1990

Binder 212, Life histories P [Trematoda Taxon Notebooks]

Harold W. Manter Laboratory of Parasitology

Cercaria acetabulopapillosa ~~sp. nov.~~ Angel and Manter, 1972
(Figs. 3-5)

Material deposited in South Australian Museum. Slides (whole mounts): rediae Nos. E865, E866; cercariae, Nos. E867, E868; metacercariae, Nos. E869, E870. Spirit material: cercariae, No. E871; gills of *Plotiopsis tetrica* with rediae and cercariae, No. E872; two *Plotiopsis tetrica* with rediae and free cercariae, No. E873; cysts, No. E874.

Since 1937, when studies on trematode life histories were begun at the University of Adelaide, the cercaria has been found in 34 of over 7,000 *Plotiopsis tetrica* Conrad examined. The infected snails have been collected at several places on the lower River Murray; the greatest number of infections (21) was from Morgan.

The cercaria is large and obvious. Not many cercariae are emitted daily by infected snails, and the number diminishes quickly, possibly due to malnutrition of the host under laboratory conditions. Although one snail under observation ceased to give off cercariae withing 10 days, another gave them intermittently for 130 days.

The digestive gland of the snail is quite free of rediae, which occur in the wall of the mantle. They sometimes seem to accumulate near the wall of the intestine in the mantle area. Free cercariae are present in abundance in some infected snails. Some are still within the mantle, but others must shelter within the shell, judging by the number which are found swimming in a dish when the snail shell is broken and removed, even though the snail tissues remain intact.

Formalinised rediae averaged about 800 by 190; the largest seen was 884 long. The most noticeable feature of the redia is the wide open mouth, up to 58 across, which gives the impression of a ring of tissue around the anterior end. The posterior end narrows to a sharp tip. The pharynx is thick-walled and obvious; in a specimen 765 long, it measured 153 by 118, the walls being 24 in thickness. Following the pharynx is an oesophagus, straight or coiled, depending on the contraction of the redia. The intestine, from 59 to 153 wide, extends to between half and three-quarters of the body length. Its contents are finely granular. There appears to be no more than one developed cercaria in each redia, though several developing ones, tail-less, are generally also present.

Cercariae for measurement were fixed in two ways. In general, an equal volume of boiling 10% formalin was added to water containing the cercariae. Ten of these measured: body, 323-576 (av. 396) by 212-288 (240); tail, 753-940 (847) by 65-76 (71). One collection was fixed by pipetting cercariae into 5% formalin just off boiling point. The bodies of these were better extended than those fixed by the former method, and the body and tail were fixed more or less in a straight line; body, 612-717 (670) by 162-176 (168); tail, 623-676 (650) by 65-76 (71).

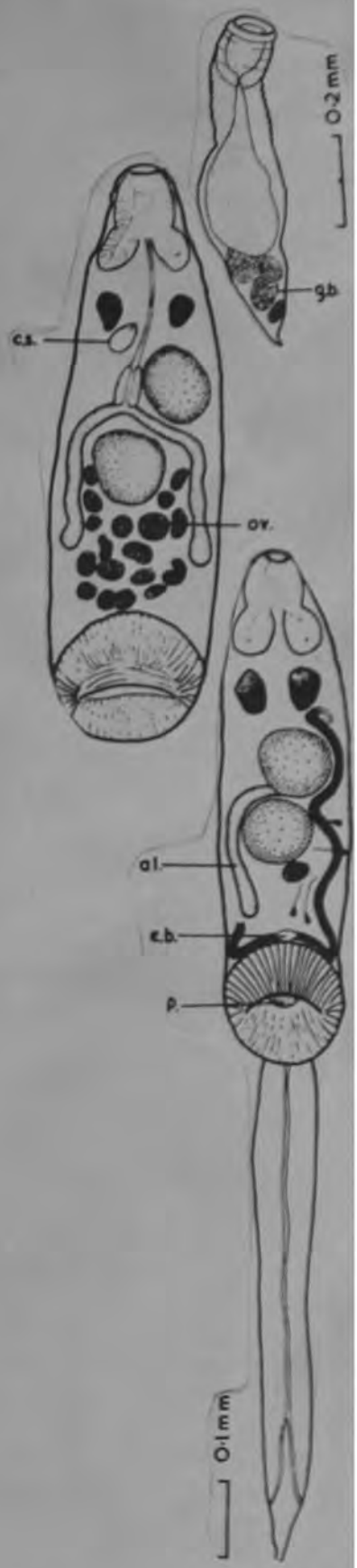
The description is based on living specimens and temporary and permanent mounts. Measurements of organs, etc., are averages taken from the holotype and one paratype (well extended specimens, mounted in balsam, 635 by 159 and 647 by 141 respectively).

Description. Mouth terminal; pharynx 64 by 62; with thick-walled pouches, 51 by 39; oesophagus not seen; oesophageal bulb near dorsal surface; bifurcation of caeca 235 from anterior end of body; caeca 32 wide, ending 220 from posterior end. Acetabulum ventro-terminal, 140 by 140, strongly muscular, with rounded elevation, 32 across, arising from floor of cavity. Tail arising dorsally. Heavily pigmented eyespots 50 by 26, 29 apart, near dorsal surface, close behind level of pharyngeal pouches, cone-shaped, with antero-dorsal part hollowed as if to contain lens.

Anlagen of reproductive system well-developed. Genital pore 12 by 21, anterior to anterior testis, or median; leading into small genital atrium, about 18 deep. Cirrus complex present. Testes 87 by 74, contiguous, generally diagonal, with anterior testis anterior to, and overlapping, left caecum; some specimens have anterior testis median or to right but always largely extracaecal. Ovary round, 43 across, immediately posterior to posterior testis. Vitellaria consisting of about 24 rounded lobes, 18 across; occupying post-testicular area and extending laterally to mid-level of posterior testis.

Subcuticular area of body filled with elongated, brownish-yellow rods, of cystogenous material, arranged in groups of ten or so; rods generally in pairs, with members of pair end to end and pairs in parallel. Adjoining groups set at different angles to each other. Individual rods measure 10-13 by 2.5.

(over)



Thick concentration of small granules of pigment immediately below cuticle, with larger aggregations of granules in tissues.

Excretory bladder immediately anterior to acetabulum. Arms of bladder filled with small granules (three or four across diameter of tube); arms hugging anterior boder of acetabulum, then winding to level of eyespots; recurrent tubes without granules, reaching nearly to acetabulum.

The presence of the rods of cystogenous material and the pigmentation of the body prevents elucidation of the details of the excretory system. Only four flame cells have been seen-lying between the anterior border of the posterior testis and the acetabulum. On each side of the acetabulum is a number of twisted tubes; several of the branches end in two fine tubes, but we have been unable to see any flame cells here. The tubes may be part of the lymphatic system, though Willey (1930) thought that the lymph system was probably not present in the cercarial stage of amphistomes.

The excretory tube in the tail bifurcates about 80 from the tip, the two branches terminating at the sides of the tail, though apparently without external opening.

In February, 1964, after infected snails had been insolated in 3 by 1 inch tubes for some days, cysts were observed on the filamentous alga (family Cladophoraceae) which commonly grows on the shells of *Plotiopsis tetrica*. In all, 23 cysts were recovered from two infected snails kept under observation as long as they were emitting cercariae. In May, 1967, one infected snail yielded 8 cysts; but in April, 1968, no cysts formed on the alga on a snail which was producing several cercariae daily. The cysts show up clearly as small black dots. The fact that they had not been observed prior to 1964, together with the erratic occurrences after 1964, suggests that the alga is not the only site used for encystment. *

Cysts have never been observed on the sides of the isolation tubes, nor on the shells of infected snails. After boiling formalin had been added to water in which cercariae were swimming, a small number of cysts was found among the cercariae. These may have encysted freely, but some of them had the appearance of having been attached, with extensions at one edge of the cyst wall.

The cysts are roughly spherical in shape, but are often flattened along one margin, where they have been attached. Ten cysts measured before fixation averaged 259 by 242.

Encystation was occasionally observed under a coverslip. This occurred if the cercariae were allowed enough fluid in which to move around freely. It rounded up quickly and a clear mucus-like exudate enclosed it. The rod-shaped granules were extruded from the surface of the cercaria and became caught up in the mucus to form a cyst wall.

* It is of interest that filamentous alga is found commonly in the stomachs of *Bidyanus bidyanus* and *Acanthopagrus butcheri*, in both of which fish *Pretestis australianus* has been found.

Seven encysted metacercariae, flattened under a coverslip and fixed in formalin, measured 690 by 238 to 1045 by 290. They were afterwards stained in Van Cleave's combination stain and mounted in balsam.

Description. Body heavily pigmented eyespots still present. Pharynx, pharyngeal pouches, oesophageal bulb and caeca as in cercaria; oesophagus a narrow straight tube. Reproductive system as in cercaria, but ovary and vitellaria better defined; anterior testis on right side in four of six specimens.

Two experiments to obtain the adult of *C. acetabulopapillosa* gave negative results. In February, 1964, a rat was fed cheese with 23 cysts; it was killed in May. In May, 1967, an attempt was made to feed a few cysts and some metacercariae, to a carp but it is not certain that the carp actually swallowed the trematodes.

Discussion. *Cercaria acetabulopapillosa* resembles *Pretestis australianus* very closely, and may even be the larval stage of this trematode. The presence of an acetabular papilla in the cercaria and its apparent absence in the adult makes it necessary to give the cercaria a distinctive name. However, the papilla was not noted when living cercariae and metacercariae were examined under a coverslip; it was not until formalinised cercariae were cleared that this feature became obvious. The surface of the elevation seems to be finely mammillated; it does not suggest a sucker in any way, and there is no obvious muscular structure. It seems likely that in living cercariae and metacercariae, which were examined under quite heavy coverslip pressure, the elevation was flattened down and rendered inconspicuous. The same may have happened with the specimens of *P. australianus*. The acetabulum as seen in mounted metacercariae resembles that of *P. australianus* very closely. In S. A. Museum No. E870 it would appear identical with the acetabulum of the adult trematode. Verification of *C. acetabulopapillosa* as the larval stage of this trematode will have to await further life-history studies, or at least the examination of specimens of *P. australianus* fixed in the same way as were the cercariae — in hot formalin, without previous flattening.

The fact that the anterior testis may be median or on the right, as well as on the left side in *C. acetabulopapillosa* agrees with the observations of Fischthal and Kuntz (1959), for *Sandonia sudanensis* and *Basidiodiscus ectorchis*, that the anterior testis may be on the left or the right side. This variation cannot be regarded as constituting a difference between *C. acetabulopapillosa* and *Pretestis australianus*, in view of the small number of the latter which have been examined from each host. (It is possible that the position of the ovary and of the genital pore may also be variable).

According to Yamaguti (1958), the only genera of the *Paramphistomatidae* in which the acetabulum has a central prominence are some members of the Diplodiscinae. Of these, *Opisthodiscus* and *Pseudopisthodiscus* have "a suckerlike central navel"; *Diplodiscus* has a central papilla; and *Megalodiscus* may or may not have a central papilla. All of these genera occur in amphibians. (*Diplodiscus cornu* (Dies., 1839) Daday, 1907, from a fish (*Doras* sp.), was transferred by Manter (1962) to a new genus, *Pseudodiplodiscus*, one of the characters of which is "acetabulum without central papilla".)

If *C. acetabulopapillosa* proves to be the larva of *Pretestis australianus*, this will be the first fish trematode so far recorded with a central papilla in the acetabulum.

No life history has yet been recorded for a paramphistome from a fish.

The snail host of *Cercaria acetabulopapillosa*, *Plotiopsis tetrica*, is a prosobranch gastropod belonging to the Thiaridae. * Although a good many paramphistome cercariae have been described, nearly all have developed in opisthobranch molluscs. We have been able to find only two apparently valid references to a prosobranch host for this family. [2] Loos (1896) [quoted by Fairley and

* Wenz's (1938) classification is used.

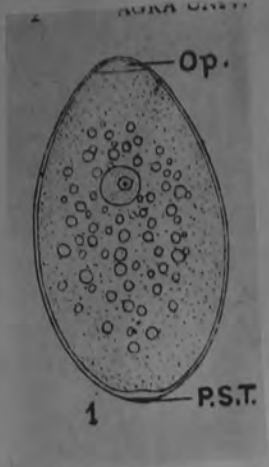
[2] Although Yamaguti (1958) quoted Cary (1909) as saying that the cercaria of *Megalodiscus temperatus* (Stafford) developed in *Goniobasis virginica* (which is placed in the Thiaridae), Cort (1915) showed that Cary had used, in his experiments, two entirely different species of cercariae, neither of which could have developed into a paramphistome. Krull and Price (1932) stated that *Helisoma trivolvis* was the only snail which had been found infected with *Diplodiscus temperatus* Stafford.

Bahr (?1919) and Yamaguti (1958)] reported a paramphistome cercaria (which he referred to *Gastrodiscus aegyptiacus* [Cobbold]) from *Cleopatra bulimoides*. Fairley and Bahr (?1919) figured a paramphistome cercaria; in the description of the figure they noted that "under this heading" were included cercariae probably of three species described by Loos

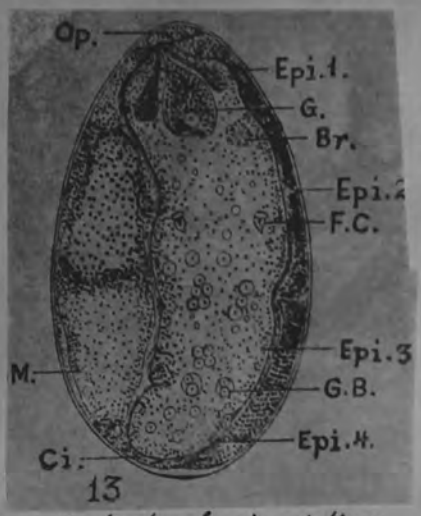
(contd - next page)

(1896). They were found most commonly in *Bullinus contortus* but were occasionally seen in *Planorbis boissyi, Limnaea caillaudi* and *Cleopatra bulimoides. C. bulimoides* is a prosobranch which also belongs to the Thiaridae. It is worthy of mention that Peter (1960) pointed out that Looss' conclusion that the cercaria from this host was the larva of *Gastrodiscus aegyptiacus* was based on the structural similarity between the cercaria and the adult, and was not supported by any experimental evidence.

