it crosses the left ramus of the gut and enters the cirrus sac. The size of the seminal vesicle varies greatly in different individuals. Very prominent gland cells which are highly vacuolate, are clustered about its thin wall. The cirrus sac measures about 0·14 mm. long and 0·06 mm. in diameter. It is quite muscular, possessing stout outer longitudinal and inner circular fibres. The tubular extension of the seminal vesicle lying within the sac leads into the pars prostatica. This portion of the male duct is short and is lined by the typical tall empty-looking cells. It receives the fine protoplasmic threads from the surrounding prostate gland which contains comparatively few darkly-staining nuclei and lies mainly outside the cirrus sac. The pars prostatica is followed by the terminal portion of the male duct approximately 0·05 mm. long which is slightly thickened and constitutes an unarmed cirrus. This leads into a short common genital atrium leading to the ventral surface.

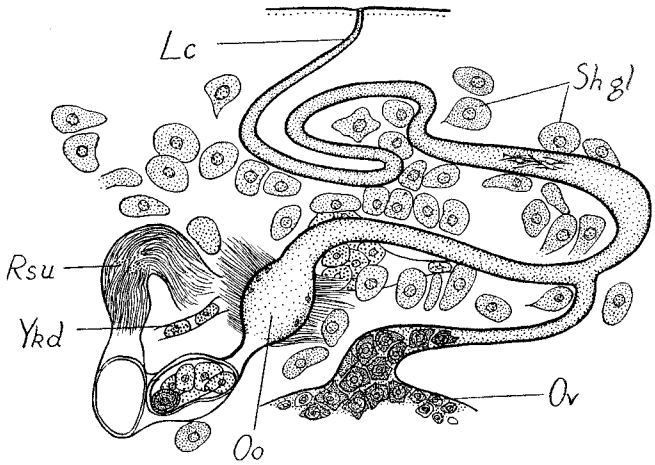

FIG. 5.—*Opecoelus tasmanicus*, n. sp., diagram of female genital complex reconstructed from transverse sections.

ii. *Female:*—The ovary is a compact kidney-shaped body lying directly in front of the anterior testis with its long axis directed transversely. In four " in toto " mounts the ovary measures approximately 0·30 x 0·15 mm. The oviduct leaves the ovary at the middle of its antero-dorsal surface, runs backwards and gives off Laurer's canal. This winds a sinuous course forwards and upwards and opens through the cuticle in the mid-line above the ovary. The canal contains masses of sperms in one specimen sectioned. After giving off Laurer's canal the oviduct expands into the ootype. This receives innumerable protoplasmic threads from the cells of the shell gland. The gland is well-developed and diffuse, extending right across the intercaecal space in front of the ovary. The gland cells are large and well defined, each containing a prominent nucleus and darkly-staining vacuolate cytoplasm. The female duct receives a short yolk duct from the yolk reservoir and

passes into the thin-walled uterus. Sperms may be present throughout the entire length of the uterus but the proximal loops consistently contain spermatic fluid and function as a receptaculum seminis. The convuluted uterus fills the intercaecal space between the ventral sucker and the ovary. It passes over the ventral sucker near the mid-line, and forwards along the left side of the seminal vesicle. The terminal portion of the uterus is muscular and may be distinguished as a metraterm. This opens into the common genital atrium in front of the male opening. The eggs are relatively large and thin-walled, possessing a circular operculum 12 μ in diameter. They are roundly ovoid in form and yellow in colour.

The vitellaria are small ovoid and irregularly formed follicles occupying the space between the lateral body margins and the gut rami. They are continued around the posterior arch of the gut and the intercaecal space in the vicinity of the ovary and the testes is largely filled by them. The yolk cells are collected by lateral yolk ducts which lie below the gut rami. Just in front of the ovary transverse ducts unite to form the central yolk reservoir. This tapers into a short duct which opens into the female duct. The vitellaria do not extend forwards beyond the posterior border of the ventral sucker.

Discussion: Opecoelus tasmanicus n.sp. seems most closely related to *O. mexicanus* Manter, from which it differs in its larger size and in the nature of the papillae of the ventral sucker. The seminal vesicle does not extend posterior to the ventral sucker in whole mounts and extended specimens. In this respect *O. tasmanicus* resembles those species placed in the genus Opegaster. However the vitellaria are entirely post-acetabular, and the glands present in the forebody do not appear to be concerned with the production of yolk. As Manter (1940) points out, the genera *Opecoelus* and *Opegaster* are very similar. It seems evident that the extent of the seminal vesicle and the vitellaria are unsatisfactory reasons for separating the genera. The tendency to raise minor differences to the rank of important diagnostic characters has long been exhibited by some writers on this group. The preferable course would seem to be the grouping of such similar species into one genus until such time as sufficiently clear sub-groups appear to warrant the setting up of several genera.

Family HEMIURIDAE

Sub-family *Derogenetinae*

Derogenes crassus Manter

(Figs 6-7)

Host: Physiculus barbartus Günther.

Location in Host: Gall bladder.

Locality: Hosts obtained from Hobart fish market.

Frequency: Seven specimens in one host (July, 1945). Absent from many hosts examined previously and since that date.

Principal Dimensions

	Length mm.	Breadth mm.	Forebody mm.	Oral Sucker mm.	Ventral Sucker mm.	Eggs μ
1.	3·44	1·12	1·50	0·37	0.81 x 0·75	64 x 28-32
2.	3·21	1·03	1·29	0·34	0·75 x 0·75	58-64 x 30-32
3.	2·85	0·93	1·17	0·34	0·67 x 0·67	60-64 x 28-32

The principal dimensions of three mounted specimens are given in the above table. The four remaining specimens were embedded and sectioned. Unfortunately the hard thick shells of the innumerable eggs which occupy most of the body prevented the preparation of successful serial sections.

