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New Trematodes from Tasmanian Fishes (Order, Digenea. Family, Allocreadiidae)

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PLATES VIII, IX

Little is known concerning the trematode parasites of Tasmanian fishes. A single species *Coitocaecum anaspidis* Hickman has been described from progenetic metacercariae in the Mountain Shrimp, *Anaspides tasmaniae* Thompson. Members of the genus *Coitocaecum* usually complete their life cycle in a fish. The present paper discusses the status of species belonging to the genus, and describes a new species, *Coitocaecum parvum*, from specimens of the freshwater fishes, *Galaxias attenuatus* Jenyns, and *Pseudaphritis urvillii* (Cuv. and Val.), caught in a brackish creek near the Bowen Monument at East Risdon.

In addition to the above, a new trematode from the purple banded parrot fish, *Pseudolabrus tetricus* Rich., is described. The species forms the type of a new genus, and the name *Gnathomyzon insolens* gen. et sp.n. is proposed.

For whole mounts specimens were fixed in 90% alcohol under slight cover-glass pressure, and stained in borax-carmine or Ehrlich's haematoxylin. For sectioning specimens were fixed in Bouin's solution and the sections were stained in Ehrlich's haematoxylin.

Family ALLOCREADIIDAE

Sub-family *OPECOELINAE* Manter.

Genus **Coitocaecum** Nicoll

The genus *Coitocaecum* was founded by Nicholl (1915) for a single species, *Coitocaecum gymnophallum*. Nicoll was uncertain of the relationship of the new genus to the Allocreadiidae, but considered that the absence of a true cirrus pouch, and the fused condition of the intestinal rami posteriorly, to form a continuous arch, excluded it from that family. Poche (1925) created the sub-family Coitocaecinae of the Allocreadiidae to contain the genus. Ozaki (1925) assigned the genus to his new family Opecoelidae. Four years later Ozaki described

C. plagiorchis, C. orthorchis, C. unibulbosum, C. diplobulbosum, and *C. latum,* and founded the family Coitocaecidae to contain these and Nicoll's species. Ozaki separated *Coitocaecum* from the Opecoelidae because of the absence of an anus in the former. Iwanitsky (1928) described *C. skrjabini,* but the original description is not available in Australia. However, a brief account of the species was given by Pigulevsky (1931) in a paper on the fish trematodes of the Dnjepr basin. In this same paper *C. macrostomum* and *C. ovatum* were also described. Wisniewsky (1932) described *C. testiobliquum* from normal adult and progenetic specimens. The progenetic metacercariae occurred in the haemocoele of *Fontogammarus bosniacus* (Schäf.) and *Rivulogammarus spinicaudatus* (Schäf.). Wisniewsky (1934) described *C. proavitum,* and divided the known species of the family Coitocaecidae Ozaki into three genera, naming the two new genera *Ozakia* and *Nicolla.* Unfortunately, the paper is not obtainable in Australia, but an abstract gives *C. plagiorchis* Ozaki as the type species of the genus *Ozakia,* and *C. ovatum* Pigulevsky as the type of the genus *Nicolla.* The present writer considers that, in view of the uniformity of the species of the genus *Coitocaecum,* the splitting appears unjustified, but until Wisniewsky's paper is examined the proposed genera cannot be adequately discussed.

Hickman (1934) described *C. anaspidis* from the progenetic metacercariae encysted in the haemocoele of *Anaspides tasmaniae* Thompson, the normal adult being unknown. Yamaguti described *C. glandulosum* in the same year, and stated that he had re-examined *C. gymnophallum* Nicoll, and found that Nicoll was mistaken in his assertion that no true cirrus pouch was present in that species. Yamaguti separated *C. glandulosum* from *C. gymnophallum* because of the presence of large gland cells in the vicinity of the anterior intestinal arch, which were not mentioned in Nicoll's description of *C. gymnophallum.* There was also a difference in egg size. *C. glandulosum* Yamaguti must be retained pending re-examination of Nicoll's material.

Stunkard (1931) regarded Ozaki's removal of *Coitocaecum* from the Opecoelidae as unjustified, since the presence or absence of an anus in the Digena was not as important a diagnostic character as previously thought. Stunkard favoured the inclusion of *Coitocaecum* with *Opecoelus,* and *Anisoporus,* in the family Opecoelidae, but pointed cut that a better course might be to reduce the family Opecoelidae to a sub-family of the Allocreadiidae. Manter (1934) set up the sub-family Opecoelinae to include the four genera and dropped the families Opecoelidae Ozaki and Coitocaecidae Ozaki. Harshey (1937) following Manter adopted this classification.