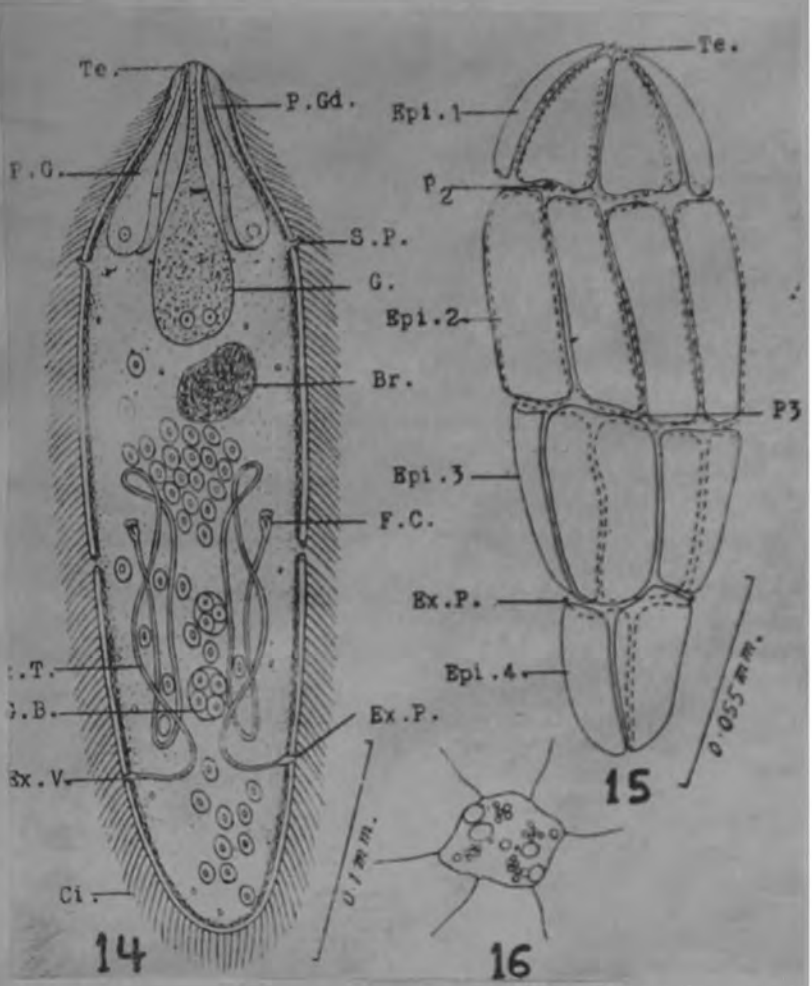
Ceylonocotyle scoliocoelium (Fischoeder, 1904) Nasmark, 1937



1. FRESH EGG



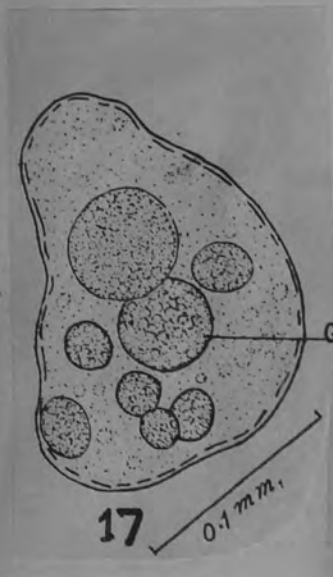
13. Fully developed miracidium

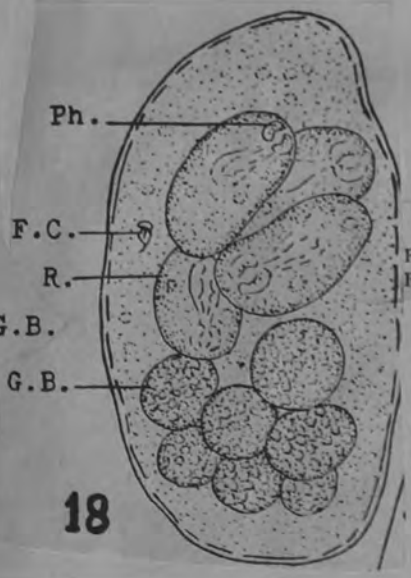


Miracidium of *Ceylonocotyle*

Fig. 14 Anatomical features of the miracidium
Fig. 15 Epithelial cells and papillae.
Fig. 16 Terebratorium. (Anterior view)

There are two pairs of penetration
coliocoelium, one pair on each side of the

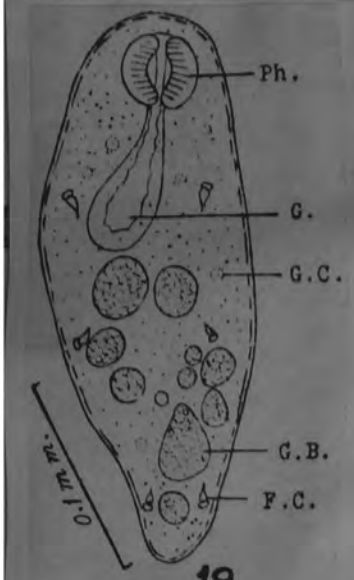




Sporocysts of *Ceylonocotyle scoliocoelium*

Fig. 17 Young sporocyst.
Fig. 18 Mature sporocyst containing [illegible]

See Reprint:
1969 JAIN, S.P. & H.D. SRIVASTAVA
AGRA UNIV. J. RES. (Sc.), 18: pt. 3: 1-16



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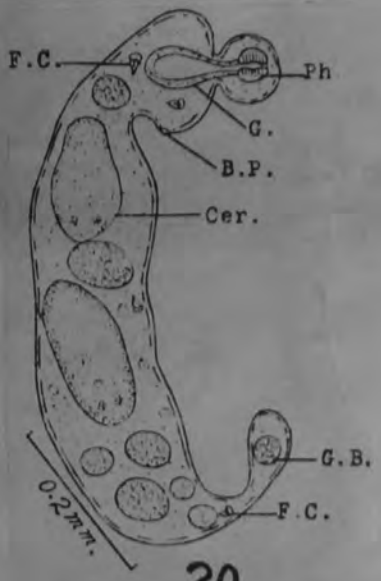

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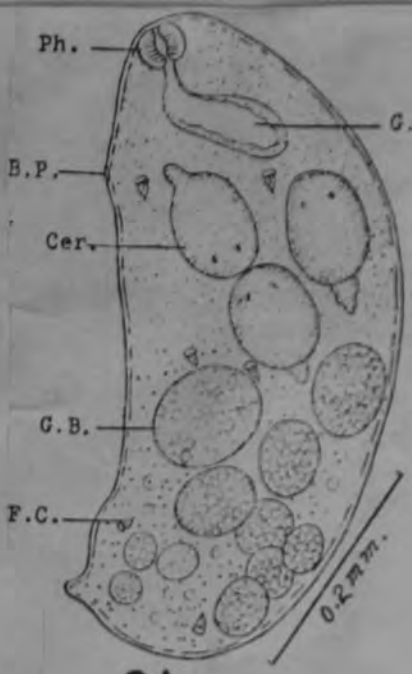

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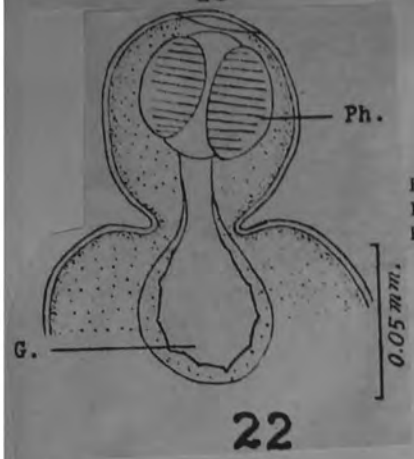

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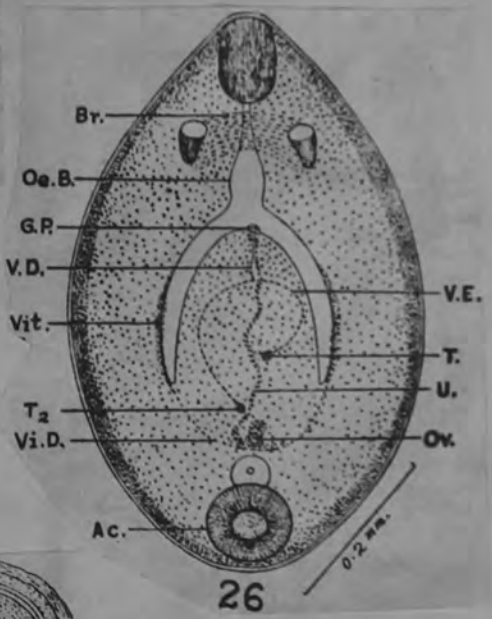
Rediae of *Ceylonocotyle scoliocoelium*

Fig. 19 Young redia
Figs. 20,21 Mature rediae containing germ balls and developing cercariae.
Fig. 22 Anterior part of the redia, showing mouth, pharynx and gut.



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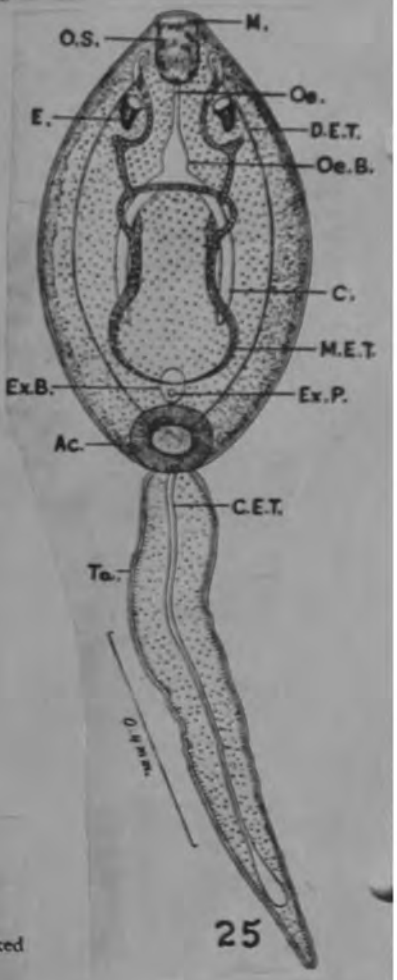

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Cercaria and Metacercaria of *Ceylonocotyle scoliocoelium*

Fig. 23 Living cercaria in extended condition.
Fig. 24 Living cercaria in contracted condition.
Fig. 25 Mature living cercaria showing excretory and digestive systems.
Fig. 26 Mature cercaria showing reproductive, digestive and nervous systems (in fixed stained mount).
Fig. 27 Encysted metacercaria.

PARAMPHISTOMIDAE LIFE CYCLES

Cotylophoron cotylophorum from rumen of *Bos taurus* in Louisiana. Eggs hatch in 11 to 29 days. Miracidium invades snails, *Fossaria parva* and *F. modicella*.

Mother sporocyst produces 9 rediae.

Each redia produces 25 cercariae which emerge from snail 30 to 91 days after infection. Cercariae encyst on vegetation where it may live over 3 months. Total life cycle 5 to 8 months.

Cort (1915) pointed out that amphistome cercariae can be divided into two groups and assigned them to the subfamilies Paramphistominae and Diplodiscinae. Beaver (1929) agrees in the two groups but believes these do not conform to present subfamilies. He recognizes Sewell's (1922) "Pigmentata" and "Diplocotylea". Byrd and Reiber (1940) agree with Beaver in following Sewell.

Life Cycles of Paramphistomatidae

Herber (1938) in Jour.Parasit., 24:549 describes the mother redia of Diplodiscus temperatus. He states:

Among the life cycle descriptions of amphistomes we find some with one and others with two generations of rediae. Looss reported one generation of rediae for Amphistomum subclavatum and Paramphistomum cervi (syn Amphistoma conicum) and Gastrodiscus aegypticus. Beaver described two generations for Allassostoma parvum . LeRoux and Bennett describe two generations for Cotylophoron cotylophorum. Krull and Price described one for Diplodiscus temperatus but Herber found this incorrect.

III. THE LIFE-HISTORY OF CALICOPHORON CALICOPHORUM (FISCHOEDER) NASMARK

By P. H. DURIE*

(*Manuscript received March* 13, 1956)

Summary

A description of the life-history of *Calicophoron calicophorum* (Fischoeder 1901) Näsmark 1937 is given, and the larval stages of this parasite within the snail intermediate host *Pygmaeus pelorius* (Iredale 1943) are described.

The pre-patent period for this fluke in a lamb was found to be in the vicinity of 80-95 days.

From Durie, 1956

(see reprint)

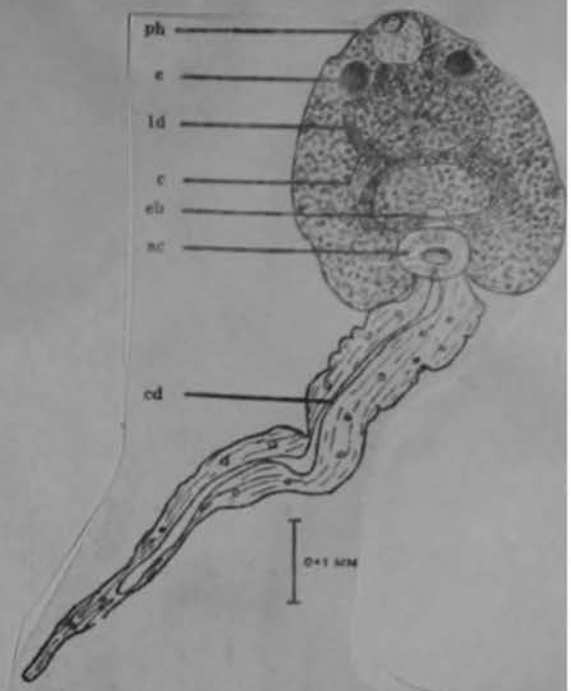
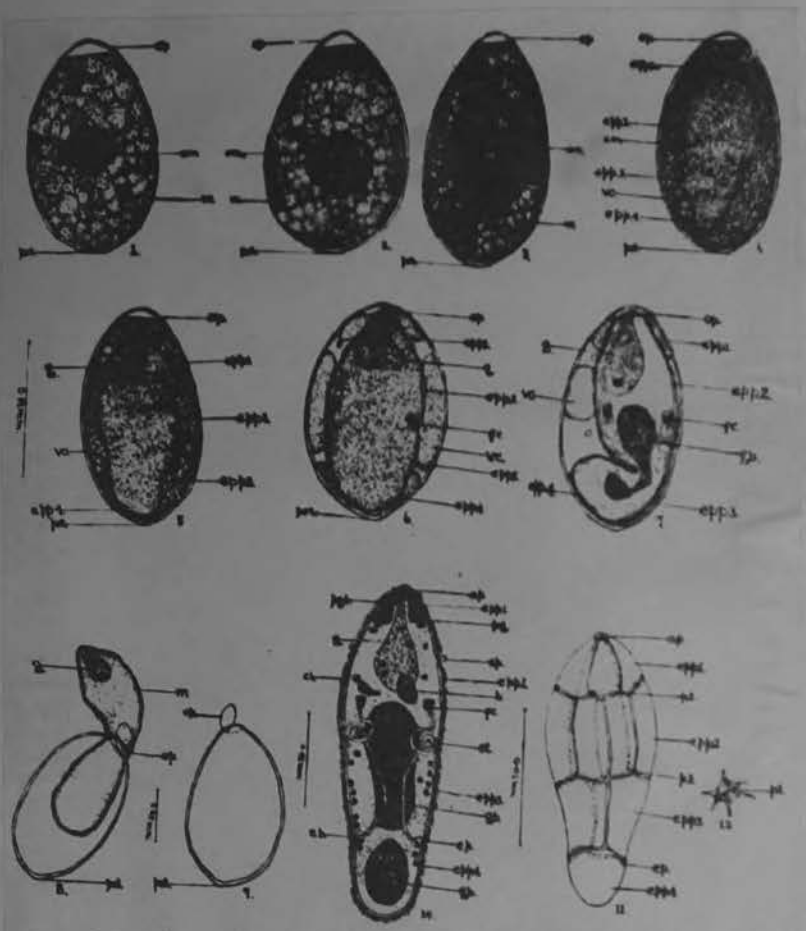


Fig. 3.—*Calicophoron calicophorum*: mature cercaria showing internal structure (ventral view); *ac*, acetabulum; *c*, caecum; *cd*, caudal excretory duct; *e*, eyespot; *eb*, excretory bladder; *ld*, main lateral excretory duct; *ph*, pharynx.

Paramphistomatidae

Fischoederius elongatus (Poirier, 1883) Stiles & Goldberger, 1910



Figs. 1. Egg taken out from fresh faeces. 2. Egg showing the embryo on the second day of development. 3. Egg showing the embryo on the third day of development. 4. Egg showing the empryo on the fourth day of development. 5. Egg showing the embryo on the fifth day of development. 6 Egg showing the embryo on the sixth day of development. 7. Egg showing the embryo on the seventh day of development. 8. Miracidium emerging from the egg after throwing open the operculum. 9. Empty egg shell with open operculum. 10. Miracidium showing the general anatomy. 11. Miracidium showing the arrangement of epithelial cells and papillae. 12. Apical papilla showing the arrangement of 1st row of papillae.