Manter (1934) describes *Derogenes crassus* from a single mounted trematode which he regards as presenting sufficient differences from known species to warrant the formation of a new one. The present specimens are slightly larger than Manter's specimen but resemble it closely in proportion, the disposition of the internal organs and in the size of the eggs. There appears to be a difference in the form of the vitellaria, those of my specimens being roundly lobed, while those of Manter's specimen are described as compact and unlobed.

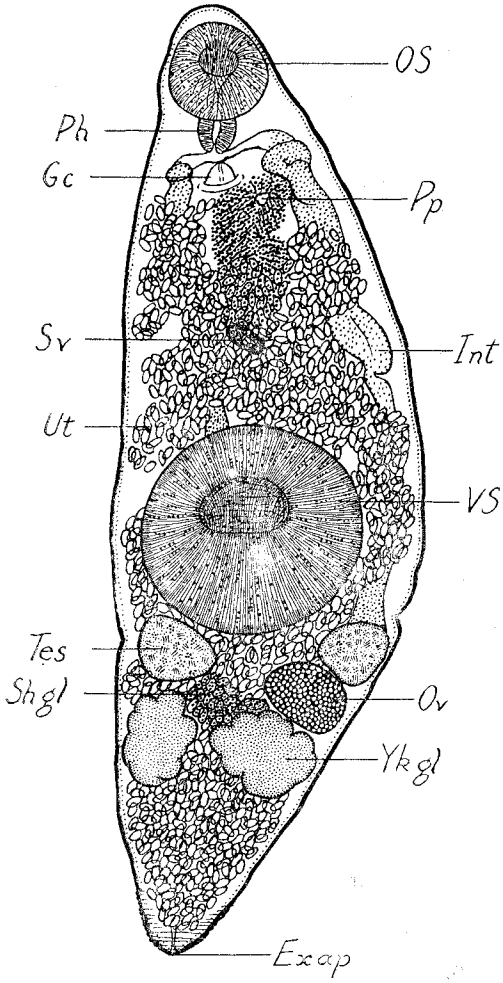

FIG. 6.—*Derogenes crassus*, whole mount from the ventral aspect.

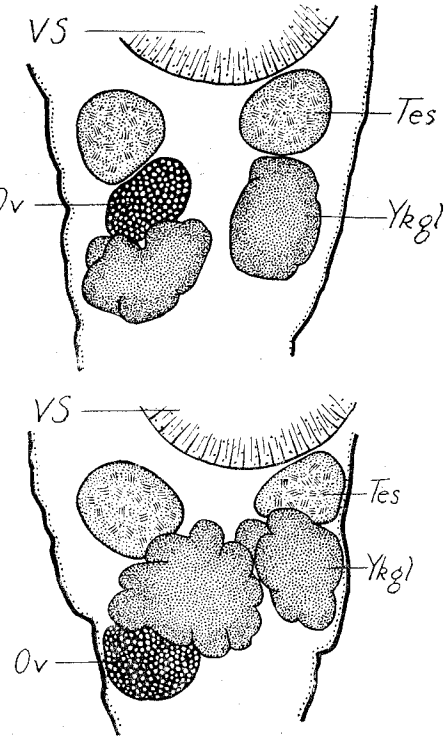

FIG. 7.—*Derogenes crassus*, sex glands of two specimens, both from the ventral aspect.

It is possible that a more detailed examination of the deep-water form from Tortugas, and of the Tasmanian form may reveal specific differences, but in view of the inadequate material available it seems quite advisable to include my specimens in *Derogenes crassus*. Slight displacement of the organs often occurs in the mounting of stout trematodes. This accounts for the variation in the relative positions of the ovary and vitellaria shown by the three mounted specimens (Fig. 7). The occurrence of the ovary on the left side in one specimen may not be due to displacement, but may represent a variation within the species.

Sub-family *Hemiurinae*

Parahemiurus lovettiae n.sp.

(Figs 8-9)

Host: Lovettia sealii Johnston ("White Bait").
Location in Host: Intestine.
Locality: Huon Estuary.
Frequency: One to three specimens in four of twelve hosts examined.

Principal Dimensions

	Length	Breadth	Fore-body	Oral Sucker	Aceta-bulum	Testes	Ovary	Eggs
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	μ
1.	1·21 + 0·25	0·29	0·18	0·08	0·15	0·13 x 0·098	0·13 x 0·08	20 x 8
2.	1·19 + 0·23	0·36	0·28	0·08	0·15	0·13 x 0·098	0·15 x 0·08	20 x 8
3.	1·27	0·39	0·16	0·08	0·15	0·098	0·114 x 0·065	20 x 8
4.	0·85 + 0·34	0·285	0·17	0·089	0·15	0·08	0·098 x 0·065	20 x 8
5.	0·91 + 0·23	0·28	0·10	0·08	0·15	0·114	0·13 x 0·08	21 x 9

External features: The body is slender and cylindrical, tapering towards the anterior end. Posteriorly the body is produced into a tapered "tail" or ecsoma, which is capable of complete withdrawal into the body. The ecsoma makes up approximately a quarter of the animal's total length. The oral sucker is terminal, its aperture being only slightly directed towards the ventral surface. The ventral sucker is situated approximately at the junction of the first and second fifths of the body length. The ratio between the suckers is 1 : 1·875. The excretory pore is at the tip of the ecsoma. The cuticle is produced into the prominent rings or plications, characteristic of the group. They extend laterally and ventrally for the full length of the soma, becoming gradually more separated towards the posterior end. They do not extend to the ecsoma. Dorsally the plications extend completely across the body beyond the level of the ventral sucker, but appear to be lacking beyond the level of the anterior testis.