Wu (1937) briefly described a *Coitocaecum* sp., encysted in shrimps from the Shanghai region and maturing in fresh water fishes. Immature stages were also reported from toads. A detailed description has not yet appeared and the species is so far unidentified. Macfarlane (1939) described the life history of a trematode which he identified as *Coitocaecum anaspidis* Hickman. The trematode occurred as a normal adult in *Gobiomorphes gobioides* Cuv. and Val., *Salmo fario* Linn., *Galaxias brevipennis* Günther, *Galaxias attenuatus* Jenyns, and in eels, and as a progenetic metacercaria in *Potamopygus* species and *Paracalliope fluviatilis* (Thompson). A description of the adult form was given to illustrate the differences that Macfarlane found between the New Zealand specimens and Hickman's description of the progenetic metacercaria. The differences were not discussed and no adequate comparison of the New Zealand progenetic metacercaria with Hickman's description was made. Wisniewsky (1933) found no significant differences between the progenetic metacercaria and normal adult of *C. testiobliquum,* except that the normal adult was slightly larger than the progenetic form. Consequently in another species of the same genus, significant differences are not expected to occur between the normal adult and the progenetic metacercaria. Nor

should differences occur between progenetic individuals from Tasmanian and New Zealand crustacea. However, a critical examination of the two papers shows the following differences:

(1) The vitellaria in *C. anaspidis* extend into the neck region, as far forward as the level of the genital pore. As the pore lies near the hind end of the long oesophagus, the foremost extent of the vitellaria is well behind the pharynx. The written description of the New Zealand specimens agrees with this, but the illustration shows the vitellaria extending forward beyond the genital pore to the level of the pharynx. An error is more likely in the text than in the figure, so that the distribution of the vitellaria in the New Zealand trematode appears to differ from that of *C. anaspidis*. The extent and distribution of the vitellaria is regarded as an important diagnostic character in the genus.

(2) Minor differences are noticeable in the descriptions of the reproductive system. In *C. anaspidis* Laurer's canal runs across the body, loops upon itself and opens by a dorsal pore situated just to the left of the mid-line. In Macfarlane's description the canal runs directly across to a dorsal pore situated well to the left of the body. A well developed prostate gland composed of large spindle shaped gland-cells is present in the New Zealand post metamorphic metacercaria, but no distinct prostate gland occurs in the Tasmanian form. Also, the ovary is nearly spherical giving off the oviduct anteriorly in *C. anaspidis*, but the New Zealand form has a pear-shaped ovary which leads into the oviduct laterally.

(3) Progenetic metacercariae taken from the haemocoele of *Paracalliope fluviatilis* had immature testes and hence give rise to miracidia parthenogetically. Metacercariae taken from *Anaspides tasmaniae*, however, possess abundant mature sperms in the seminal vesicle and receptaculum seminis uterinum, so that it is probable that the miracidia are formed from fertilized ova.

(4) Hickman's specimens measured 2·4-2·8 mm. long. The progenetic metacercariae from New Zealand measured 1·5-2·00 mm. long.

In view of the differences between the original description of the species, and Macfarlane's account of the New Zealand form, the identity of the latter must be in doubt until material from both sources is available to the one investigator.

In 1940, Manter described *C. tropicum* from the Galapagos Islands and Yamaguti, continuing his studies on the helminth fauna of Japan, described *C. xesuri* and *C. leptoscari*. Yamaguti considered that *C. diplobulbosum* Ozaki and *C. unibulbosum* Ozaki were described from specimens of the one species in different stages of contraction. Ozaki separated the two forms principally because of the constricted pharynx and longer oesophagus of the former. The present writer does not consider these characters variable to such an extent that Ozaki's two descriptions could apply to the one species, and retains *C. diplobulbosum* Ozaki and *C. unibulbosum* Ozaki. *C. xesuri* Yamaguti was described from a single example and differs from *C. unibulbosum* Ozaki in its larger size, and slight differences in the position of the acetabulum and testes. This example may not represent a distinct species, but if further specimens exhibiting the same differences from *C. unibulbosum* are obtained, the species *C. xesuri* Yamaguti might be acceptable.

A description of *C. tropicum* Manter is not available in Australia.

Coitocaecum parvum, sp.n.

(Plate VIII, fig. 1, and Plate IX, figs 3 and 4)

Trematodes of small but variable size, the average dimensions being 0·86 mm. long and 0·34 mm. wide, under slight cover glass pressure. The length of individual specimens varies from 0·57-1·8 mm. The worms are of long oval shape

with a tapered anterior end, and are broadest in the vicinity of the acetabulum or just behind that organ. In section the body is slightly flattened dorso-ventrally. The acetabulum is relatively large and strongly muscular. It is situated in the posterior of the anterior half of the body, and measures approximately 0·19 x 0·14 mm. The inner surface of the gape may be papillate. The oral sucker is sub-terminal and measures about 0·09 mm. in diameter.