From Mukherjee, 1966
Indian J. Helminthol. 18 (1): 5-14

EGG – 7-10 days → MIRACIDIUM → REDIA →
* CERCARIAE → METACERCARIAE → 126 days in grass
after ingestion → ADULT cow

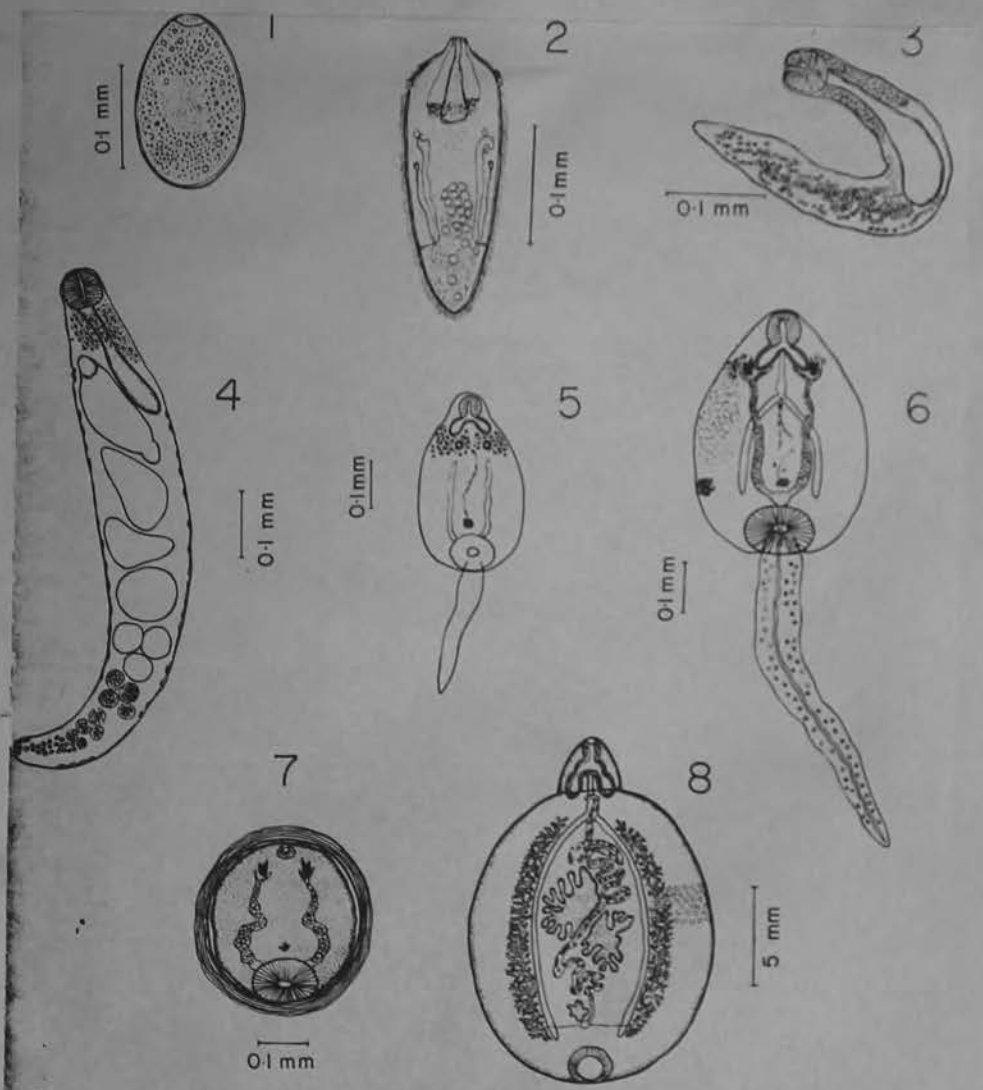
* CERCARIAE INDICAE XXIX SEWELL, 1922

SNAILS:
LYMNAEA ACUMINATA CALCUTTA
L. SUCCINEA MALABAR
L. LUTEOLA HYDERABAD, MADRAS
L. LUTEOLA f. SUCCINEA BAREILLY, India
GYRAULUS EUPHRATICUS CALCUTTA

Gastrodiscus aegyptiacus (Cobbold, 1876) Looss, 1896

Emile A. Malek 1971 J. Parasitology.
Department of Parasitology, Tulane School of Public Health and Tropical Medicine, New Orleans, Louisiana

ABSTRACT: The life cycle of *Gastrodiscus aegyptiacus*, a parasite of African equines, is described. Amphistome cercariae of the Diplocotylea type emerged from naturally infected *Bulinus* (*Bulinus*) *forskali* and encysted on grass. Metacercariae fed to a donkey developed to mature adult flukes. The possible role of other planorbid snail species as intermediate hosts of *G. aegyptiacus* is discussed.



FIGURES 1–8. Life history stages of *Gastrodiscus aegyptiacus*. **1.** Unembryonated egg from feces. **2.** Hatched miracidium. **3.** Young daughter redia. **4.** Mature redia. **5.** Immature cercaria from the snail's tissues. **6.** Mature cercaria after emergence from the snail. **7.** Metacercarial cyst. **8.** Adult fluke, ventral view.

Studies on Amphistomes

– SEE REPRINT –

V. On the Life History and Validity of *Gigantocotyle bathycotyle* (Fischoeder, 1901) Nasmark, 1937 — An Amphistom ein the Bile Ducts of Bovines

Zool. Anz., Jena 200 (1978) 3/4, S. 185–218

By Surendra Prakash Jain

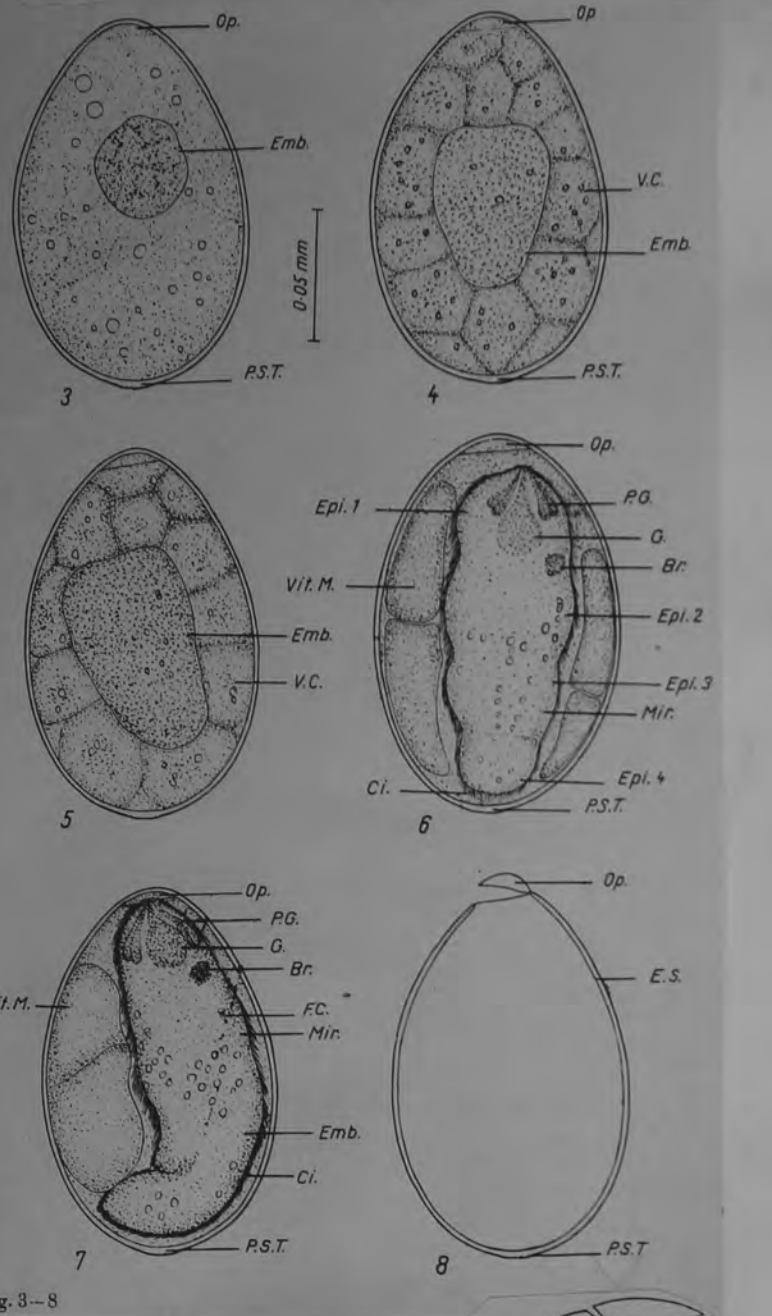


Fig. 3–8

Fig. 3. Fresh egg deposited by adult worm
Fig. 4. Egg on the 3rd day of development
Fig. 5. Egg on the 4th day of development
Fig. 6. Egg on the 6th day of development
Fig. 7. Egg on the 9th day of development
Fig. 8. Empty egg-shell with open operculum

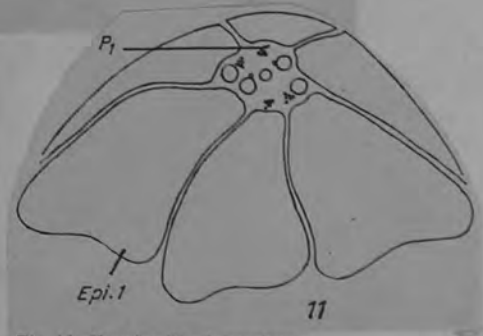


Fig. 11. Showing Terebratorium

Paramphistomatidae

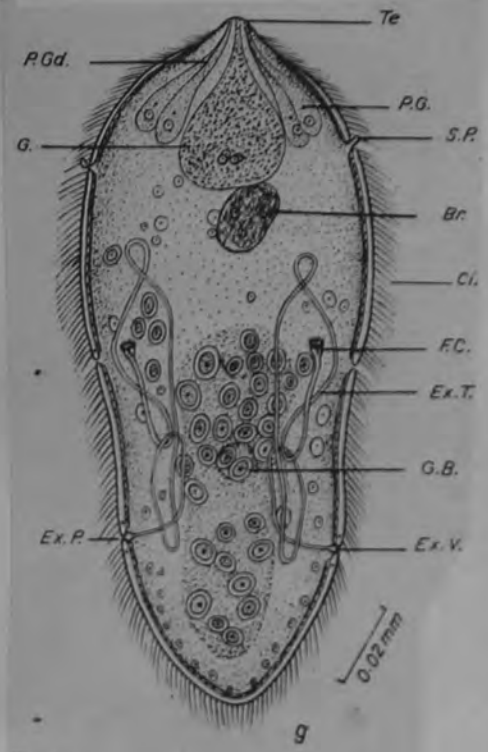
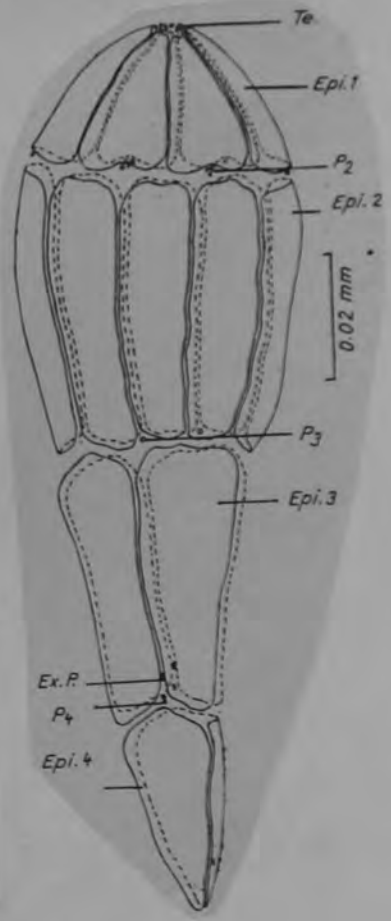


Fig. 9. Anatomical features of the miracidium



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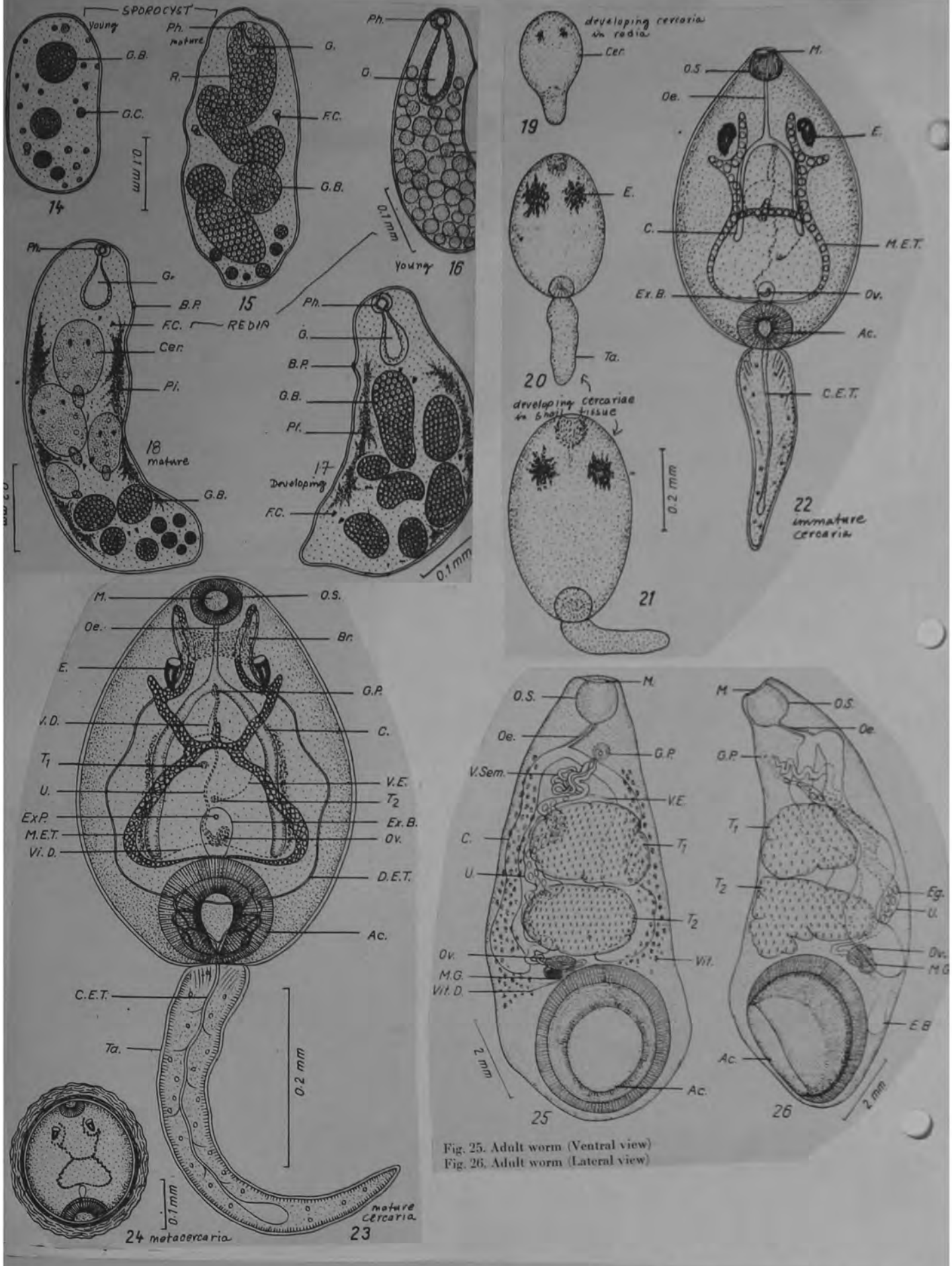
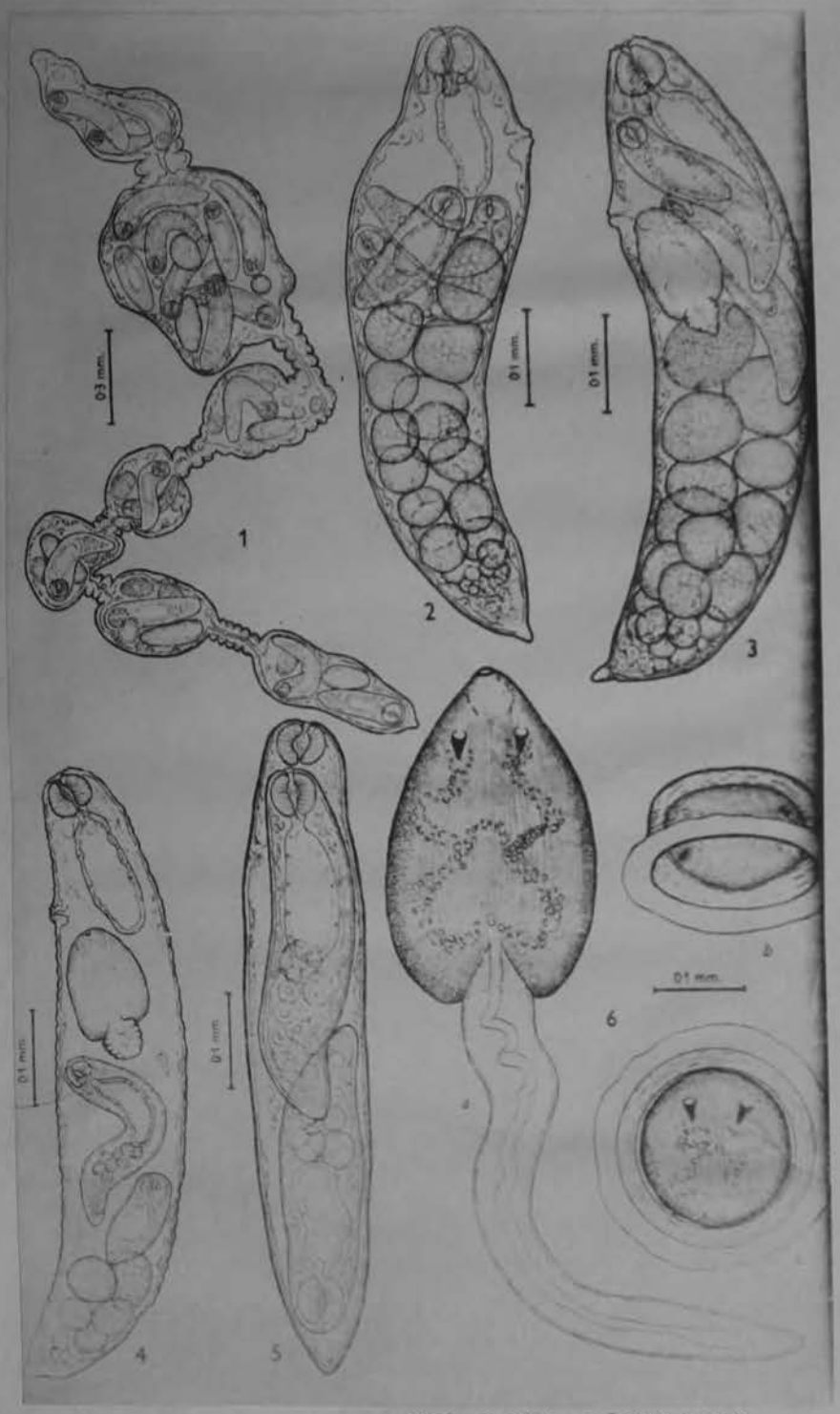