Alimentary System: The oral sucker opens directly into the pharynx. This is spherical and measures 0·05 mm. in diameter. The pharynx leads into a globular muscular oesophagus or oesophageal pouch. Posteriorly the wall of the oesophagus is thickened to form a sphincter through which the oesophagus communicates with the two gut rami. The proximal portions of the rami are unlined and run directly transversely. The rami then turn sharply backwards and expand into thin-walled sinuous tubes, which are lined by an epithelium of closely-packed tall cells with basal nuclei. The cuticle does not appear to extend into the gut beyond the pharynx. The rami continue backwards lying dorsal to the ovary and vitellaria and enter the ecsoma, in some cases extending almost to the tip of the tail. The gut wall is very weakly muscular.

Excretory System: This species presents no variation from the typical system of the family. A single tubular vesicle penetrates the ecsoma and bifurcates approximately at the level of the testes. The branches diverge and pass forwards and towards the dorsal surface, fusing to form a continuous loop above the pharynx.

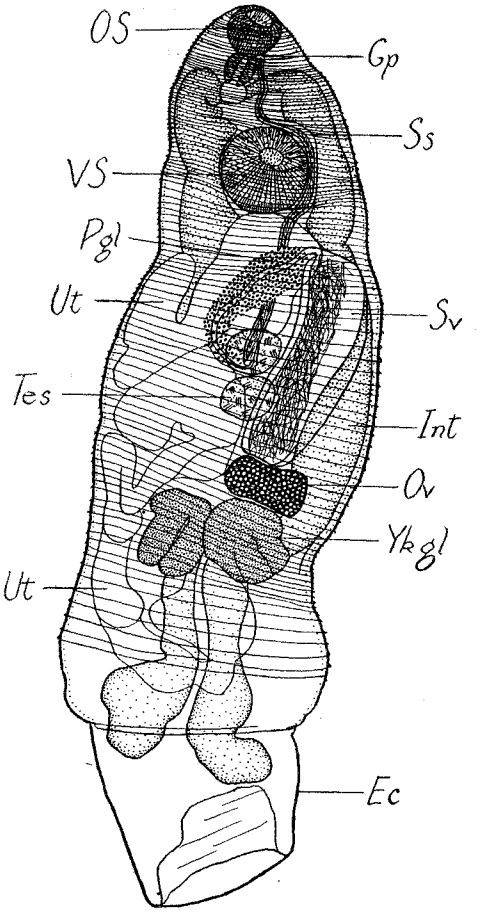

FIG. 8.—*Parahemiurus lovettiae*, n. sp., whole mount from the ventral aspect.

Reproductive System: i. *Male:*—The two testes are ovoid unlobed bodies lying directly or slightly obliquely in tandem in the middle region of the body. In all specimens examined the testes are in contact, never separated by loops of the uterus. The relative size of the testes varies somewhat in different individuals but they are always smaller than the ventral sucker and in most specimens, smaller than the ovary. The vasa deferentia are very short as they pass directly to the base of the seminal vesicle which may be to the right of the testes or directly dorsal to them. The vesicle is a large spindle-shaped muscular sac which extends obliquely forwards from the vicinity of the posterior testis to a point mid-way between the anterior testis and the ventral sucker, or almost to the posterior border of the latter. The seminal vesicle measures 0·2-0·3 mm. in length and 0·05-0·08 mm. in diameter at its middle length. The wall is extremely thick, the lumen measuring 0·032 mm. in diameter in the transverse section of a vesicle 0·08 mm. in diameter. As is the case in the other species placed in this genus the lumen is undivided. At its anterior extremity the vesicle tapers into a slender muscular duct which turns backwards and expands slightly forming a long pars prostatica 0·022 mm. in

diameter. The prostate gland consists of numerous individual small vacuolate cells which have prominent nuclei, clustered uniformly around the pars prostatica throughout its length. The prostate cells are not enclosed by any limiting membrane, and they become sparser posteriorly finally petering out. The male duct then meets and fuses with the narrow terminal portion of the female duct, forming the long narrow hermaphrodite duct which passes directly forwards over the ventral sucker, through the neck region to the genital pore. Throughout its entire length the duct is enclosed by a strongly muscular sinus sac which is separated from the duct by a narrow space. It seems certain that the terminal portion of the hermaphrodite duct functions as the copulatory organ, as Woolcock (1935) observes in the case of *P. australis.*

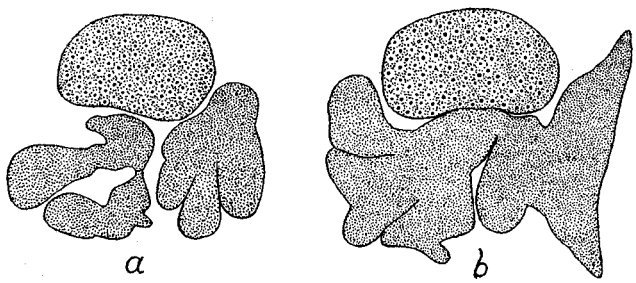

FIG. 9.—*Parahemiurus lovettiae*, n. sp., female glands of two specimens, "a" ventral view, "b" dorsal view.

ii. *Female:* The ovary is a smooth ovoid body situated towards the left side of the animal mid-way between the ventral sucker and the posterior end of the soma. In most specimens it is in contact with the posterior testis but it may be separated from that organ by loops of the extensive uterus. The ripe egg-cells measure 8 μ in diameter. The vitellaria are two adjacent lobed bodies lying immediately behind the ovary. In form they may be roundly bilobed or somewhat more divided (Fig. 9). The material is not favourable for the detailed examination of the course of the oviduct and vitelline ducts. However, the ootype lies immediately behind the ovary in a position dorsal to the vitellaria, and is surrounded by small cells with densely-staining contents, which constitute the shell gland. A small receptaculum seminis is present beside the shell gland. The uterus runs back into the ecsoma and then turns forward and fills most of the body spaces behind the ventral sucker. It is voluminous and contains very numerous elongate-ovoid eggs, which are light-brown in colour. The uterus narrows abruptly before fusing with the male duct to form the hermaphrodite duct or genital sinus.