The living trematodes are of a white translucent appearance, and of a yellowish colour in the regions of the vitellaria. The principal organs, vitellaria, testes, ovary, and alimentary system can readily be seen when the animal is viewed by transmitted light. A change in the proportions of the body takes place as the young adults mature. Very young specimens are broadest in the region of the testes, and the acetabulum is situated about the middle of the body. Older specimens show elongation of the body behind the acetabulum accompanied by relative enlargement of the testes.

The oral sucker leads by a very short prepharynx into the globular muscular pharynx, which measures 0·48-0·72 mm. long and 0·44-0·76 mm. in diameter. This is followed by the oesophagus, the length of which varies greatly according to the general state of contraction of the specimen. The average length of the oesophagus is about 0·04 mm. It has a fairly stout muscular wall composed of inner circular and outer longitudinal muscles. The hind portion of the pharynx and the whole length of the oesophagus are surrounded by gland cells. The oesophagus joins the intestine, the two rami of which are simple and tubular and run backwards laterally, to unite below the excretory vesicle forming a continuous arc. The posterior intestinal arc lies along the posterior edge of the hind testis. There is no connection between the intestine and the excretory vesicle.

The common genital pore opens on the ventral surface to the left and just anterior to the intestinal fork. The testes are two large lobed bodies lying in tandem or oblique fashion, within the posterior intestinal arch. The hind testis is frequently larger than the anterior. They measure approximately 0·16 x 0·09 mm. and 0·17 x 0·1 mm. respectively. The vasa deferentia are given off anteriorly and run forward to the base of the seminal vesicle, where they unite. The seminal vesicle lies within the anterior intestinal arch, dorsal to the acetabulum, and to the left of the mid-line. It crosses the left ramus of the intestine just below the fork. The vesicle is sac-like and may extend backwards to the posterior edge of the acetabulum, but is frequently shorter. It measures about 0·16 mm. long. Anteriorly the vesicle tapers and enters the cirrus sac, where it passes over into the ejaculatory duct. The seminal vesicle thus lies entirely outside the cirrus pouch, with the exception of the short tubular portion leading to the ejaculatory duct. The ejaculatory duct is coiled once before leading into the common genital atrium. The terminal portion is thickened to form a small unarmed cirrus. The cirrus sac is pear-shaped, being narrow where it joins the seminal vesicle, and expanded to contain the anterior coiled portion of the ejaculatory duct. The sac measures 0·064 mm. long and 0·032 mm. broad at the broad anterior region. Its wall is thin but muscular, being composed of inner circular and outer longitudinal muscles. Scattered darkly staining cells forming the prostate are present in the anterior of the sac. There appears to be no distinct pars prostatica.

The ovary is ovoid and lies on the right side of the body directly in front of, or obliquely to, the anterior testis. It measures approximately 0·09 x 0·06 mm. Anteriorly and dorsally the ovary tapers into the oviduct. The oviduct passes dorsally and divides, one branch leading into the ootype, the other running across the body as Laurer's canal. The canal forms a ventrally directed loop, and opens on the dorsal surface by a pore situated to the left of the mid-line, at the level of the yolk reservoir.

The ootype is situated about in the mid-line of the body and passes into the uterus, which describes a few intercaecal turns before turning forward over the left side of the acetabulum. When the proximal portion of the uterus is not distended with eggs a slightly expanded receptaculum seminis uterinum containing sperms can be seen a short distance from the ootype. Anteriorly, the uterus, together with the seminal vesicle, passes under the left ramus of the gut and ends in a well developed metraterm. This lies above the cirrus sac, and opens into the common genital atrium, just in front of the male aperture. The eggs are ellipsoid, light brown in colour, and measure 0·06-0·076 x 0·032-0·04 mm. The number of eggs present in the uterus is usually few, only five, six or seven being found in small specimens, but in larger individuals the uterus may contain twenty or more eggs. In small specimens the eggs appear relatively enormous. They have an operculum, 0·016 mm. diameter, at one end. No filament is present.