Fig. 25. Adult worm (Ventral view)
Fig. 26. Adult worm (Lateral view)

Paramphistomum microbothrium Fischoeder, 1901

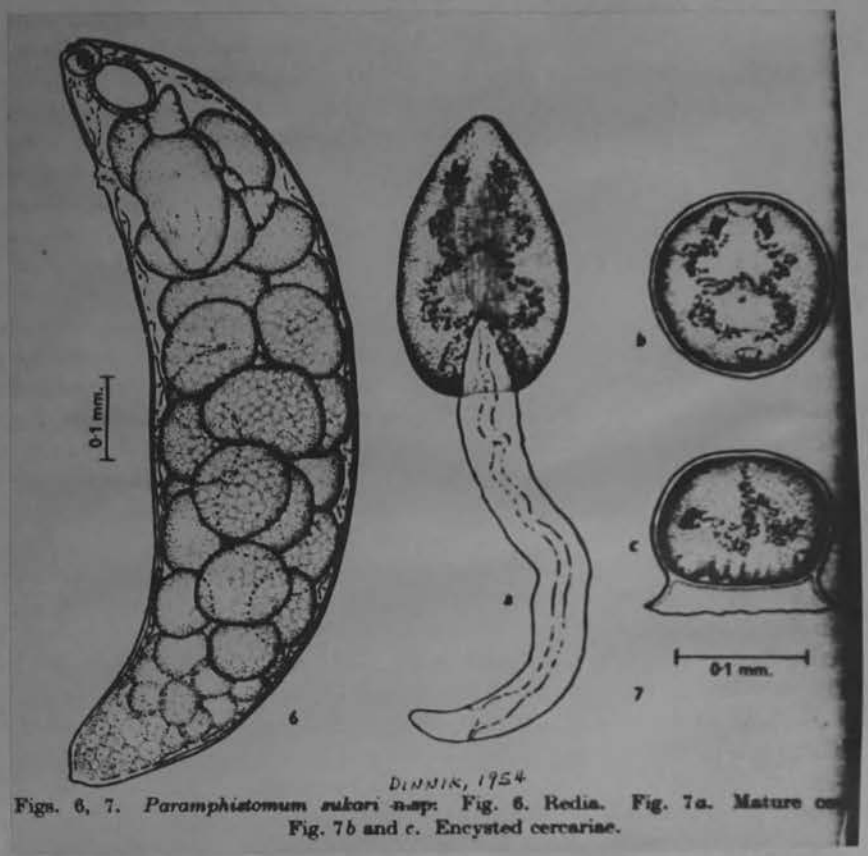


FROM DINNIK AND DINNIK (1954)
PARASITOL. 44: 286-299

1. SPOROCYST
2. REDIA OF 1ST GENERATION / YG. DAUGHTER REDIA
3. " " " " / 2 DAUGHTER REDIA AND ME DEVELOPING CERCARIA — 42 DAYS AFTER EXPOSURE
4. " " " " — END OF PRODUCTIVITY — 74 DAYS AFTER EXPOSURE
5. DEAD REDIA / 2 DAUGHTER REDIA — 76 DAYS AFTER EXPOSURE.
6. (a) MATURE CERCARIA (b-c) ENCYSTED METACERCARIA

Bulinus allwardi (Dautzenberg, 1908)

Paramphistomum sukari Dinnik, 1954



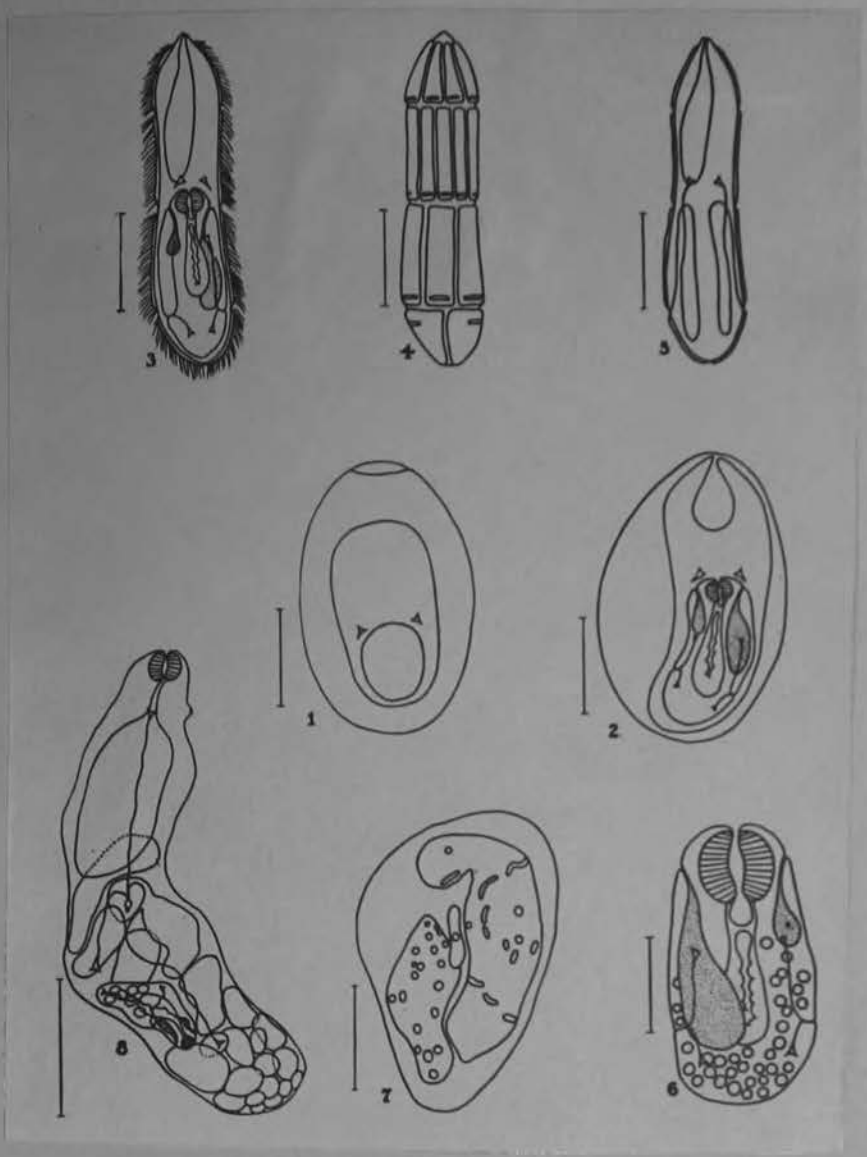
DINNIK, 1954

Figs. 6, 7. *Paramphistomum sukari* n.sp. Fig. 6. Redia. Fig. 7a. Mature ce
Fig. 7b and c. Encysted cercariae.

DEVELOPS IN BIOMPHALARIA PFEIFFERI (KRAUSS)

Paramphastomidae

Stichorchis subtriquetrus (Rud.)Nasmark,1937



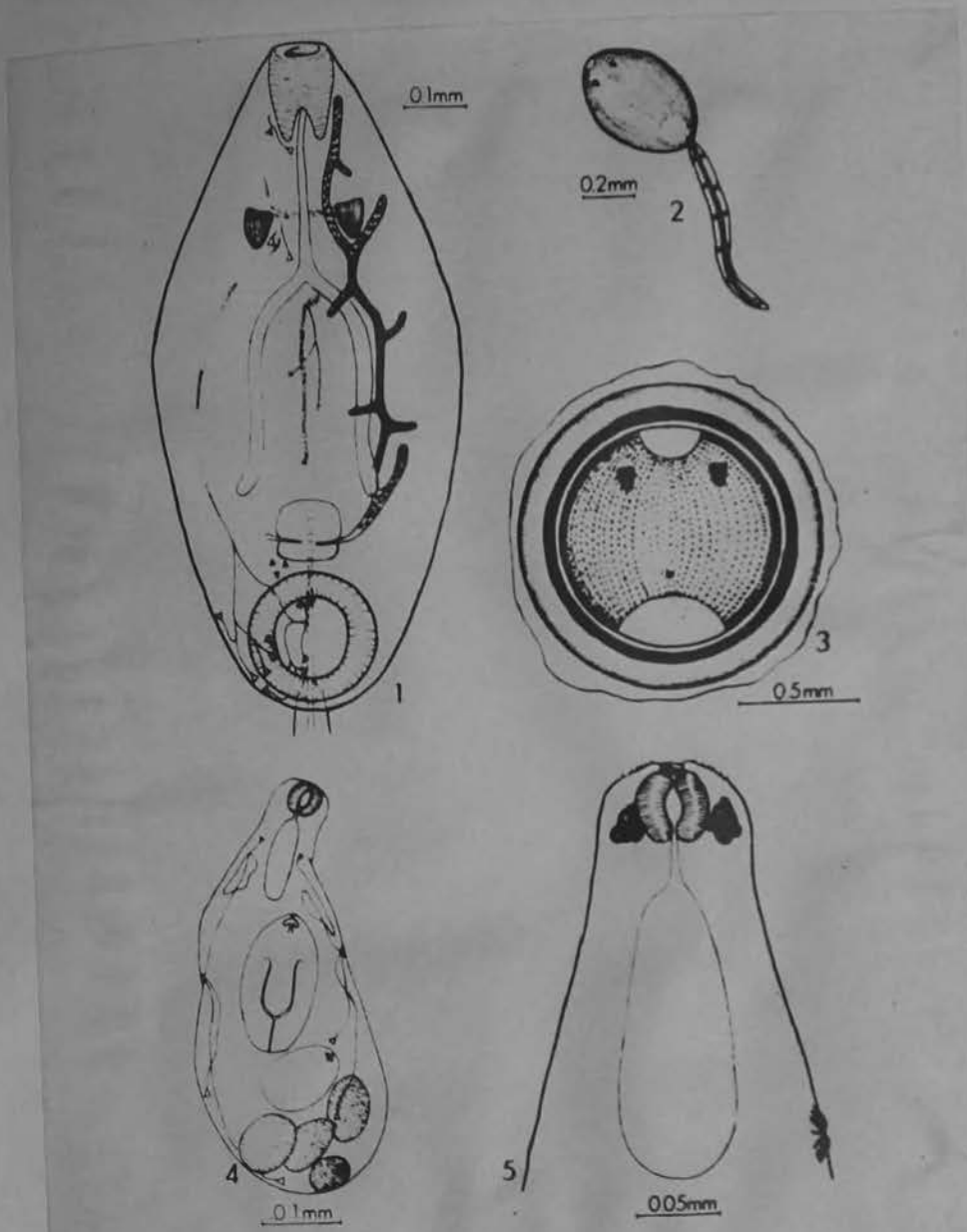
Adult in beaver,Castor canadensis carolinensis, in Louisiana
Eggs hatch after about 3 weeks.
Miracidium with epithelial plate pattern 6:8:4:2 , contains a single well formed redia, penetrates a snail,Fossaria parva, and soon liberates redia which migrates to liver of snail where daughter rediae are produced.
Similar to life cycle of Typhlocoelium cymbium, a monostome.
Cercariae not reported.
Reference: Bennett,Harry J & Arthur G.Humes. 1939
Jour.Parasit.,25:223-231

AND EAST,

STAGES IN THE LIFE CYCLE OF *WARDIUS ZIBETHICUS* BARKER, 1915*

K. Darwin Murrell
Department of Parasitology, University of North Carolina, Chapel Hill

ABSTRACT: Muskrats collected in a stream in Emmet Co., Michigan were naturally infected with *Wardius zibethicus*. *Helisoma antrosa* collected from this locality shed cercariae of *W. zibethicus* in the laboratory. Rediae and cercariae from these snails are described. Comparative measurements are given for a similar species of paramphistome cercaria. The cercariae demonstrated both positive phototaxis and emergence periodicity. Green vegetation was preferred as an encystment site. Incomplete development of the adult stage was attained in hamsters, white mice, a deer mouse, and guinea pigs.



FIGURES 1–5. Life-cycle stages of *Wardius zibethicus*. (All figures drawn with the aid of a camera lucida.) **1.** Body of mature cercaria, dorsal view. **2.** Dorsal view of swimming cercaria. **3.** Metacercarial cyst. **4.** Redia. **5.** Anterior end of redia, showing detail.

(dupl)

ON A NEW AMPHISTOME CERCARIA, *C. LEWERTI*, FROM INDIA

By

KR. SURESH SINGH

Reprinted from
TRANSACTIONS OF THE AMERICAN MICROSCOPICAL SOCIETY
Vol. LXXVI No. 4, October, 1957

ON A NEW AMPHISTOME CERCARIA, *C. LEWERTI*, FROM INDIA

KR. SURESH SINGH
Department of Zoology, University of Lucknow, Lucknow, India

During the past several years, a number of snails has been examined for larval trematodes. The present contribution gives an account of a new species of amphistome cercaria collected near Lucknow, India. Thirty-five snails, *Indoplanorbis exustus*, were collected from La Martiniere Lake at Lucknow, and nine of these were shedding amphistome cercariae of the *Pigmentata* group. The cercariae when swimming appeared as dark brown organisms, moving rapidly on all sides of the container but showing a preference toward the lighted side. They were shed usually between 9:30 A.M. and 2:30 P.M.

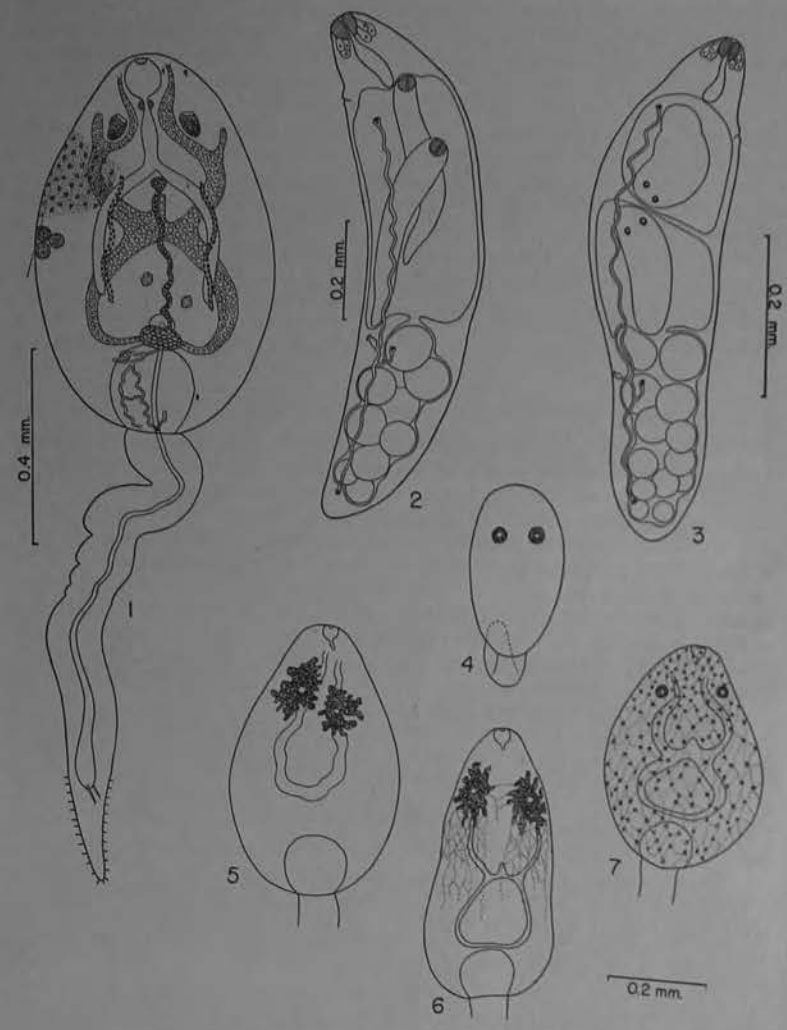
As far as possible the material was studied alive. Neutral red and brilliant cresyl blue were used as *intra vitam* stains. Temporary mounts, especially to demonstrate details of the rudiments of the genital organs, with aceto-carmine were very useful.