Discussion: Since the genus *Parahemiurus* was erected by Vaz & Pereira (1930), with *P. parahemiurus* as the type, ten species have been added. Of these Manter (1940) recognizes only six, regarding *P. parahemiurus, P. platichthyi, P. atherinae,* and *P. harengulae* as synonyms of *P. merus* (Linton), and retaining *P. merus, P. australis, P. anchoviae, P. sardinae, P. seriolae,* and *P. ecuadori.* The species described above closely resembles *P. australis* in the form and proportions of the body, in the shape of the seminal vesicle, which in this species at least, does not appear to be variable, and in the size of the eggs. However, the body and all organs are markedly smaller and it differs from *P. australis* in the greater extent of the plications of the cuticle. The diagnostic value of the latter character is

generally accepted, but it is sometimes difficult to ascertain the extent with certainty and published descriptions are not always clear on this point. Until workers are agreed on the relative diagnostic importance of morphological characters in the Trematoda, and until the extent of the effects of different hosts and conditions upon a species are understood, the recognition of individual species of *Parahemiurus* will remain controversial. However, there is a sufficiently clear group of related species with sufficiently marked individual differences to ensure the survival of this genus.

Parahemiurus australis Woolcock

(Fig. 10)

In a previous paper (Crowcroft, 1946), the writer pointed out the presence of a Hemiurid which appeared to be *Parahemiurus australis*, in the stomach of the 'Rock Cod', *Physiculus barbartus* Günther. The principal dimensions of the specimens are given here for purposes of comparision with those of the preceding species. An illustration of a whole mount is given for the convenience of local students.

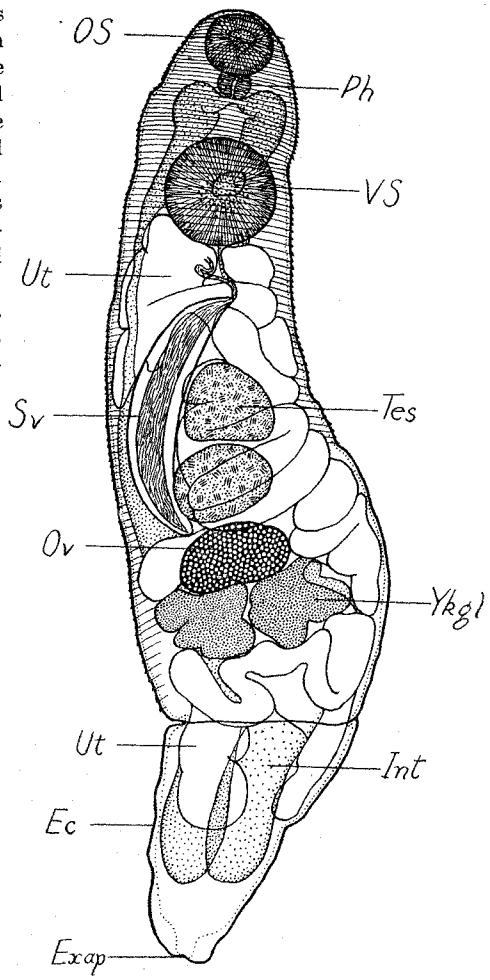

FIG. 10.—*Parahemiurus australis*, whole mount from the dorsal aspect.

Principal Dimensions

	Length	Breadth	Fore-body	Oral Sucker	Aceta-bulum	Testes	Ovary	Egg
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	μ
1.	1·83 + 0·44	0·51	0·29	0·15	0·28	0·23 x 0·15	0·28 x 0·13	20 x 8
2.	1·68 + 0·52	0·72	0·34	0·18	0·32	0·18 x 0·11	0·26 x 0·15	24 x 8
3.	1.66 + 0·41	0·52	0·39	0·18	0·29	0·19 x 0·11	0·26 x 0·13	20 x 8
4.	1·55 + 0·42	0·46	0·29	0·13	0·24	0·13	0·20 x 0·12	22 x 6
5.	1·38 + 0·52	0·54	0·27	0·16	0·25	0·23 x 0·16	0·24 x 0·13	22 x 8

Hemiperina manteri n.sp.

(Figs 11-12)

Hosts: 1. *Latridopsis forsteri* Castelnau (" Bastard trumpeter ").
2. *Cheilodactylus spectabilis* Hutton (" Carp ").

Location in Host: Stomach.

Locality: Hosts obtained from Hobart fish market.

Frequency: Twenty-one specimens in the first host and two specimens in the second. (March, 1946.)

External features: The body is elongate, and almost round in section being only slightly flattened ventrally. The thick cuticle is unspined and smooth. The body is broadest at the level of the ventral sucker which is situated at the junction of the second and last thirds of the body length. In front of the ventral sucker the body tapers gradually to the bluntly rounded anterior end. Posteriorly the body tapers strongly. The oral sucker is surmounted by a fleshy pre-oral lip. The principal dimensions of nine mounted specimens are given in the following table. Specimens 5 and 6 are those taken from the second host mentioned above.