The yolk follicles are numerous, and extend laterally from the level of the pharynx to the posterior region of the body, where they fill the body behind the testes. Laterally the follicles lie above, below, and external to the gut rami, occasionally surrounding them completely. Their shape varies, but is generally ovoid, measuring 0·036-0·048 mm. in greatest diameter. Anterior and posterior collecting ducts, on each side, fuse in a transverse duct. In the mid-line, or slightly to the right of the mid-line, the transverse ducts enter the spindle-shaped yolk reservoir. The median yolk duct leaves the reservoir antero-dorsally, runs directly dorsally and then turns and enters the ootype laterally (Pl. IX, fig. 3). A group of shell glands surrounds the yolk duct where it joins the ootype.

The excretory vesicle is large and club shaped. It opens at the excretory aperture situated in the mid-line of the posterior border of the body, and extends forward as far as the yolk reservoir. Near the anterior extremity of the vesicle two main collecting ducts arise. These ducts run forward beneath the rami of the gut into the neck region.

Hosts. *Pseudaphritis urvillii* (Cuv. and Val.). *Galaxias attenuatus* Jenyns.

Locality. Creek, near Bowen Monument, Risdon (April, 1944).

Type. It is proposed to deposit the type specimen in the Sydney Museum.

Affinities

The general characters of the trematode place it at once in the genus *Coitocaecum* Nicoll. It seems to be most closely related to *C. anaspidis* Hickman. The present writer agrees with Stunkard, Harshey, and Manter that the absence of an anus and the minor differences from *Opecoelus* are not sufficient reasons for removing *Coitocaecum* from the Opecoelidae. Further, that the family Opecoelidae should be abandoned and the genera in that family included with *Coitocaecum* in the sub-family Opecoelinae Manter (1934) of the Allocreadiidae.

Key to Coitocaecum Species

1.	Vitellaria entirely postacetabular	2
	Vitellaria extend into neck but are broken at the level of the acetabulum	3
	Vitellaria reach the top edge of the acetabulum or extend into the neck, but not broken at the level of the acetabulum	4
2.	Large gland cells present in the vicinity of the anterior intestinal arch	*C. glandulosum* Yamaguti
	Large gland cells not present	*C. gymnophallum* Nicoll
3.	Body broad oval, testes transversely elongate and in tandem, hind testis smaller	*C. testiobliquum* Wisniewsky
	Body elongate oval testes roundly lobed, and oblique, hind testis larger	*C. ovatum* Pigulevsky

4. Genital aperture median, cirrus sac within intestinal arch .... *C. macrostomum* Pigulevsky
   Genital aperture to one side of the mid-line, seminal vesicle crossing intestine 5
5. Oral sucker almost as large as acetabulum .... *C. skrjabini* Iwanitsky
   Oral sucker approximately half as large as acetabulum 6
6. Body round .... *C. latum* Ozaki
   Body ovoid or elongate oval 7
7. Pharynx constricted posteriorly .... *C. diplobulbosum* Ozaki
   Pharnyx globular 8
8. Vesicula seminalis interna spherical .... *C. plagiorchis* Ozaki
   Vesicula seminalis interna tubular 9
9. Posterior intestinal arch immediately behind the hind testis .... *C. parvum*, n.sp.
   Posterior intestinal arch near to posterior border of body 10
10. Cirrus sac completely muscular .... *C. leptoscari* Yamaguti
    Cirrus sac partly or entirely membranous 11
11. Cirrus absent .... *C. unibulbosum* Ozaki
    Cirrus present 12
12. Oesophagus short, cirrus sac entirely membranous .... *C. orthorchis* Ozaki
    Oesophagus long, cirrus sac muscular anteriorly .... *C. anaspidis* Hickman

Sub-family *ALLOCREADIINAE*

Gnathomyzon, gen.n.

Diagnosis. Small pyriform worms with a flattened elliptical cross-section. Integument spinous. Oral sucker sub-terminal. Acetabulum large, possessing a pair of lateral muscular gripping jaws. Intestinal limbs simple, tubular, reaching almost to the posterior edge of the body. Testes, one behind the other in the posterior third of the body. Ovary directly in front of anterior testis. A large receptaculum seminis present, lying transversely, and dorsal to the ovary. Laurer's canal long. External seminal vesicle large and tubular. Cirrus sac highly muscular, containing a large internal seminal vesicle. Diffuse prostate gland present. Definite pars prostatica absent. No true cirrus present. Coils of uterus few, intercaecal, and between acetabulum and ovary. Short metraterm present. Genital aperture to the left of the mid-line, slightly in front of the intestinal fork. Excretory vesicle tubular, bifurcating anteriorly.

Gnathomyzon insolens, sp.n.