Cercaria lewerti n. sp.

(Measurements below in millimeters)
(Fig. 1)

DIAGNOSIS: Body pigmented heavily dorsally and ventrally; numerous pigmented stellar areas joined by smaller "dots", pigmented more heavily dorsally; body oval, 0.684–0.865 long and 0.447–0.485 wide; tail colorless, transparent 0.95–1.08 long and 0.13–0.143 wide; small spines at posterior end; two eye-spots, lens elliptical and followed by cone of heavy pigment, present on anterior dorsal side; muscular oral sucker at anterior end, 0.074–0.086 in diameter; crown of small processes absent; sucker leading to small muscular pharynx and short oesophagus, latter dividing into two intestinal ceca running posteriorly and terminating anterior to ventral sucker; ventral sucker ciliated, 0.129–0.172 in diameter, present posteriorly.

Pigment and cystogenous cells obscure small details of excretory system; excretory bladder rounded, lying anterior to ventral sucker; posteriorly and ventrally, two excretory ducts arise possibly from bladder, running posteriorly for short distance, turn anteriorly, run laterally to middle of body, again running medially, there joined by transverse connection with median anterior duct; excretory ducts again run anteriorly and laterally, passing medially to eye-spots, and reflexed back on reaching anterior end; small ducts branch off just posterior to eye-spots; small network of narrow ducts, probably joined to main excretory ducts, with ciliated areas seen on ventral sucker; caudal excretory duct arises from excretory bladder dorsally, running posteriorly to tail, there gradually widening, giving rise to two narrow ducts, latter remaining open during early life of cercaria; few flame cells seen; descending limbs of main excretory ducts ciliated in two areas; in larger ducts, rounded to oval refractile excretory granules present, showing deposit of excretory product



EXPLANATION OF FIGURES

(All diagrams made with aid of a camera lucida.)

FIGURE 1. *Cercaria lewerti* n. sp., living specimen. Genital organs have been superimposed from a camera lucida drawing. Pigment and cystogenous cells only partly shown.

FIGURE 2. Mother redia with daughter rediae, living.

FIGURE 3. Young daughter redia with cercariae inside, living.

FIGURES 4–7. Immature cercariae showing development of pigmentation.

by concentric rings; excretory pore, surrounded by sphincter muscles, on dorsal side of excretory bladder; rounded cystogenous cells, abundant within body, contain rod-like cystogenous matter, packed together in small bundles.

Ovarian cells present just anterior to ventral sucker; from ovary, cells forming uterus "string out" anteriorly, ending in mass of cells posterior to intestinal bifurcation representing genital pore; two testes, one slightly anterior to other, present anterior to ovary and to either side of uterus; rudiments of vitellaria seen on lateral side as two columns of cells ventral to intestinal ceca.

HOST: *Indoplanorbis exustus*, a fresh-water snail.

LOCALITY: La Martiniere Lake, Lucknow, India.

TYPE: In the helminthological collection, University of Lucknow, Lucknow, India.

DESCRIPTION OF THE REDIA AND EARLY CERCARIA

There are two generations of rediae. The mother redia is elongated, measuring 0.903–0.998 long and 0.2–0.22 wide. The mouth opening is terminal and is followed by a muscular pharynx, 0.43 in diameter. The intestine is comparatively small, 0.194–0.22, in fully-developed mother rediae. Three pairs of salivary glands are present at the anterior end. The excretory system is represented by three flame cells on each side. The excretory pore is present in the posterior half of the body and it leads into a small excretory vesicle. The excretory ducts arise from the vesicle, one running anteriorly and terminating in a flame cell near the anterior end, the other duct running posteriorly. The posterior excretory duct, immediately after arising from the vesicle, gives off a small duct which ends in a flame cell near the excretory vesicle, after which the duct runs posteriorly, ending in a flame cell near the posterior end. The mother redia usually contains one or two daughter rediae in the middle of the body, and eight to eleven germ-balls in the posterior region (Fig. 2). The daughter rediae inside the mother redia measure 0.32–0.38 long and 0.067–0.07 wide. The pharynx is 0.034–0.039 in diameter. The birth pore is present on a small papilla near the anterior end. The locomotor appendages are absent.

The daughter redia is structurally similar to the mother redia, measuring 1.1–1.52 long and 0.17–0.3 wide (though one daughter redia measured only 0.684 long), and contains two or three developing cercariae and 13–15 germ-balls (Fig. 3). The daughter rediae and cercariae were never found together inside a mother redia.

Since the cercariae were shed in very early and immature stages from the rediae, it was possible to study the process of pigmentation (Figs. 4–7). At first a dark brown area appeared near the anterior region while the cercaria was still inside the redia. This area gradually grew in size and assumed the stellar shape around the eye-spot. From this area a large number of thin "threads" of pigment ran on all sides, especially posteriorly, and these "threads" formed a close network. The crossing of the meshes were the points where more and more pigment was deposited so that a "beaded chain" was formed. These "beads" grew in size and assumed stellar shapes with a clear space in the middle representing the "nucleus."

Most of the cercariae were in this stage when the snail host was dissected, and appeared greyish-white to the naked eye. When the cercaria is fully mature and is outside the shell of the host, it appears dark brown to the naked eye. The pigment was decolorized by nascent chlorine and aceto-carmine.

The cercariae, when allowed to remain undisturbed, encyst readily on the leaves and walls of the container. It was noticed that almost invariably the cercariae encysted near the water-level mark, preferably on the lighted side. The free life of the cercariae before encystment varies from 20 to 130 minutes, the average time being about 56 minutes. Before encysting, the cercaria drops to the bottom or attaches itself to the leaves and creeps for some distance, lashing its tail vigorously and continuously. After some time, the cercaria begins swimming again and this is repeated several times before it finally encysts. Just before encystment, the cercaria stops moving and the cystogenous matter is exuded and distributed evenly around the body due to the lashing of the tail. Shortly, the tail is cast off but swimming continues for some time. The cercaria keeps moving inside the partly-formed cyst. After the cyst is completed, it appears as a tough brownish membrane, though the pigment, refractile granules, and the ventral sucker can be seen through the cyst wall.

Discussion

A number of amphistome cercariae have been described but not all of them belong to the *Pigmentata* group. Of these several are well-known due to the works of Looss (1896), Sewell (1922), Grobbelaar (1922), Faust (1926), Bennett (1936), and Porter (1938).

The present form differs from *Cercaria pigmentata* Sonsino, in having three pairs of flame cells in the redia instead of five pairs, in the lateral extension of the excretory duct nearly to the eye-spots, and in differences in size of the body and other organs.

From *C. paramphistomi calicophorum* Porter, 1921, it differs in having the lateral extension of the excretory duct near the eye-spots, in the absence of the lateral ceca of the oesophagus, and in the widely different position of the testes. In *C. lewerti* n. sp., the tail is spined and much longer than the body.

From *C. stelliae* Porter, 1938, it differs in the presence of the lateral extension of the excretory duct near the eye-spots, in possessing the median extension of the transverse connection, and in the presence of the pharynx followed by a simple oesophagus; the tail is also longer than the body.

From *C. frondosa* Cawston, *C. lewerti* n. sp. differs in the absence of the paired oesophageal pouches and the presence of the transverse connection between the main ducts.

From *C. indicae* XXIX Sewell, 1922, it differs in the presence of the lateral extension of the excretory duct near the eye-spots, in the position of the testes, in details of the genital pore, and in size of the body.

From *C. indicae* XXXII Sewell, 1922, the present form differs in the size of the body, tail and the suckers, in the absence of sphincter muscles at the posterior end of the oesophagus, in the presence of the median duct from the transverse connection, and in having two generations of rediae.

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PARAMPHISTOMIDAE

LOOSE LEAF INDEX

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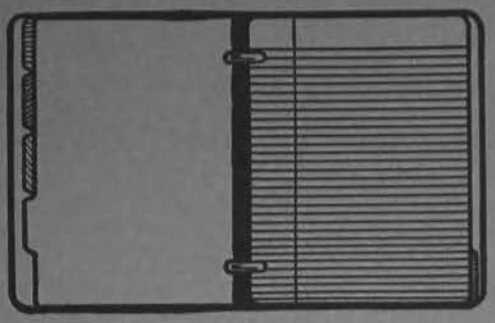

IDEAL FOR CLASSIFYING, OR SEPARATING STUDIES, VARIOUS SUBJECTS OR MISCELLANEOUS DATA.

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SUBJECTS

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CLASS SCHEDULE

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	INSTRUCTOR								
ESDAY	COURSE								
	INSTRUCTOR								
EDNESDAY	COURSE								
	INSTRUCTOR								
HURSDAY	COURSE								
	INSTRUCTOR								
RIDAY	COURSE								
	INSTRUCTOR								
ATURDAY	COURSE								
	INSTRUCTOR								

Philophthalmidae

Cloacitrema michiganensis McIntosh, 1938

A PRELIMINARY REPORT ON THE LIFE CYCLE OF *CLOACITREMA MICHIGANENSIS* McINTOSH, 1938 (TREMATODA).

The trematode genus *Cloacitrema* was erected by Yamaguti (1934, Jap. J. Zool. 6: 161–163). *Cloacitrema ovatum*, the type species, was found in the cloaca of *Bucephalo clangula clangula*, from the Arctic Prefecture. The only other species in this genus is *Cloacitrema michiganensis* McIntosh (1938, Proc. Helminth. Soc. Washington 5: 46–47) from the cloaca of the spotted sandpiper from Michigan and of the black-necked stilt from Florida.

Several years ago a number of specimens of *Cloacitrema michiganensis* were recovered from the cloaca of the spotted sandpiper, *Actitis macularia*, the western willet, *Catoptrophorous semipalmatus inornatus*, and the sea gull, *Larus californicus*. These birds were collected in the Playa del Rey region, Los Angeles County, along the coast of Southern California.

The eggs contain fully developed miracidia which may hatch in the uterus of the adult worm or in sea water. The miracidia are very active, swim rapidly and invade the snail host. Of the marine snails examined, only *Cerithidea californica* Haldeman was found naturally infected with the larval stages of this trematode. Two generations of rediae, mother and daughter, develop within the snail host. The cercariae are of the megalurous group and develop in the daughter rediae. They encyst as metacercariae on the surface of snail shells and on other objects. Two immature female sea gulls, *Larus californicus* were fed viable metacercariae and became infected with the adult flukes. The complete life cycle is the first recorded in the genus *Cloacitrema*.

Cloacitrema closely resembles *Parorchis* in structure and life cycle, both probably having an ancestor in common.

The morphology of the larval stages and a comparison of the life cycles of *Cloacitrema michiganensis* and *Parorchis acanthus* Nicoll, 1907 will be described in detail in a future report.—HENRY W. ROBINSON, *University of Southern California, Los Angeles, California.*

JP 38:368 (1952)

Philophthalmus andersoni Dronen and Penner, 1975

Eggs and Miracidia (Figs. 3 and 4)

Forty fully developed live eggs shed from 112-day old flukes were 101 (96 to 113) long, containing fully developed miracidia with dark pigmented eyespots. Miracidia, 155 (140 to 165) long by 56 (52 to 60) wide, with single eyespot and a tetranucleate apical gland at the anterior end of body; two single nucleate penetration glands just posterior to eyespot and one pair of flame cells midway down the body; posterior third of body containing a single mother redia; epithelial plates difficult to observe but apparently in four tiers, with six at the anterior end, followed by a row of seven, a row of four and finally two; radial papillae evident on both sides of body extending between the first and second rows of plates where they are joined by a duct.

Rediae (Fig. 5)

Thirty-five fully developed rediae were 1840 (1790 to 1950) long by 330 (312 to 350) wide and contained two or three fully developed cercariae along with several others in varying stages of development.

Cercariae (Figs. 6 and 7)

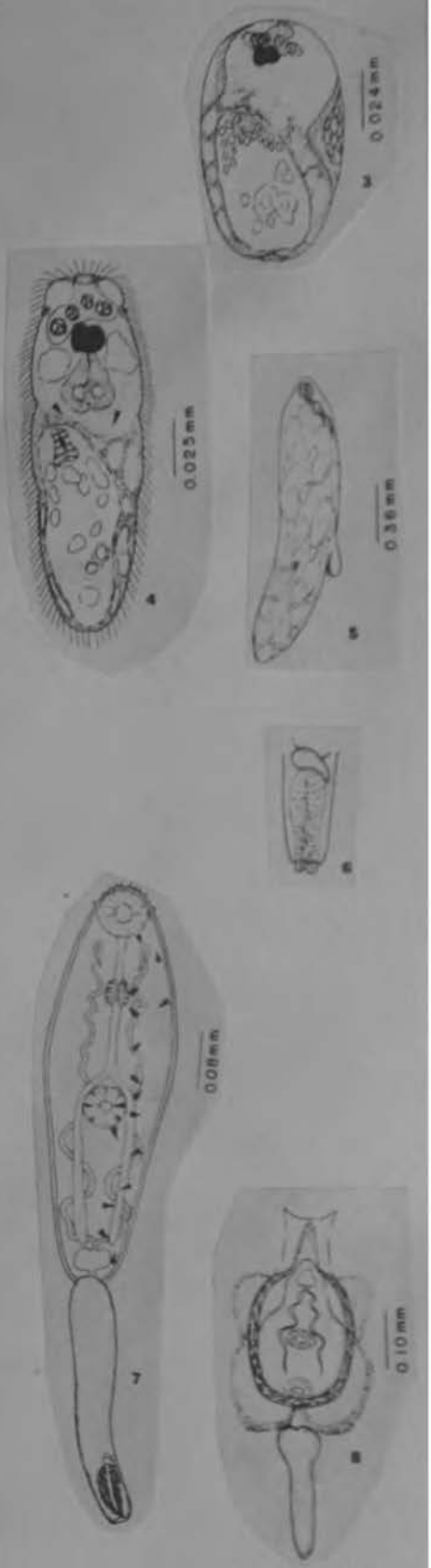
Fifty-two cercariae fixed in AFA were 540 (500 to 650) long by 172 (144 to 240) wide at level of acetabulum, distome packed with parenchyma cells, tail 360 (300 to 450) long with protusable adhesive gland in its tip; oral sucker 68 (52 to 80) wide; acetabulum 70 (60 to 80) wide; muscular pharynx, 42 (36 to 44) long; esophagus dividing just anterior to acetabulum with ceca extending to just anterior of the excretory bladder; excretory system composed of an oval bladder with two collecting ducts extending anteriorly to the level of the prepharynx and then posterior again; flame cell pattern 2 [(3+3+3) + (2+2+2)].

Metacercariae (Fig. 8)

Twenty-five metacercariae, flask-shaped, 365 (320 to 380) long by 175 (160 to 192) wide; neck of cyst 114 (98 to 126) long by 62 (54 to 68) wide.

The cercariae crawl like inchworms in the process of encystment, using the oral sucker and the tail adhesive gland, until the body contracts into a flask-like configuration and secretes a cementing material around its periphery. The tail is lost at the time of attachment and the cercaria becomes elongated at the anterior end secreting a cystogenous material which establishes the rough shape of the metacercaria. The worm then turns around with its posterior end toward the neck of the cyst and moves continuously from side to side until the metacercaria has worked into its characteristic shape. Metacercariae observed 24 hours after encystment showed that most worms return to the original position with their anterior end toward the neck of the metacercaria.