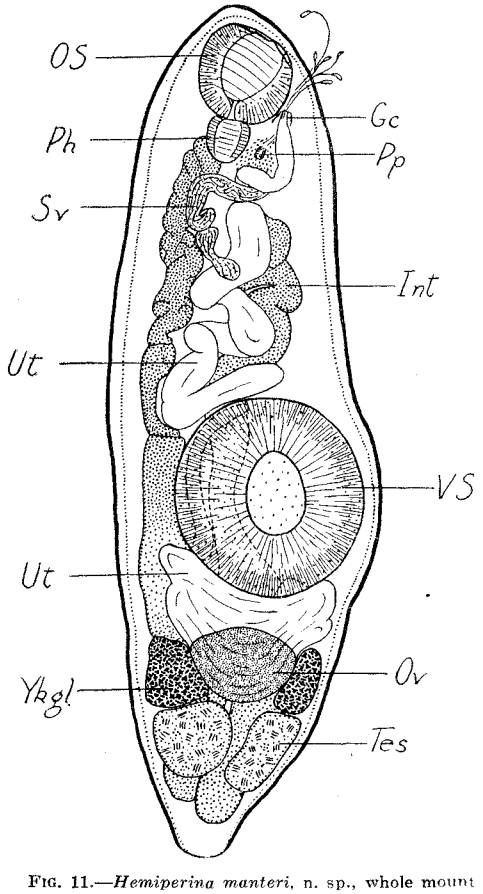

FIG. 11.—*Hemiperina manteri*, n. sp., whole mount from the ventral aspect.

Principal Dimensions

	Length	Breadth	Forebody	Oral Sucker	Ventral Sucker	Eggs
	mm.	mm.	mm.	mm.	mm.	μ
1.	2·07	0·68	0·93	0·24	0·50	32 x 12
2.	2·10	0·79	1·03	0·24	0·46	32 x 12
3.	2·23	0·64	1·08	0·26	0·46	32 x 12
4.	2·44	0·81	1·11	0·29	0·62	32 x 12
5.	2·51	0·81	1·16	0·27	0·52	32 x 12
6.	2.62	0·81	1·45	0·29	0·55	32 x 12
7.	2·62	0·83	1·24	0·29	0·60	36 x 12
8.	2·67	0·78	1·35	0·31	0·59	32 x 12
9.	3·01	0·70	1·47	0·28	0·55	40 x 8-12

The common genital aperture is situated at the end of a protusible genital cone, which is median in position, a short distance behind the oral sucker. The excretory aperture is a simple pore at the posterior extremity.

Digestive System: The oral sucker is applied to the pharynx postero-dorsally, a prepharynx being absent. The pharynx is slightly longer than its diameter, measuring 0·114 mm. x 0·08 mm. Posteriorly it opens into a short oesophagus whose wall is thinly muscular consisting of inner circular and outer longitudinal fibres. At its junction with the pharynx, the oesophagus is narrow but it rapidly expands into the oesophageal pouch frequently seen in this family. The oral sucker, pharynx and oesophagus are lined by an internal extension of the cuticle. The gut rami arise from the dorsal wall of the oesophageal pouch. A proximal portion of each ramus is smooth and unlined and runs directly outwards from its origin. The rami then turn backwards and pass through the long forebody. They lie some distance from the body margins and enclose the uterus. They pass over the ventral sucker lying closely together, diverge behind that organ to encompass the shell gland and continue backwards side by side almost to the posterior end of the body. Throughout their length the rami are lined by large collumnar cells containing prominent nuclei. These cells are somewhat separated from one another and impart a speckled appearance to the rami of the stained " in toto " mounts. The actual wall of the gut is membranous and apparently lacks distinct muscle fibres.

Excretory System: The posterior, single median portion of the excretory vesicle is quite short bifurcating behind the level of the vitellaria. The two arms run forward side by side to about the level of the ovary. They then diverge and come to lie beneath the gut rami. In this position the paired canals run forward throughout the forebody. Anteriorly they pass towards the dorsal surface and are seen to be continuous with one another above the pharynx.

Reproductive System: i. *Male.*—There are two roundly triangular entire testes lying almost side by side in the posterior fifth of the body. In specimens 5 and 6 of the above table the testes measured 0·26 x 0·21 and 0·13 x 0·24 and 0·19 x 0·29 respectively, but they were either lacking or partially disintegrated in the specimens taken from *Latridopsis forsteri.* The testes lie immediately behind the vitellaria, and when fully developed their posterior border is but a short distance in front of the termination of the gut rami. The fine vasa deferentia were not completely traced forwards but were seen to unite at the base of the seminal vesicle mid-way between the suckers. The seminal vesicle takes the form of a sinuous tube 0·05 mm. in diameter which runs forward almost to the bifurcation of the gut. Its wall is membranous and contains widely-scattered flattened nuclei. At its anterior end the vesicle narrows abruptly into a duct which runs forward and downwards and opens through a sphincter into the pars prostatica. This measures 0.018 mm. in

diameter. The lumen is very narrow due to the lining of tall empty-looking cells. The pars prostatica and the narrow portion of the seminal vesicle leading to it are surrounded by the numerous cells which constitute the well-developed diffuse prostate gland. Fine protoplasmic threads radiate backwards and outwards from the wall of the pars prostatica to the vacuolate prostate cells. The pars narrows and passes through the somewhat diffuse meridional muscles which must be regarded as constituting a sinus-sac. The typical prostatic lining is lost and when the male duct penetrates as far as the centre of the sinus-sac, it receives the metraterm posteriorly, forming the genital sinus or hermaphrodite duct. The sinus-sac measures 0·068 mm. in diameter and appears to be responsible for the eversion of the genital cone through which the hermaphrodite duct passes to the genital aperture situated at its extremity.