(Plate IV, fig. 2, and Plate V, figs 5 and 6)

Small pyriform trematodes. Specimens fixed under slight cover-glass pressure measured 1·40-2·00 mm. long, and 0·61-0·94 mm. wide at their broadest region, this being in the posterior third of the body. The oral sucker is sub-terminal and measures 0·14-0·19 mm. diameter. The acetabulum measures 0·32 mm. diameter and is remarkable in that it possesses a pair of differentiated lateral thickenings or gripping jaws, which are present and identical in every specimen examined.

The living animal has a white translucent appearance, the prinicipal organs, testes, receptaculum seminis, ovary, vitellaria and cirrus pouch being visible in transmitted light. The cuticle is covered with minute spines, and the active mobile neck region of the body is leech-like in appearance.

The oral sucker is followed by a short prepharynx 0·1 mm. long, which leads into the strongly muscular pharynx which measures 0·08 mm. in diameter. The oesophagus is 0·08 mm. long. It has a fairly muscular wall and leads to the bifurcation of the gut, whence the two rami of the gut run backwards as simple unbranched tubes almost to the posterior end of the body. The bifurcation is mid-way between the pharynx and the anterior edge of the acetabulum. There is no connection between the gut and the excretory vesicle.

The two testes are transversely elongated and lies one behind the other in the posterior third of the body. Under slight cover-glass pressure they measure

0·44 x 0·13 mm. and are slightly lobed in outline. The very slender vas deferentia lead past the left side of the ovary, and meet at the posterior extremity of the seminal vesicle, which extends forward from just behind the acetabulum. Posteriorly it is large and sac-like, but narrows and passes over the acetabulum as a thin walled tube. At the anterior margin of the acetabulum the vesicle narrows and passes into the posterior end of the cirrus sac. Within the cirrus sac it expands into a large internal seminal vesicle, which in the turgid condition completely fills the cirrus sac except at the anterior end, where the vesicle narrows into a short ejaculatory duct leading into the genital atrium. The terminal portion of the ejaculatory duct is not thickened or armed to form a distinct cirrus, but from the appearance of the musculature at the anterior end of the cirrus sac, it seems to be protrusible. The ejaculatory duct and the tapered anterior end of the internal seminal vesicle are surrounded by numerous small gland cells whose long thin ducts can be seen leading through the muscular wall. There is no distinct pars prostatica. The cirrus sac extends from the level of the anterior edge of the acetabulum to the genital atrium, which is situated slightly to the left of the mid-line at the level of the posterior edge of the pharynx. The sac thus passes under the left branch of the gut near the bifurcation. It measures up to 0·13 mm. in diameter and 0·24 mm. long, and has a strongly muscular wall composed of a thick outer layer of longitudinal muscles and an inner layer of thick circular muscles.

The ovary is a transversely elongated ovoid body, slightly indented in outline, and lying against the anterior testis. It may be median or slightly displaced toward the right side of the animal. It measures 0·21-0·31 x 0·08-0·13 mm. Dorsally the ovary tapers into the oviduct, the proximal portion of which is expanded into a fertilization chamber. The oviduct then passes transversely and dorsally towards the left side, meeting a transverse passage, which expands on the right side into a large receptaculum seminis. On the left side, the transverse passage gives off the uterus ventrally and continues across the body as Laurer's canal. The latter forms a ventrally directed loop and returns to the dorsal surface to open at a pore situated to the left of the mid-line, at the level of the yolk reservoir. The uterus passes ventrally, receives the median yolk duct from the vitelline reservoir, and expands slightly to form the ootype, into which open a group of shell-glands having short wide ducts. The convolutions of the uterus are intercaecal and few in number. They lie between the acetabulum and the anterior testis, ovary, and receptaculum seminis. The uterus passes forward over the acetabulum slightly to the left of the mid-line, and lying above the cirrus sac, extends to the level of the genital pore. A short muscular metraterm passes ventrally to open into the common genital atrium in front of the male aperture. The circular muscles of the metraterm are continuous with those of the ejaculatory duct. The eggs are ellipsoid in form and the shell is dark brown in colour. They measure 0·056 x 0·032 mm. and possess an operculum 0·008 mm. in diameter at one end. No filaments are present.

The yolk follicles form a densely aggregated mass above, below, and external to the intestinal rami. They extend from the posterior of the body to about the level of the middle of the acetabulum, and also occupy the posterior region of the body behind the posterior testis. The follicles are somewhat angular in shape and vary in size from 0·048 mm. in diameter to 0·10 x 0·036 mm. The yolk is collected by tubules which unite into main right and left longitudinal ducts. The main longitudinal ducts of each side unite into the right and left transverse ducts, which pass dorsally and meet in the spindle-shaped reservoir situated to the left of the mid-line and slightly behind the ovary. From the left end of the reservoir a short duct runs forward to the uterus.