DRONEN AND PENNER, 1975



PHILOPHTHALMIDAE

PHILOPHTHALMUS GRALLI MATHIS AND LEGER, 1910

EXPERIMENTAL DETERMINATION OF THE LIFE HISTORY

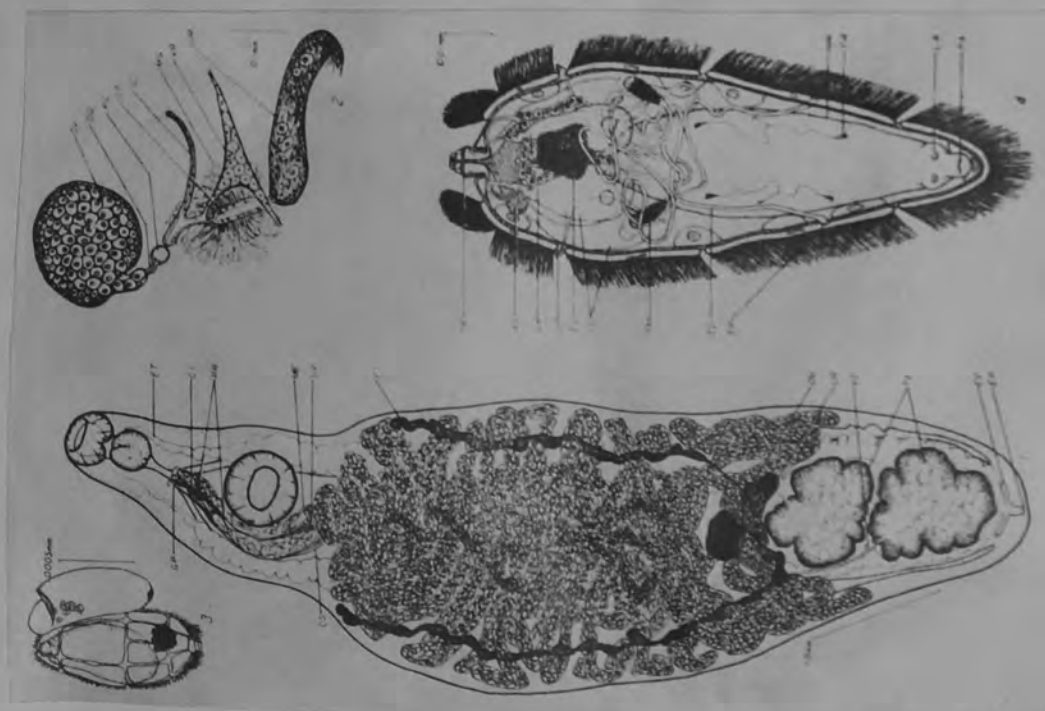
The first part of the life history was demonstrated experimentally by rearing the adult parasite in the orbit of chickens which were fed metacercariae. The cercariae were from naturally infected snails. The larvae normally encyst on the exoskeleton of arthropods, especially crayfishes, but cysts used in infection experiments were scraped from finger bowls. Many of the worms probably were injured in that process because some chickens did not become infected and others harbored fewer worms than the number of metacercariae fed. It is also likely that some of those that were not injured failed to reach the orbit for other reasons. The largest number of worms found in a naturally infected bird was 20 in a green heron, *Butorides virescens;* they were of various ages to judge from their sizes in contrast to the usually very uniform size of worms from chickens fed a single lot of metacercariae.

The life history was further elucidated experimentally by infecting snails with miracidia from worms reared in chicks. Many snails were thus exposed and sacrificed at intervals to study larval development of the parasite, but 15 *Goniobasis* sp. and 10 *Pleurocera acuta* were maintained and examined periodically for emerging cercariae. Six *P. acuta* survived and 3 shed cercariae at the end of 4 months. When *Goniobasis* sp. did not do so by the end of the 6th month, the 3 surviving individuals were sacrificed; one contained daughter rediae and a few apparently mature cercariae.

Because it is difficult to maintain prosobranch snails in a state of good nutrition in the laboratory, it is possible that under more favorable conditions, infected snails might shed cercariae within less time. Furthermore, it may be that the larger body of *P. acuta* favors the development of rediae and cercariae over the smaller *Goniobasis* sp. which, in natural infections, shed much smaller numbers of cercariae than did *P. acuta*.

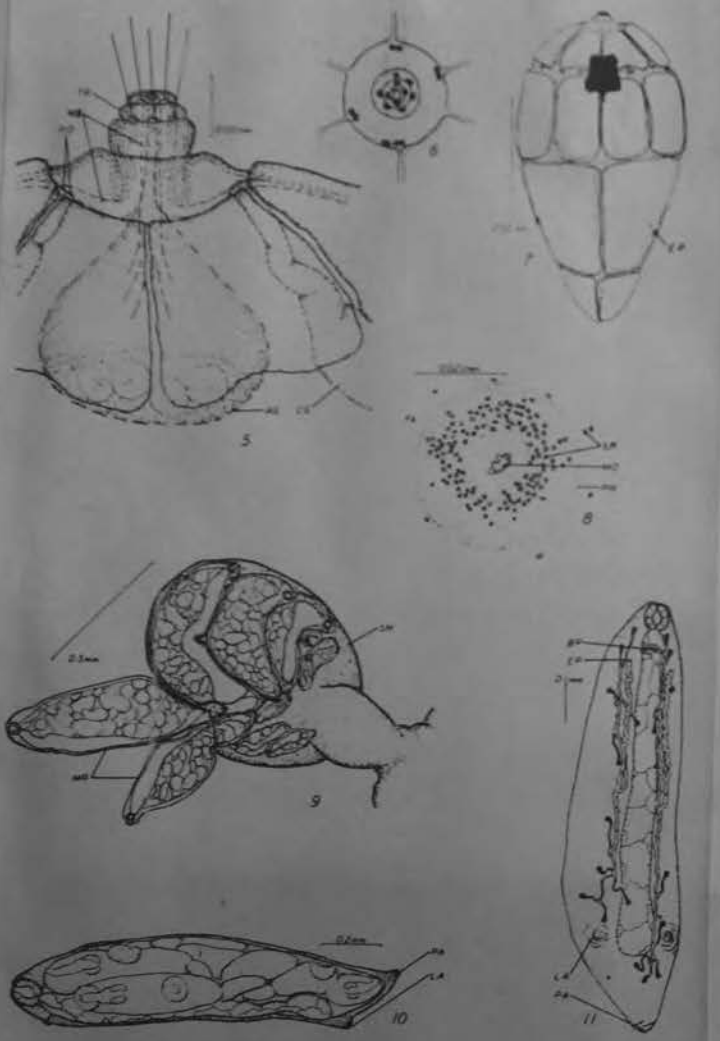
Experimental demonstration of the life history was completed by permitting cercariae from experimentally infected *P. acuta* to encyst and feeding the metacercariae back to a chicken which had provided miracidia used to infect the snails, thus obtaining adult worms for the 2nd time from a single host.

FROM WEST, 1961



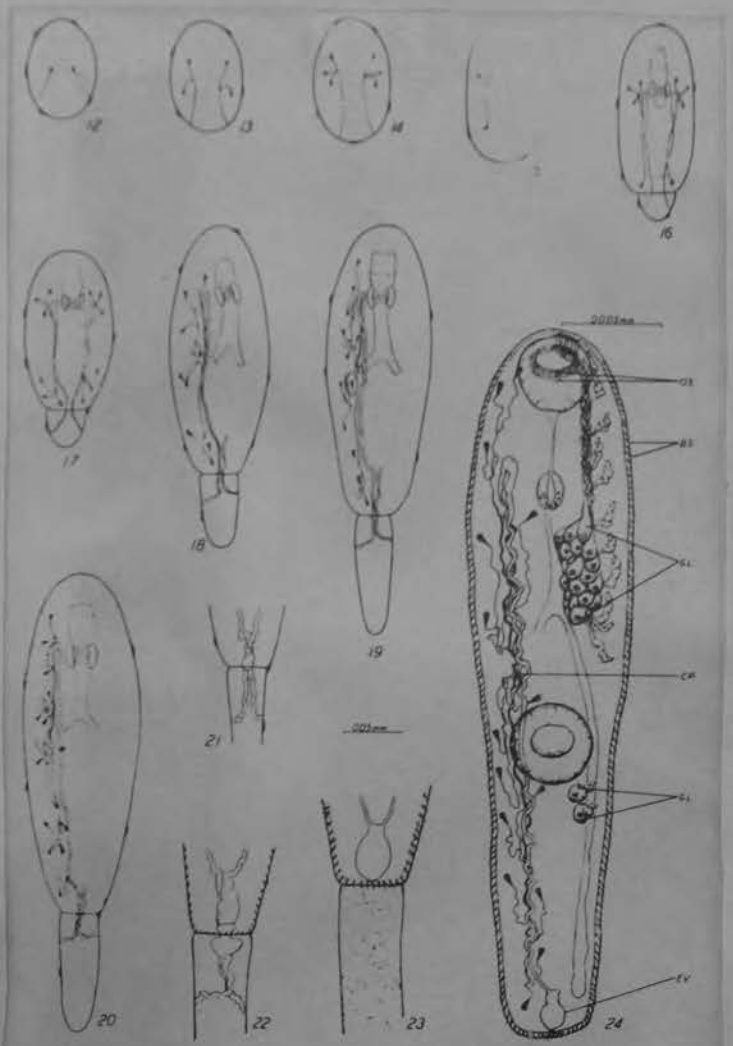
Figs. 1-4. 1. Adult *Philophthalmus gralli* from naturally infected Kingfisher (*Megaceryle alcyon alcyon*), ventral view. 2. Female complex (freehand). 3. Miracidium and egg shell, fixed in AgNO$_3$ (freehand). 4. Miracidium enlarged to show details (freehand). FROM WEST, 1961

PHILOPHTHALMUS GRALLI MATHIS and LEGER, 1910 (cont.)



Figs. 5-11.—5. Terebratorium, showing sensory papillae, muscle bands, glands and their openings (freehand). 6. Same, end view (freehand). 7. Epithelial plates of miracidium (freehand). 8. Sensory papillae of rediae, oral region. 9. Mother rediae in snail heart. 10. Daughter redia. 11. Redia, showing excretory system and gut cells (freehand). (Abbreviations as in Figs. 1-4.)

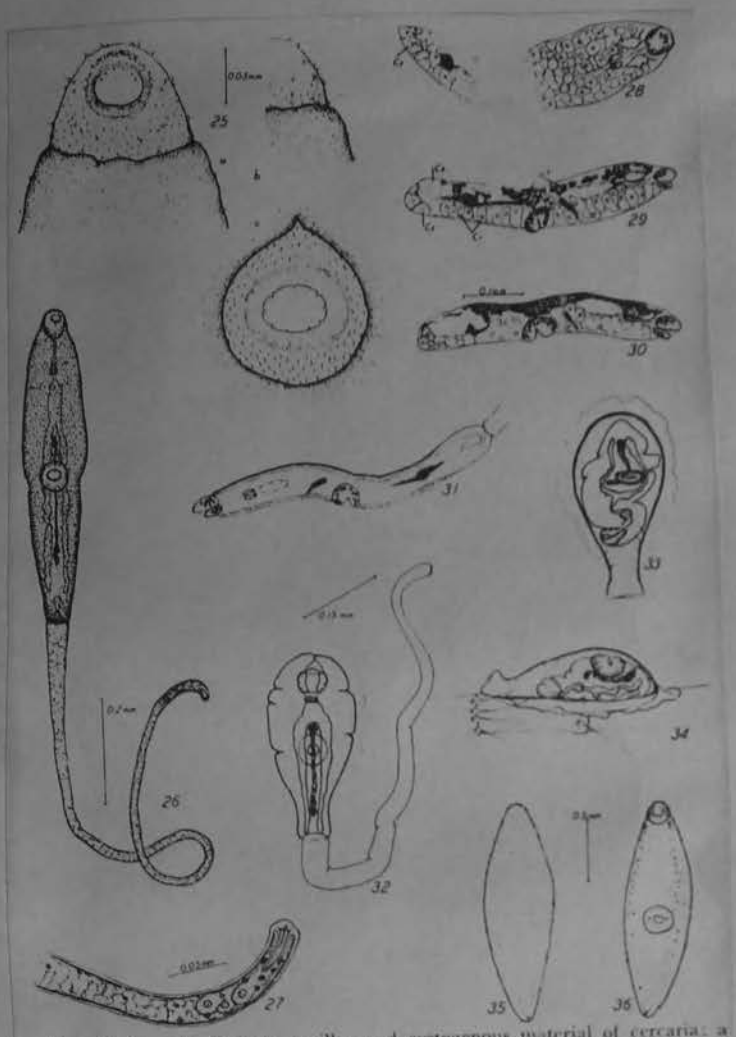
From WEST, 1961



Figs. 12-24.—12-20. Developmental stages of cercarial flame cell pattern (freehand). 21. Excretory vesicle forming (freehand). 22. Same, later. 23. Same, completed, caudal excretory ducts degenerating. 24 Metacercaria showing spines, glands and excretory system (freehand). (Abbreviations as in Figs. 1-4.)

From WEST, 1961

PHILOPHTHALMUS GRALLI MATHIS AND LEGER, 1910 (CONT.)



Figs. 25-36. 25. Sensory papillae and cystogenous material of cercaria; a and b, anterior end; v, ventral sucker (freehand). 26. Cercaria. 27. Tip of cercarial tail (freehand). 28. Embryo cercaria, frontal section showing ventral cystogenous glands. 29. Same, sagittal section showing cystogenous glands. 30. Same, later. 31. Cercaria, showing distribution of cystogenous material on surface of body. 32. Cercaria encysting. 33. Metacercaria cyst. 34. Se[illegible] on crayfish antenna. 35-36. Metacercaria, $AgNO_3$ fixed, showing sensory papillae; dorsal and ventral views respectively. (Abbreviations as in Figs. 1-4.)

FROM WEST, 1961

From Caballero Vol, 1960

Observations on the life history of Philophthalmus, a species of eye-fluke of birds in Hawaii *

JOSEPH E. ALICATA AND KAORU NODA

Description of Stages in the Life-cycle (all measurements in mm.)

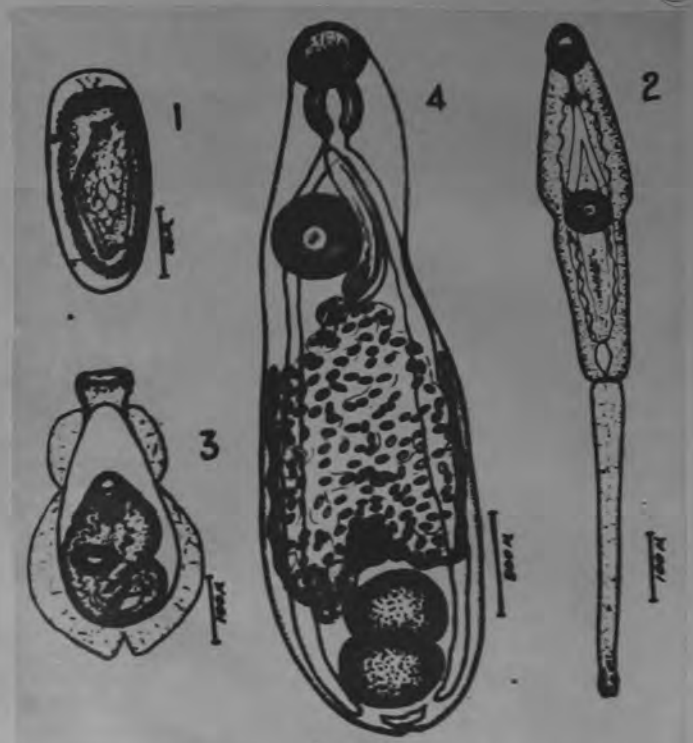
Egg (fig. 1).—The fully developed eggs which have been recovered fro washings of the conjunctival sac of experimentally infected birds, have a th yellowish shell without operculum. They measure 0.140-0.157 by 0.060-0.074 an contain fully developed ciliated miracidia with eyespots. Each miracidium enclos a young redia which fills most of its body cavity.

The fully developed eggs present in the terminal part of the uterus of th parasite are symmetrical and almost elliptical in shape. The pole next to th anterior end of the miracidium is usually slightly larger than the opposite pol The undeveloped eggs in the proximal part of the uterus, however, have parall curved sides and one pole is conspicuously wider than the other. About one-ha of the wider area encloses a rounded and colorless developing miracidium; th other narrower half encloses small and dark yolk cells. These undeveloped egg measure about 0.070 by 0.030 and are therefore about one-half the size of th developed eggs. However, as these eggs are gradually pushed up in the uteru and as the miracidia undergo further growth, the eggs increase in size.

Miracidium (fig. 1).—The eggs hatch immediately or within a few minute after they have been recovered in washings, and the miracidia swim actively i water. They do not appear to be attracted by light. If live adult flukes are kep in water, the eggs hatch in the uterus and the miracidia eventually find their wa out into the water. Miracidia, killed in a relaxed position with hot formalin solution, measure about 0.118 in length and 0.060 in width.

Redia (fig. 1).—As indicated above, each fully developed miracidium within the egg encloses a young redia which measures about 0.088 in length and 0.037 in width. The redia possesses a pair of small lateral appendages near the posterior end of the body and encloses undifferentiated germ balls. Snails, *T. granifera mauiensis*, dissected 28 days following experimental exposure to miracidial infection, contained rediae which measured 0.787 in length and 0.378 in width and enclosed a second generation of rediae. Further development of the rediae has not been observed.