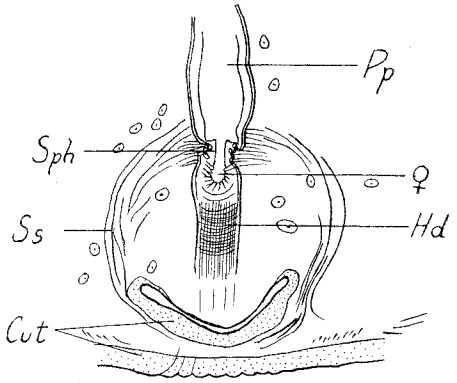

FIG. 12.—*Hemiperina manteri*, n. sp., portion of a transverse section showing junction of male and female ducts.

ii. *Female:* The ovary is situated a short distance in front of the testes in a median position. It is globular and in specimens mounted under cover-glass pressure appears transversely elongated measuring 0·098-0·19 x 0·16-0·29 mm. The nuclei in the ovary measure 0·008 mm. in diameter. Dorsally the ovary passes into a narrow oviduct which runs directly dorsal for a short distance. It then turns abruptly and receives Laurer's canal. This runs forward sinuously for a short distance and opens on the dorsal surface, in the mid-line. The canal is slightly dilated a short distance from its origin and may function as a receptaculum seminis. Laurer's canal measures 0·015 mm. in diameter but is lined by a thick non-staining layer which leaves only a narrow lumen. A very short distance from its junction with Laurer's canal the oviduct receives a short narrow yolk duct from the central yolk reservoir, and enters the compact shell gland. The latter is globular and measures 0·09 mm. in diameter. The numerous cells of the gland display abundant contents and prominent nuclei. Within the shell gland the female duct runs backwards, describes a complete turn and runs antero-ventrally as the ootype.

The vitelline glands are two entire ovoid bodies lying on either side of the ovary and extending slightly beyond that organ posteriorly. They are approximately equal in size measuring about 0·16 x 0·11 mm. and vary only slightly in form in the mounted specimens. The glands are bounded by thin membranous

walls and are loosely packed with yolk cells. The cells contain yolk particles and large spherical nuclei each with a single prominent nucleolus. A yolk duct leaves each gland on its innermost surface and runs obliquely dorsally between the ovary and the gut. They unite into a fairly large yolk reservoir dorsal to the ovary and immediately behind the origin of the oviduct.

After leaving the shell gland the female duct expands slightly into the uterus. This describes many loops and below and in front of the ovary forms a compact mass which extends forward to the ventral sucker. The uterus then passes over the ventral sucker between the gut rami and describes a helical spiralled course to the level of the prostate gland. Here it narrows into a muscular metraterm 0·028 mm. in diameter which runs forwards and downwards and penetrates the sinus-sac. It opens through a stout sphincter into the common genital sinus which measures 0·024 mm. in diameter and 0·06 mm. long when the genital cone is retracted. The first loops of the uterus contain numerous sperms and function as a uterine seminal receptacle.

The innumerable eggs are light-brown in colour. They are elongate, bearing a bluntly-rounded operculum in front and at the other end tapering into a very long slender filament which is many times longer than the body of the egg.

Discussion: The genus Hemiperina was set up by Manter (1934) for a single species, *Hemiperina nicolli.* Manter did not include this species in the genus *Hemipera* Nicoll " because of the evident lack of a cirrus sac, absence of a seminal receptacle, better prostate gland and much smaller eggs." The species described above is identical in size with *Hemiperina nicolli* and closely resembles it in structure, The chief differences are in the form of the seminal vesicle and the presence in *Hemiperina manteri* of a weakly-developed sinus-sac. The genus *Hemipera* Nicoll contains two species *H. ovocaudata* Nicoll and *H. sharpei* Jones. The four allied species are compared in the following table:—

	Hemipera ovocaudata	*H. sharpei*	*Hemiperina nicolli*	*H. manteri*
Host	*Lepadogaster gounnaii*	*Cepola rubescens*	*Chaunax nuttingi Diplacanthopoma brachysoma Dibranchus atlanticus*	*Latridopsis forsteri Cheilodactylus spectabilis*
Location in Host	Stomach	Under Gill-cover	Stomach	Stomach
Length mm.	1·54 x 0·56	4·77 x 0·85	2·07-3·13 x 0·72-0·87	2·07-3·01 x 0·68-0·83
Oral Sucker	0·22 mm.	0·37 mm.	ratio 2 : 3 or 3 : 4	0·24-0·31 mm.
Ventral Sucker	0·4 mm.	0·74 mm.		0·46-0·62 mm.
Termination of male duct	Cirrus-sac present containing prostate gland. Vesicula seminalis externa present	Cirrus-sac present, probably contains prostate gland, and seminal vesicle	Cirrus-sac absent. Well-developed free prostate gland and seminal ves. present. Vesicle sac-shaped and muscular	Sinus-sac weakly developed. Well-developed free prostate gland and seminal ves. present. Ves. tubular, thin-walled
Female Complex	No distinct receptaculum sem. Laurer's canal 'apparently absent'	Prominent receptac. sem. present. Laurer's canal present	Receptac. sem. uterinum present. Laurer's canal not described	Receptac. sem. uterinum present. Laurer's canal present
Eggs	μ 100 x 27 with short filaments	100 x 38 with filaments about 11 times egg length	44-52 x 16-20 with filaments at least 20 times egg length	32-40 x 8-12 with filaments at least 20 times egg length

Although a weakly-developed sinus-sac is present in *Hemiperina manteri* this structure does not correspond to the cirrus-sac of *Hemipera* but is parallel rather with the sinus-sac of *Theletrum.* The generic diagnosis of *Hemiperina* must therefore be amended to include forms in which a sinus-sac is in evidence.