The excretory pore is situated on a sunken papilla in the middle of the posterior margin of the body. The excretory vesicle is simple and tubular, and extends from the pore to the posterior testis, above which it may extend forward for a short distance. The vesicle measures 0·3 mm. long, and 0·03 mm. diameter, and is lined with a glandular epithelium. At its anterior end it bifurcates into two main collecting tubes, which pass forward on either side of the hind testis within the dorso-ventral muscles. These main tubes run towards the dorsal surface for a short distance, pass downwards within the dorso-ventral muscles and come to lie below the rami of the gut. Fine collecting tubules open into the main tubes throughout their length.

Host. *Pseudolabrus tetricus* Rich.

Locality. Derwent Estuary, Tasmania (March, 1944).

Type. It is proposed to deposit the type specimen in the Sydney Museum.

Affinities

The general characters of the trematode place it in the sub-family Allocreadiinea of the Allocreadiidae, although it differs in that a prominent cirrus is not developed. The genus is distinguished by its peculiar ventral sucker. Manter (1934) described *Myzoxenus vitellosus*, from *Calamus calamus* (Cuv. and Val.) and *Decodon puellaris* (Poey), which possesses apparently similar gripping structures. Manter also mentions that a rather similar modification of the ventral sucker occurs in *Dolichosaccus amplicava* Travassos.

I wish to express my gratitude to Professor V. V. Hickman for his kind advice and encouragement, and for making the original slides of *C. anaspidis* available for comparative study. My thanks are also due to Mrs. B. Sikk for her willing assistance in translating from the Russian the descriptions of *C. ovatum*, *C. macrostomum*, and *C. skrjabini*.

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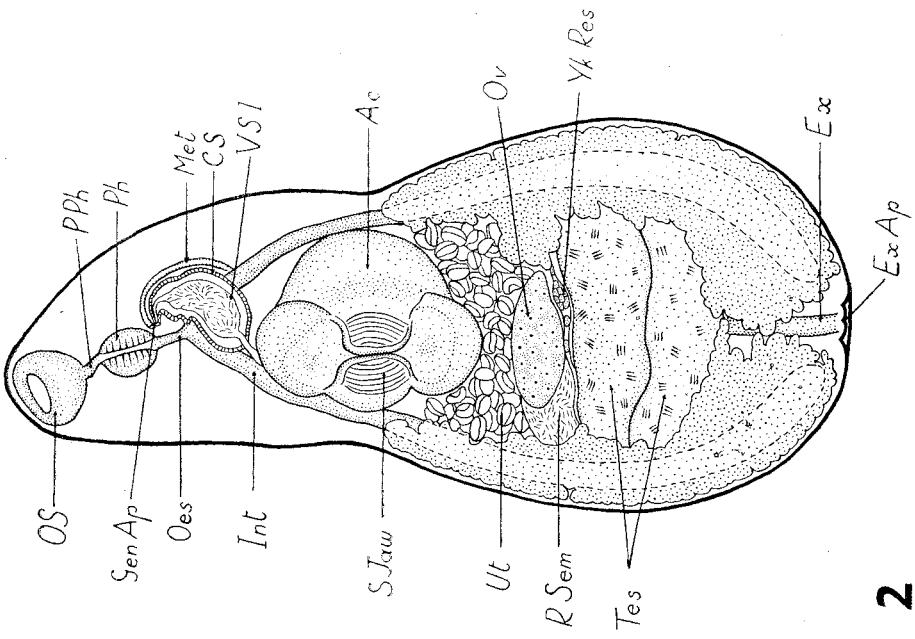
PLATE VIII

FIG. 1.—*Coitocaecum parvum* (0·8 mm.), dorsal view.

FIG. 2.—*Gnathomyzon insolens* (2·00 mm.), ventral view.