Cercaria (fig. 2).—The cercariae are usually shed from infected snails in the early morning, and continue to emerge for a few hours everyday for several days. In water the body is stretched out and exhibits jerky movements. The cercariae encyst quickly when they contact solid objects. Encystment has been noted on the outer shell of living snails and on the wall of glass containers, most frequently near the water level. Cercariae which rise to the surface of the water become temporarily attached by the tip of the tail to the surface film. In this suspended position they continue active movements from one side to the other. After a period of several hours the cercariae drop to the bottom and encyst. In the manner of attachment of these cercariae to the surface film, they resemble Cercaria *megalura* described by Cort (1915). Because of the peculiarity of the tip of the tail of these cercariae, Cort proposed the term megalurous as a subgroup of the gymnocephalus type of cercariae.



(Figs. 1-4. *Philophthalmus* sp. All figures were drawn with the aid of a camera lucida.)

Fig. 1. Fully developed egg, containing miracidium and young redia, recovered from washings of the eyes of experimentally infected chicks. Fig. 2. Mature cercaria, fixed in formalin, obtained from naturally infected snails, *Tomichia granifera mauiensis*, Lea. Fig. 3. Metacercaria, encysted on glass. Fig. 4. Gravid adult from the conjunctival sac of an experimentally infected chick.

Cercariae which have been killed in a relaxed position with hot formalin solution measured as follows: Length of body 0.535-0.567; maximum width of body, 0.117-0.132; diameter of oral and ventral suckers, each 0.058-0.060; length of tail 0.409-0.456; maximum width of tail 0.044. The digestive system consists of the oral sucker followed by a narrow prepharynx 0.029 long, a small pharynx 0.022 long by 0.014 wide, a slender esophagus about 0.05 long, and a pair of intestinal ceca which extend almost to the excretory bladder at the posterior end of the body. A characteristic feature of this cercaria is a constriction at the level of the ventral sucker which is located slightly below the midregion of the length of the body. The tip of the tail of these cercariae is truncated and slightly bulbous. In living condition this region is usually bent like a hook. The central portion of the tip of the tail is invaginated and is surrounded by small club-shaped glands. Cort (1915) was of the opinion that these glands secrete a substance which make it possible for the adhesion of the tip of the tail to surfaces.

NATURAL INFECTION IN FELIS AMERICANA ALAI PERLE (Sep. of Am. cast)

METACERCARIA (fig. 3).—Just before encystment the cercaria creeps for a short distance, then suddenly the body flattens and stretches out while the tail keeps on moving from side to side. Shortly cystogenous material is exuded and distributed evenly around the body. Gradually the body shrinks away to leave behind an outer membranous wall with 2 lateral wing-like expansions. This wall actually constitutes the body-outline of the stretched-out anterior and posterior halves of the cercaria with its constriction slightly below the central region. The tail of the cercaria remains attached for a short time and then becomes detached leaving behind a dome-like elevation. Within the above outer cyst an inner fine wall with a pear-shaped cavity is immediately formed. At first, the newly forme metacercaria faces the broader end of the inner cyst cavity, then within a sho time it completely turns around and remains inactive in a contracted positio (fig. 3). The entire cyst measures 0.362-0.378 in length and 0.220-0.236 maximum width. The inner cyst measures 0.283-0.299 in length and 0.157-0.18 in maximum width. Encysted metacercariae which have been fed to chicks 24 hou after encystment developed to adults.

ADULT (fig. 4).—Adult worms containing eggs with miracidia in the uter were obtained from the conjunctival sac of young chickens and ducks 20 da after experimental infection. Flukes recovered 20 days after infection showed in mature eggs in the eyes of the host, the flukes were often seen clusters and firmly attached by the ventral sucker to the lining of the conjunctiv A part of this lining was usually sucked in by the sucker so that when the flu was detached a nipple like protuberance remained at the point of attachmen Considerable congestion and exudate were frequently noted in the affected ey of ducks but not of chickens.

Seven adult flukes which were recovered from experimentally infected chi and were fixed and stained showed the following diagnostic features: Body elo gated, attenuated anteriorly and broadly rounded posteriorly, measuring 2.36-3. in length and 0.503-1.13 in width. Cuticle unarmed. Oral sucker subtermina 0.255-0.293 by 0.285-0.398 in size. Ventral sucker, 0.293-0.353 in size. Pharyn just posterior to oral sucker, 0.223-0.260 long by 0.195-0.255 wide. Esophag 0.047-0.110 in length. Intestinal ceca simple, extending almost to posterior en of body.

Testes frequently semicircular in outline, occasionally slightly lobed, oblique in position and located in posterior fourth of body length. Anterior testis, 0.30 0.398 in length by 0.360-0.555 in width. Posterior testis, 0.255-0.305 in length b 0.330-0.523 in width. Cirrus sac slender, extending beyond level of ventral sucke Cirrus studded with minute spines best visible in living specimens. Common ge ital opening median, slightly behind pharynx.

Ovary spherical in outline, on median line, pretesticular and 0.180-0.195 diameter. Uterine coil extending from level of anterior testis to behind poster border of ventral sucker. Vitellaria tubular, extracecal, extending posteriorly fro middle of body to level of anterior border of anterior testis. Fully developed eg in terminal portion of uterus, 0.130-0.157 by 0.060-0.074. They enclose fully d veloped miracidia provided with pigmented eyespots.

RELATED TO P. GRALLI MATHIS AND LEGER, 1910

DISCUSSION

As far as the writers are aware, this paper constitutes the first report on t life history of any member of the genus *Philophthalmus*. Two kinds of melan snails present in Hawaii, namely, *Tarebia granifera mauiensis* Lea and *Melanoid newcombi* (Lea) serve as intermediate hosts under natural conditions. There a possibility that the cercariae found by the writers in these snails are similar the megalurous type of cercariae reported by Lutz in 1893 from *Melania baldw* Annecy and *Melania newcombi* Lea, collected in Hawaii (*fide* Cort, 1913). T two species reported by Lutz are now believed to be synonyms of *Melanoid* ***newcombi* (Lea). Furthermore, the megalurous cercariae found by Martin (1958) in *T. granifera mauiensis* and *M. newcombi* from Hawaii, are believed to be similar to the ones observed by the writers.**

ETC.

Parorchis acanthus (Nicoll, 1906) Nicoll, 1907

Syn. *Distomum pittacium* Braun, 1901
Parorchis asiaticus Strom, 1928
Parorchis avitus Linton, 1914
Parorchis snipis Lal, 1936
Proctobium gedoelsti Skrjabin, 1924
Proctobium proctobium Travassoss, 1918
Zeugorchis acanthus Nicoll, 1906
Cercaria purpurae Lebour, 1911
Cercaria sensifera Stunkard and Shaw, 1931

DESCRIPTION: Body spinose throughout, without eyespotted pigment. Oral sucker with 3-4 rings of setate papillae. Occasional papillae also observed on body. Prepharynx present. Pharynx anteroposteriorly elongated. Esophagus dividing near ventral sucker than pharynx. Intestinal ceca extending up to anterior border of excretory vesicle. Esophagus and ceca delicate, not filled with inclusions. Ventral sucker larger than oral. Sixty-four spines, arranged in a single row, interrupted ventrally, in postequatorial region of oral sucker. At anterior border of cercaria 16 openings of ducts, arranged as under: 2 openings on sides, 12 openings in between; ducts from these openings leading as far posteriorly as posterior to oral sucker; glands leading to ducts not observed. Cystogenous glands with granular inclusions occupying ventral aspect of body. Glands with rhabditiform contents situated dorsally. In living cercariae, especially in semicontracted forms, a shallow transversely elongated depression of thick walls, immediately anterior to ventral sucker. Excretory vesicle saccate, variable in form and extent. Main excretory ducts arising terminally, extending up to prepharyngeal region with formation of loop. Secondary excretory ducts dividing near anterior border of ventral sucker. Caudal excretory duct bifurcating in proximal region of tail. Main excretory ducts enclosing refractile excretory granules of small size throughout. Flame cell formula 2 [(3+3+3)+(3+3+3)] = 36. Tail aspinose, with posterior extremity invaginable; this latter zone highly thick-walled, adhesive; no finfold on tail, no hairs; tail subterminally attached, filled with globular bodies of variable size stainable with neutral red. Cercariae emerging throughout day and night. Encysting almost immediately after emergence from snail. Encystment on bottom of finger bowl; also on slide while being observed under microscope. Cyst wall very adhesive, consisting of two layers: an outer layer, irregular around margin, to which debris becoming attached; inner layer thin walled, laminated, thinner than outer layer, of uniform diameter, cannot be removed without injury to metacercaria. While cysts being transferred by pipette, outer layer remaining behind attached to substratum. Ducts with granular material still present in encysted cercariae as well as glands with rhabditiform contents. According to Rees (1937), in *Cercaria purpurae*, which is a synonym of *Parorchis acanthus*, the above mentioned ducts probably coming from glands which help cercariae to emerge from snail. Since cercariae encyst in open, these «penetration ducts» reminiscent of other cercariae, do not seem to perform any function.

Measurements: body 0.666-0.702 by 0.153-0.180; tail 0.297-0.335 by 0.045-0.054; oral sucker 0.060-0.073 by 0.050-0.52; prepharynx 0.030-0.042 long; pharynx 0.024-0.034 by 0.018-0.022; esophagus 0.120-0.142 long; ventral sucker 0.072-0.084 by 0.064-0.076.

Cyst: fully formed younger cysts larger than older ones, measuring 0.261 by 0.225, excluding outer irregular covering; older cysts, excluding outer covering, measuring 0.196-0.234 by 0.150-0.198. Irregular outer covering, which is readily peeled off, 0.006-0.030 thick; inner covering attached to metacercaria, brownish in color, 0.004-0.008 thick.

Host: *Melongena melongena* L.

Locality: Laguna de Chacopata, Península de Araya, Sucre State, Cumaná, Veneuzela.

REMARKS: *Cercaria purpurae* Lebour, 1911 parasitic of *Nucella* (*Purpura*) *lapillus*, in Scotland and Wales (James, 1968; Rees, 1937), was experimentally connected with *Parorchis acanthus* (Nicoll, 1906) Nicoll, 1907 (Rees, 1939, 1940).

Stunkard and Shaw (1931) described a new cercaria, *Cercaria sensifera*, from *Urosalpinx cinerus*, in Woods Hole, Massachusetts, USA, and expressed the possibility of its synonymy with *Cercaria purpurae* in Europe. Rees (1937, 1939, 1940), on the basis of structural peculiarities, did synonymize it with *C. purpurae*.

With a consideration to several aspects like the excretory system, number of cephalic spines, invaginable caudal tip, cystogenous gland complex, and the digestive system, the subject of the present investiga-

-OVER-

tion is indistinguishable from the European and the North America representatives of *Parorchis acanthus*. However, there are twelve pen tration ducts in the European cercaria, and the cyst measures 0.295 i comparison with sixteen ducts in the Latin American form and the cyst measures 0.196-0.261.

Holliman (1961) recovered the adults of *Parorchis acanthus* from the chickens which were fed with the metacercariae formed by cercariae found in *Cerithidea scalariformis*, Florida, USA. The corresponding cercaria was characterized with about 70 collar spines, 36 flame cells in all, and the invaginable caudal tip. The presence of about 70 cephalic spines, instead of 64, could be an instance of intraspecifically varied specimens, or a question of interpretation.

Cercaria caribbea LIX Cable, 1963 from *Thais rustica*, Rocky splash pools, North of Curaçao, is also provided with an invaginable caudal tip. Its general morphology is similar to that of *Parorchis acanthus*, but there are about 58 cephalic spines, and numerous flame cells the pattern of which could not be determined.

Echinostome II Maxon and Peqegnat, 1949 parasitic of *Cerithidea californica*, Upper Newport Bay, has a caudal tip which is inverted suckerlike, anterior and posterior excretory loops are present, the cephalic spines are 65, and the flame cell formula in the order of 2 [(3+3+3+3+3)] with an additional flame cell in the posterior region. *Parorchis acanthus* differs in having 36 flame cells in all, and only the anterior excretory loop is present.

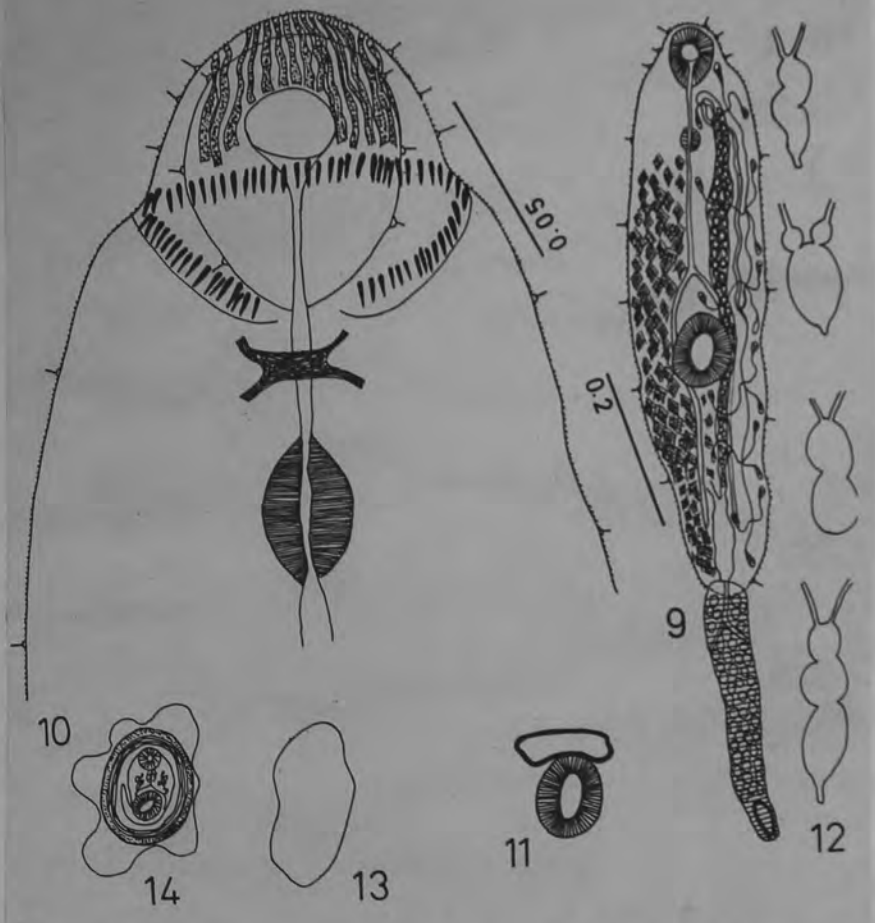


Fig. 6 - *Parorchis acanthus* (Nicoll, 1906). 9, Glands with rhabditiform contents and flame cells shown on one side only; note invaginable caudal tip. 10, Anterior region of body showing penetration ducts, cephalic spines, rudiments of nervous system, pharynx and part of gut. 11, Elongated depression in front of ventral sucker. 12, Variations in shape of excretory vesicle. 13, Another variation of excretory vesicle. 14, Encysted metacercaria showing outer layer of cyst wall of granular nature to which debris becomes attached, and inner laminated layer of cyst wall.

FROM NASIR, 1976

PHILOPHTHALMIDAE

Paralepoderma brumpti (Buttner, 1950) Buttner, 1950
(syn. Plagiorchis brumpti Buttner, 1950)

Summary

The cercariae of *Paralepoderma brumpti* (Buttner) were the cause of a great mortality among *C. albula* and *C. lavaretus* fry in breeding ponds. It was found that the death of the host was mainly caused by factors of mechanical character, out of which the following were most important: the mode of passage of the parasite through the host's body, the localization, the ratio between the host's and parasite's body size, and the number of parasites. The damage to the tissues due to the cercariae moving in the body of the fry was also discussed.