Family BIVESICULIDAE

Bivesicula australis n.sp.

(Figs 13-15)

Host: Neosebastes thetidis Waite.

Location in Host: Intestine, near stomach.

Locality: Hosts obtained from Hobart fish market.

Frequency: One in each of three hosts, two in one host, absent from four others examined (December, 1944; March, 1945).

Principal Dimensions

	Length mm.	Breadth mm.	Oral Sucker mm.	Ovary mm.	Testis mm.	Eggs μ
1.	1·59	0·62	0·15	0·15	0·24 x 0·29	84 x 48
2.	2·51	1·04	0·31	0·13 x 0·16	0·41	60 x 44
3.	2·54	1·17	0·26	0·19	0·39 x 0·41	72 x 48

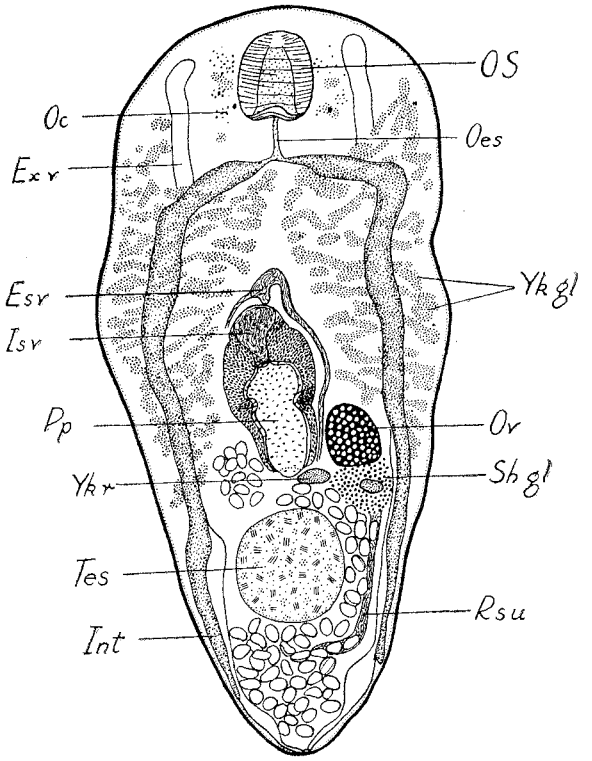

FIG. 13.—*Bivesicular australis*, n. sp., contracted whole mount from the dorsal aspect.

External Features: The small, highly-contractile trematodes, appear fusiform in the extended state, but when contracted they are clavate, tapering from before backwards. The oral sucker is funnel-shaped, and is terminal in position. It may be completely withdrawn into the body and in this position it communicates with the exterior through a ventral invagination of the body wall. No acetabulum is present.

The cuticle is thick and towards the front end of the animal is armed with extremely minute spinules. Numerous blindly terminating tubules occur around the border of the oral sucker and for some distance posterior to that organ. These tubules are quite similar to those described by Woolcock (1935) from *Helicometra tenuifolia*. As in that species the tubules are probably excretory in function. The genital pore is situated on the ventral surface in the mid-line, at the junction of the middle and last thirds of the body. The excretory pore is at the posterior extremity. The worms are 'ocular', an area containing pigment granules occurring on either side of the oesophagus.

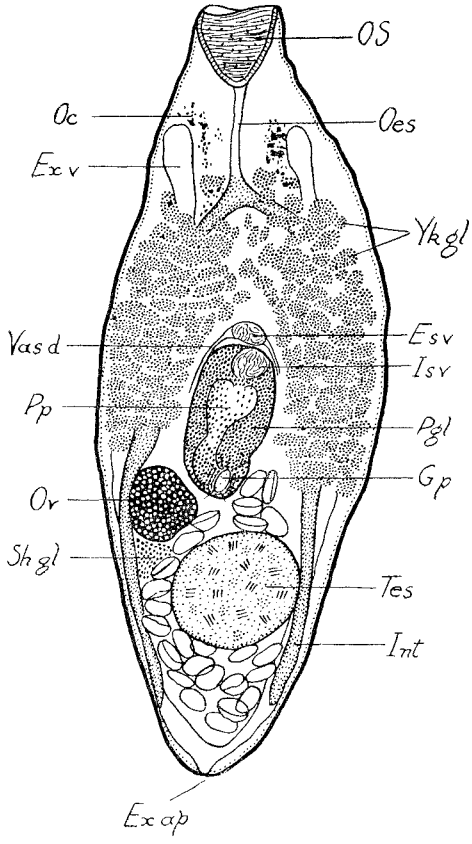

FIG. 14.—*Bivesicula australis*, n. sp., extended whole mount from the ventral aspect.

Alimentary System: The oral sucker opens directly into the oesophagus, a distinct pharynx being absent. The oesophagus is narrow and its length varies greatly according to the state of contraction of the specimen. When contracted its wall is strongly muscular possessing stout inner circular and outer longitudinal fibres. Posteriorly the oesophagus opens into the gut rami, which diverge sharply and come to lie close to the body margins. The rami extend backwards almost to the posterior extremity of the body, as smooth sinuous tubes, uniformly round or oval in section and tapering considerably towards their extremities. The walls of the rami are membranous and lined by a flattened epithelium containing very numerous ovoid nuclei.

Excretory System: Paired excretory vesicles fuse immediately in front of the excretory pore. They extend forwards from this point as greatly distendable tubes which pass forwards on either of the testis, lying below the gut. Anterior to the testis they narrow and pass between the gut rami and the cirrus-sac. In front of the cirrus-sac they pass between the converging gut rami, and occupy the bulk of the lateral regions of the body. In contracted specimens the vesicles appear to terminate in front of the posterior border of the oral sucker, but when the animal is normally extended they do not reach the level of that organ. The walls of the excretory vesicles are membranous, containing widely-separated nuclei.