Ac., acetabulum; CS., cirrus sac; Ex., excretory vesicle; ExAp., excretory aperture; GenAp., genital aperture; Int., intestine; Met., metraterm; Oes., oesophagus; OS., oral sucker; Ov., ovary; P Ph., pre-pharynx; Ph., pharynx; R Sem., receptaculum seminis; S Jaw., gripping jaw of acetabulum; Test., testes; Ut., uterus; VS., seminal vesicle; VSI., internal seminal vesicle; YkRes., yolk reservoir.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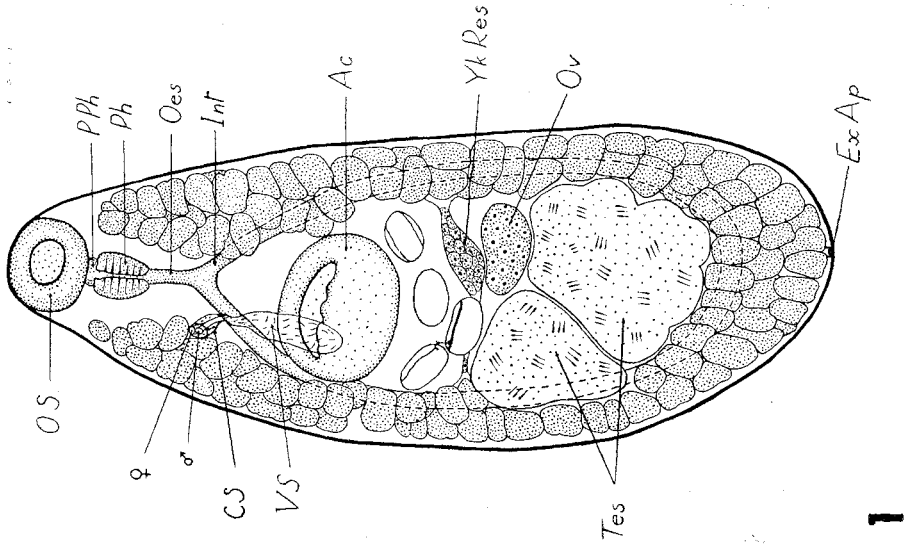
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PLATE IX

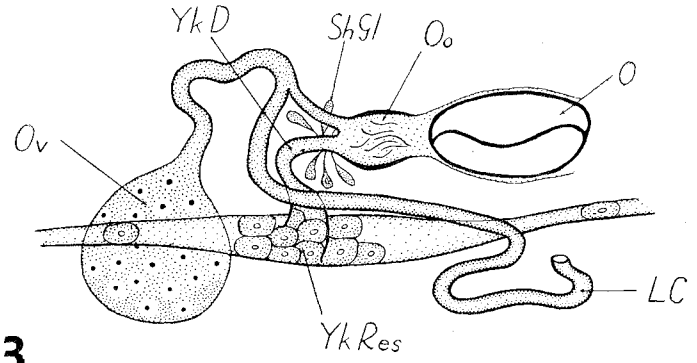
FIG. 3.—*Coitocaecum parvum*, dorsal view of female genital complex

FIG. 4.—*Coitocaecum parvum*, genital end organs in longitudinal section.

FIG. 5.—*Gnathomyzon insolens*, view of female genital complex from posterior aspect.

FIG. 6.—*Gnathomyzon insolens*, diagram of median longitudinal section through gripping jaw.

C., cirrus; Ejd., ejaculatory duct; F Ch., fertilization chamber; LC., Laurer's canal; Met., metraterm; O., ovum; Oo., ootype; PG., prostate gland; R Sem., receptaculum seminis; ShGl., shell gland; YkGl., extent of vitellaria. For remaining references see Plate VIII.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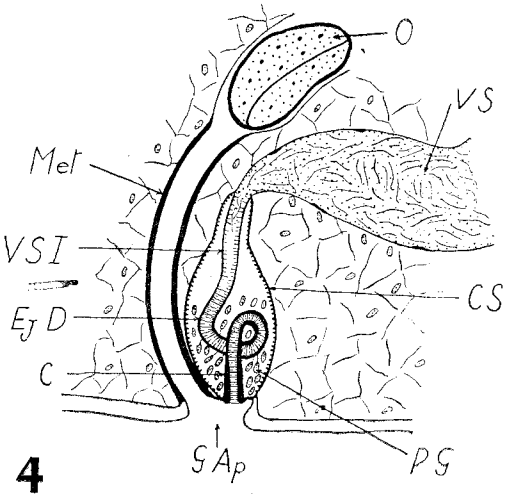
3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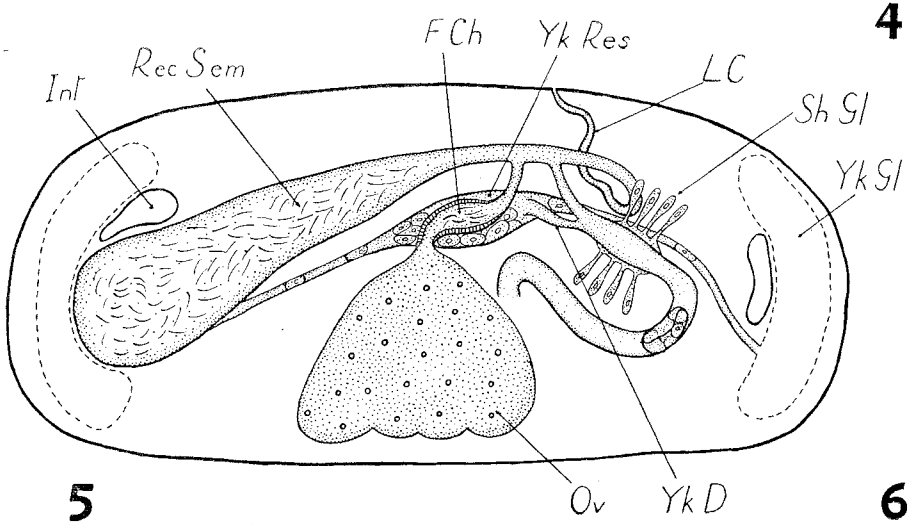
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LC
Sh Gl
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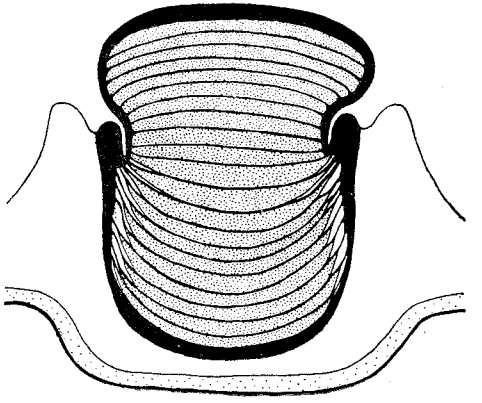
Ov
Yk D