Reproductive System: i. *Male.*—The single large testis is median, lying in the intercaecal space in the posterior third of the body. It is circular or roundly oval in outline and flattened dorso-ventrally. The testis is bounded by a membranous wall containing flattened nuclei. Two vasa deferentia arise from the anterior border of the testis, and run forward along the right and left sides of the cirrus-sac. The cirrus-sac is a relatively large cylindrical structure which measures 0·33 mm. in diameter, and 0·65 mm. long in the largest specimen. It occupies the middle third of the body length and lies in the mid-line entirely in front of the genital pore. Its wall is strongly muscular, consisting of stout inner circular and outer longitudinal fibres. The vasa deferentia expand and fuse into a small 'external' seminal sevicle which lies at the anterior end of the cirrus-sac. This vesicle communicates with an 'internal' seminal vesicle within the cirrus-sac, by means of a fine duct.

The 'internal' seminal vesicle possesses a weakly muscular wall and is almost spherical in form. It narrows abruptly into a short muscular duct surrounded by a sphincter. This duct leads into the pars prostatica, which occupies most of the volume of the cirrus-sac. The wall of the pars is thick, being composed of stout outer longitudinal and inner circular fibres. It is lined by the typical empty-looking cells, which are relatively tall. The musculature and the epithelium are more strongly developed along one side producing a prominent ridge which projects into the lumen. Anteriorly the pars is produced into two lateral pouches, one of which extends forwards on either side of the internal seminal vesicle. The remaining space within the cirrus-sac is occupied by the well-developed prostate gland. This consists of a matrix in which numerous ovoid nuclei are embedded. The nuclei are densely arranged in an outer zone near the sac wall, leaving an inner clear zone surrounding the pars prostatica which consists of radiating protoplasmic strands. A short distance in front of the posterior end of the cirrus-sac the pars prostatica passes through the ventral wall of the sac and opens into the common genital atrium.

ii. *Female.*—The ovary is a smooth spherical or ovoid body lying on the right side of the body at the level of the genital aperture or slightly in front of that level. Topographically it lies between the right ramus of the gut and the hind end of the cirrus-sac, and towards the dorsal surface. The ripe egg-cells measure 12 μ in diameter. Postero-ventrally the ovary tapers into a wide muscular oviduct. This runs backwards and expands, directly behind the ovary, into the ootype. Laurer's canal is given off approximately at the middle length of the oviduct. The canal, which is very narrow, winds a sinuous course to a minute pore in the cuticle in the mid-line at the level of the anterior border of the testis. The ootype is surrounded by a large compact shell gland which consists of a vacuolate matrix through which numerous nuclei are uniformly distributed. Individual cell boundaries are not distinguishable.

The yolk follicles are numerous small irregular bodies filling the body from the level of the genital atrium to the level of the middle of the oesophagus. In a small mounted specimen (Fig. 14), the follicles are more uniform and display a greater degree of independence than in the larger specimens. The follicles of

the latter have a tendency to fusion (Fig. 13). The yolk is collected into a transversely elongated reservoir which lies on the left side of the shell gland. A duct from the reservoir opens into the oviduct as it enters the shell gland.

The uterus passes directly backwards on the right side lying near the dorsal surface, and fills the body behind the testis. The proximal descending portion of the uterus functions as a receptaculum seminis uterinum. After describing two or three loops behind the testis the uterus passes forwards beside its proximal portion and crosses the body in front of the testis. It describes a loop to the left side of the cirrus-sac before narrowing abruptly into a muscular metraterm

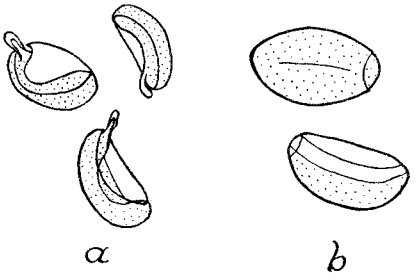

FIG. 15.—*Bivesicula australis*, n. sp., "a" eggs with polar process occurring in one specimen collected, "b" eggs from specimen in Fig. 14.

which leads to the genital atrium. The few eggs are light-yellow in colour and variable in size. In one specimen (2, in the above table), the eggs bear at one end, a blunt hollow appendage measuring 16 μ long and 5 μ thick (Fig. 16). In the remaining specimens this appendage is entirely lacking. The presence of this unipolar process upon the eggs of the one specimen does not appear sufficient grounds for placing it in a separate species.

Discussion: The genus *Bivesicula* was erected by Yamaguti (1934) for a single species, *B. claviformis*. He considered that form sufficiently differentiated from the rest of the Monorchiidae to warrant the formation of a new sub-family. Later Yamaguti (1938) described two further species, *B. synodi* and *B. epinephali*. A further allied species which differed from the above three species in that the intestine and vitellaria extended backwards beyond the testis, and in that the uterus was limited to a region in front of that organ, was placed in a new genus *Bivesiculoides*. The same author (1940) raised the sub-family to family rank.

Bivesicula australis n.sp. resembles the three known species of the genus in the extent of the vitellaria and the uterus but it is similar to *Bivesiculoides* in that the gut rami extend almost to the posterior end of the body, and in the possession of the lateral pouches of the pars prostatica. It thus provides a link between the two genera. The length of the gut can no longer be regarded as a means of distinction between the two genera, and accordingly the generic diagnosis of *Bivesicula* must be amended to include species in which the gut rami may extend posterior to the testis.

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