5



6

plan, and that the modern representatives, far from displaying simple and primitive characters as was at one time thought to be the case, are, in point of fact, a highly specialized group of mammals.

The early promammals were oviparous and from this oviparous stock the Monotremata arose.[1] Later, a group of early mammals achieved viviparity and from this stock both the marsupials (Didelphia) and the so-called placental mammals (Monodelphia) arose. Following on Hill's noteworthy discovery in 1895 of a true allantoic placenta in *Perameles,* most embryologists and morphologists subscribed to the view that those viviparous early mammals had an allantoic placenta, and that all the early marsupials were allantoplacental. Further consideration of this question, however, is outside the scope of the present paper, but it should be observed that the views of Bensley (1903) and McCrady (1938) that the presence of an allantoplacenta in the somewhat specialized *Perameles* may be nothing more than an instance of convergence are worthy of careful consideration.

Whatever opinion may be held on this matter it seems certain that the prototypal marsupial had a rudimentary placenta, formed either by the yolk-sac or allantois, which could not have been very efficient. Foetal life was short in consequence, and parturition took place by way of the two Müllerian ducts.

The ancestral marsupial had a fairly simple type of urogenital system. Each Müllerian duct was probably divided into the three constituent parts as we now know them, Fallopian tube, uterus, and vagina. In recent Didelphia and Monodelphia the right and left uteri approach each other medially and the latter group may coalesce. It is reasonable to conclude, therefore, that the convergence of the uteri was present in the ancestral type from which both groups arose, and if that were so it would follow that the early marsupials also had converging uteri. As the post-uterine portions of the two Müllerian ducts in these prototypal marsupials were obliged to pass lateral to the ureters there would be a tendency to develop vaginal kinks which are typical of all recent marsupials. These primitive vaginae probably lacked the vaginal culs-de-sac (text fig. 1) and it was by way of these simple ducts that fertilization and parturition were effected. At their caudal extremities the two vaginae opened together into the urogenital sinus which also received a short urethra from the urinary bladder at the same level. The relation between the ureter and Müllerian duct as seen in recent marsupials was already laid down in the prototypal form, that is to say, the ureters occupied a medial position in relation to the Müllerian ducts which is the reverse of the condition in modern placental mammals.

Didelphidae

(Text figs 2, 4, and 5)

It is generally accepted that the Didelphidae represent among recent marsupials the nearest approach to the prototypal condition. In most members of this family the two Müllerian ducts remain separate throughout life, in itself a primitive character (text fig. 4). The two uterine portions converge to take up a medial position side by side, while the Fallopian tubes and vaginae retain their original lateral positions. Thus the characteristic marsupial kink or elbow is formed in the course of each Müllerian duct at the junction of the uterus and vagina. It is at this point that a median cul-de-sac (text fig. 4, *m.c.*) grows backward from each vagina. These vaginal culs-de-sac vary considerably in different species as regards size and general topography, and rarely, if ever, grow as far back as the

[1] Hubrecht (1908), however, considered that the Monotremata were derived from viviparous mammals which later reverted to the reptilian method, but there would appear to be no sound reasons for this view.