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KOZICKA, J. AND K. NIEWIADOMSKA 1966 A CASE OF THE LETHAL EFFECT OF PARALEPODERMA BRUMPTI (BUTTNER, 1950) ON THE FRY OF COREGONUS ALBULA, C. LAVARETUS, AND RUTILUS RUTILUS UNDER BREEDING CONDITIONS. ACTA PARASITOL. POLONICA 14: 15-20

[FIRST REPORT OF P. BRUMPTI CERCARIAE IN FISHES]

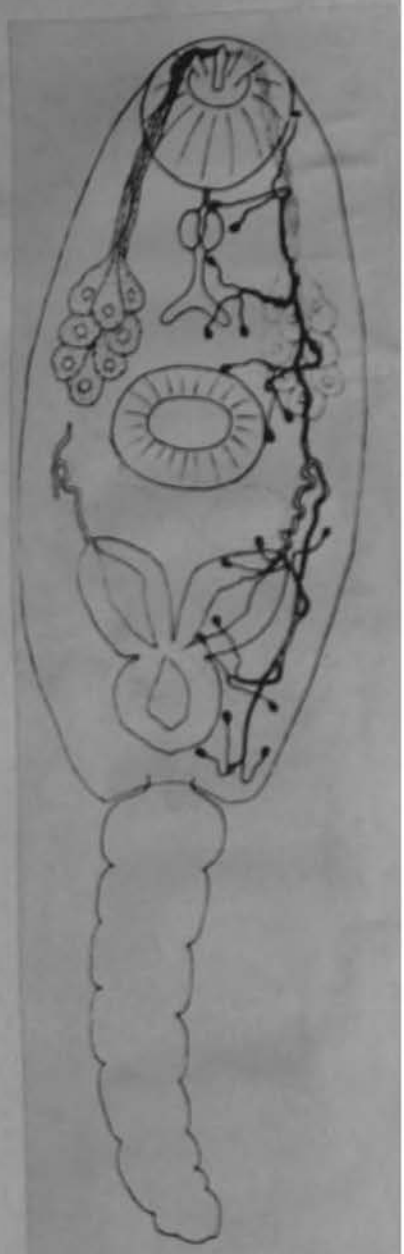


Fig. 1. Cercaria of *Paralepoderma brumpti*

Precocious Development of Plagiorchids

McMullen, Donald B. 1938
Observations on precocious metacercarid development in the trematode superfamily Plagiorchioidea.
Jour. Parasit., 24:273-280.

Metacercariae up to young adults in snail hosts.
Apparently no egg production.
Caused by approaching senility of snail and trematode and perhaps other factors,

Species observed:

- Plagiorchis muris Tanabe
- P. proximus Barker
- Alloglossidium corti (Lamont) *
- Macroderoides typicus (Winfield)*
- Plagiorchis micracanthus Macy*
- Cercorchis medius (Stunkard)*

* = new observation

Plagiorchiidae

THE JOURNAL OF PARASITOLOGY
Vol. 51, No. 4, August 1965, p. 587–593

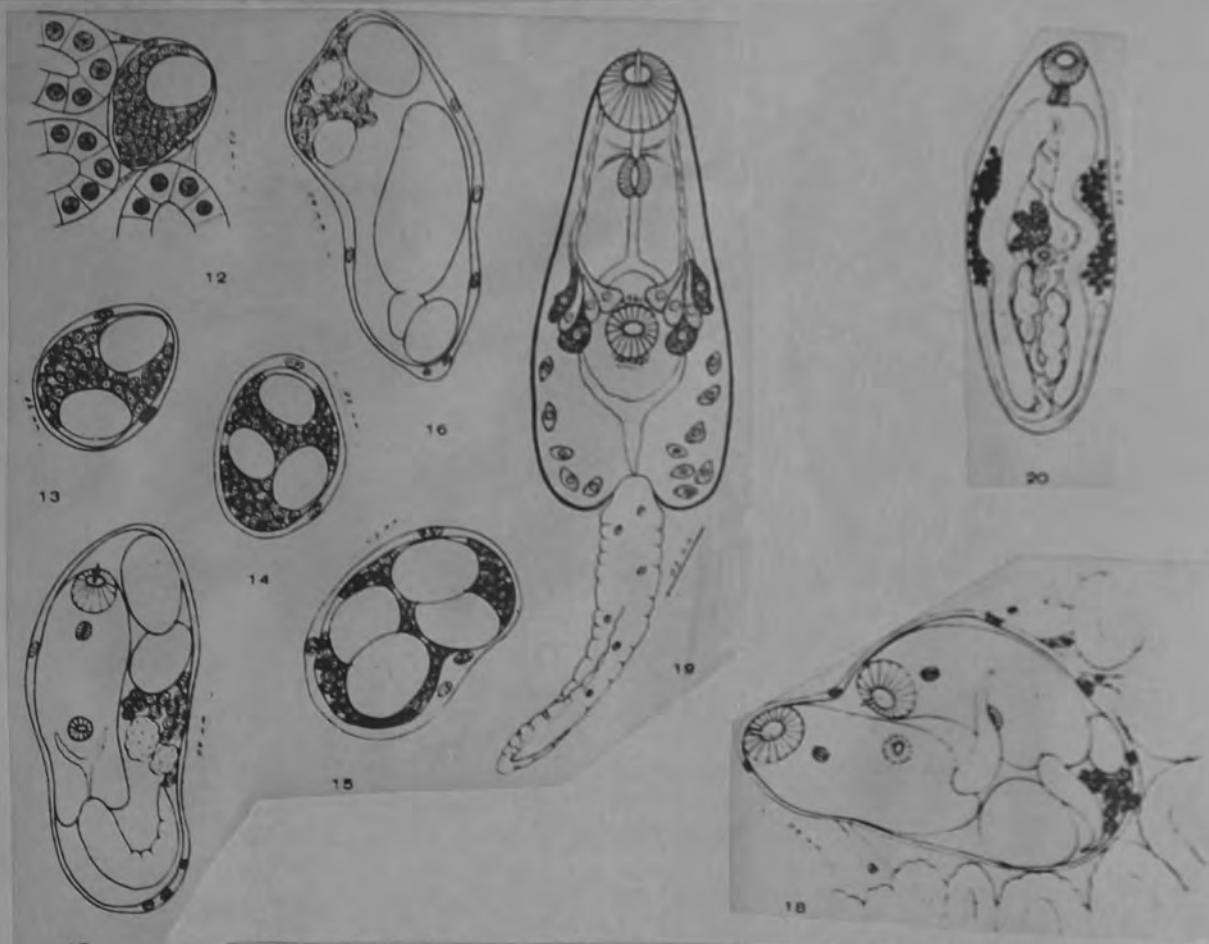
THE LIFE HISTORY OF *HAEMATOLOECHUS BREVIPLEXUS* STAFFORD, 1902 (TREMATODA: HAPLOMETRIDAE McMULLEN, 1937), WITH EMPHASIS ON THE DEVELOPMENT OF THE SPOROCYSTS

Stewart C. Schell
Department of Biological Sciences, University of Idaho, Moscow

ABSTRACT: Embryonated eggs of *Haematoloechus breviplexus* Stafford, 1902 were fed to laboratory-reared specimens of *Gyraulus similaris* (F. C. Baker, 1919). Miracidia hatch in the snail intestine, then invade the intestinal epithelium, many penetrating only as far as the basement membrane, but some passing through to the hemocoel of the snail. In either location they metamorphose to the mother sporocyst which enlarges gradually as the germinal cells multiply. Those mother sporocysts that are enclosed by basement membrane soon become pedunculate and detach from the intestine when the basement membrane ruptures. By the 12th day, the limiting membrane of many mother sporocysts ruptures, freeing the germinal cells which continue multiplying in the hemocoel of the snail. Between the 12th and 22nd days, the germinal cells give rise to many daughter sporocyst embryos which also undergo their development in the hemocoel. There is no host cellular response to the parasite, and consequently, paletots do not develop around the sporocysts. Xiphidiocercariae of the Ornatae group are produced within 31 days and encyst in the branchial basket of naiads of the dragonfly, *Aeschna multicolor* Hagen, 1861. Metacercariae were fed to newly metamorphosed specimens of *Rana pretiosa* (Baird and Girard, 1853), and young adults of *H. breviplexus* were recovered 22 and 23 days later. The development of sporocysts of *H. breviplexus* is compared to that of several other species of plagiorchioid trematodes formerly studied by the author. Sporocyst development of *H. longiplexus* Stafford, 1902 and *H. parviplexus* (Irwin, 1929) was also observed and found to be identical to that of *H. breviplexus*. New host and distribution records are given for *H. longiplexus* and *H. breviplexus*.

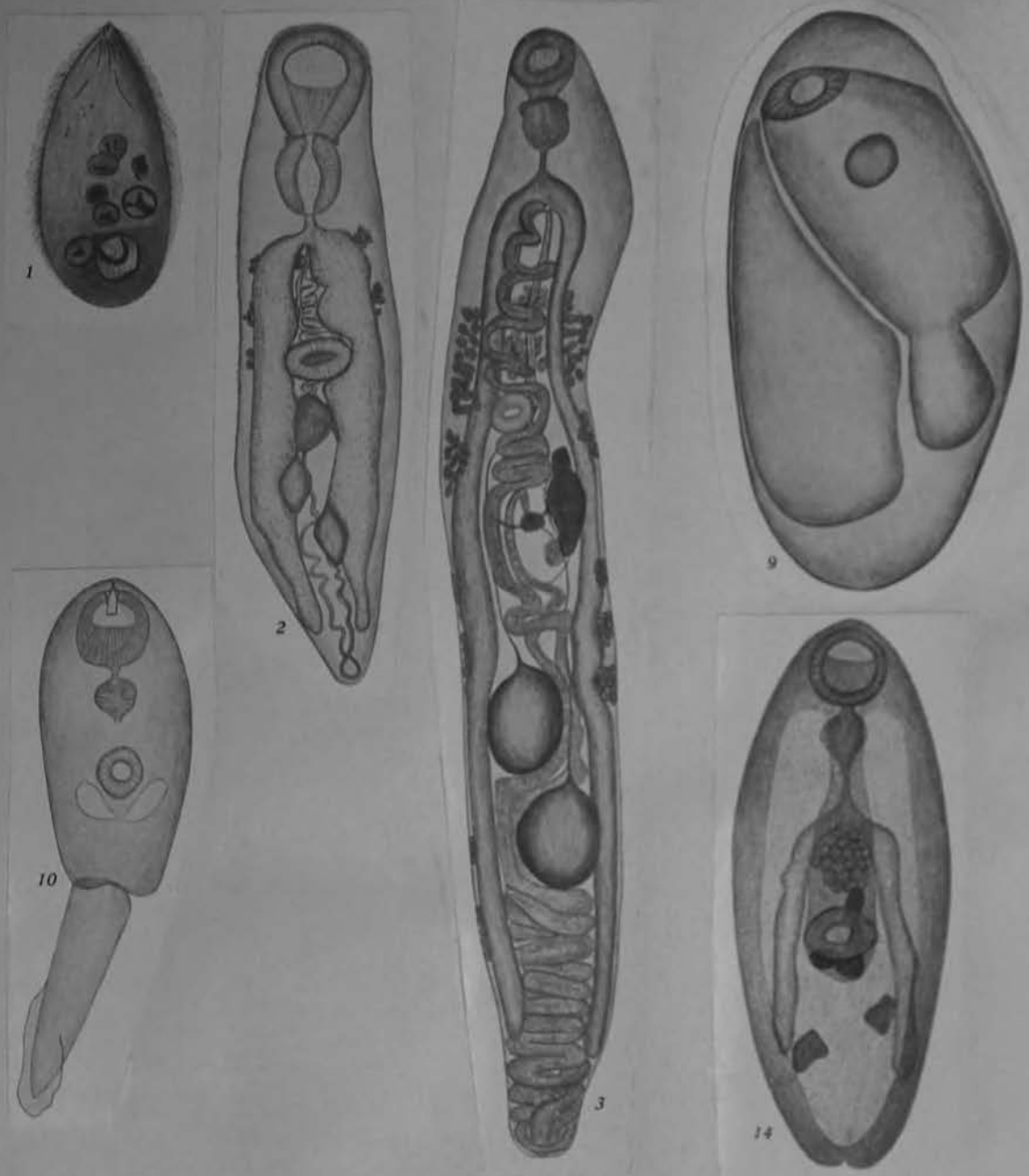
MIRACIDIUM

MOTHER SPOROCYST FREE IN HEMOCOEL, 3 DAYS



FIGURES 12–20. Developmental stages of *Haematoloechus breviplexus*, continued. **12** Daughter sporocyst on salivary gland, 13 days. **13** Daughter sporocyst, 14 days. **14** Daughter sporocyst, 16 days. **15** Daughter sporocyst, 20 days. **16** Daughter sporocyst, 25 days. **17** Daughter sporocyst, 28 days. **18** Mature daughter sporocyst, 31 days. **19** Cercaria. **20** Young adult, 23 days.

Haematoloechus oxyorchis (Ingles) --- Life Cycle.



The eastern frog, *Rana pipiens*, could not be infected with *Ostiolum oxyorchis*. *R. boylii* could be infected experimentally, but was not found harboring the flukes in nature. *R. aurora*, which inhabits ponds but not streams was found infected in nature.

The adolescaria hosts for *O. oxyorchis* are the dragonflies, *Sympetrum illotum* (Hagen) and *Plathemis lydia* (Drury). The nymphs of *Mesothemis simplicicollis* Say were not infected in the pond where 50 per cent of the *S. illotum* harbored metacercariae.

Planorbis (*Gyraulus*) *parvus* Say and *P.* (*G.*) *vermicularis* Gould were experimentally infected by feeding them with eggs of the fluke. The infection was found only in the former species in nature. The parasite feeds on nearly all the tissues in the lung of the frog.

CYCLE ÉVOLUTIF DU TRÉMATODE *MACROLECITHUS PAPILLIGER* REES. 1968 (ALLOCREADIIDAE), PARASITE DE *PHOXINUS PHOXINUS* (L.).

Life-cycle of the Trematoda *Macrolecithus papilliger* Rees, 1968, parasite of *Phoxinus phoxinus* (L.).

The life cycle of *Macrolecithus papilliger* Rees, 1968 (Trematoda - Allocreadiidae) an intestinal parasite of *Phoxinus phoxinus* (L.) has been demonstrated under natural conditions and verified experimentaly.

— The egg is expelled into the water with the faeces of the Minnow ;

— The ciliate, ocellate miracidium enters a Lamellibranch Sphaeridae *Pisidium casertanum* (Poli, 1791) where at least two generations of redia give rise to Ophthalmoxiphidiocercaries.

— After leaving the mollusc, the cercaries enter the larvae of Ephemeropterous insects of the *Caenis* genus where they turn into encysted metacercariès.

— The minnows are infected by ingesting these insects and the metacercariès becomes adults in their digestive tube.

This cycle is similar to that demonstrated for species of the genus *Crepidostomum*.

2 — Stades larvaires (Fig. 3 et Planche).

L'œuf operculé, présente souvent, au pôle opposé à l'opercule, un épaississement plus ou moins saillant, brun foncé. Nous avons obtenu expérimentalement le miracidium après 18 jours d'incubation est piriforme et occupe toute la zone comprise entre l'ocelle et l'extrémité antérieure. Le système excréteur est constitué par une paire de protonephridies, déjà décelables dans l'œuf quelques jours avant l'éclosion.

Le premier hôte intermédiaire où pénètre le miracidium est un Lamellibranche Sphaeridae : *Pisidium casertanum* où se développent les rédies qui produiront les cercaires.

Les rédies (Pl. : Fig. 1 et 2).

Elles sont très allongées et peuvent atteindre 2.5 mm sur 0.3 mm. Les plus petites observées mesurent 0.25/0.07 mm. Le pharynx globuleux a un diamètre de 0.040 à 0.050 mm. Le tube digestif est difficilement observable car comprimé par des balles germinatives et les cercaires.

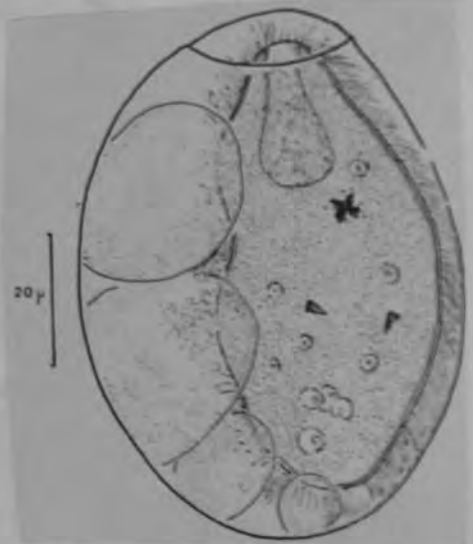
L'appareil excréteur de la rédie est constitué par une vingtaine de protonephridies. Deux générations de rédies au moins se succèdent à l'intérieur du Mollusque. Nous avons observé une rédie contenant deux rédies filles de 0.25 et 0.30 mm avec un pharynx de 0.030 mm de diamètre. Le reste de la rédie est occupé par des balles germinatives en voie de différenciation.

Les cercaires (Pl. : Fig. 3 et 4).

Elles se développent donc à l'intérieur des rédies filles. Ce sont des xiphidiocercaires ocellées. La cuticule est lisse. La ventouse ventrale occupe la région médiane du corps.

Les mensurations principales moyennes sont les suivantes (d'après les préparations in toto) :

Corps : longueur 0.28 mm ; Largeur : 0.16 mm.
Queue : longueur 0.34 mm ; Largeur : 0.03 mm.
Ventouse ventrale : 0.053 mm de diamètre.
Ventouse orale : 0.052 mm de diamètre.
Rapport ventousaire : $\simeq$ 1.
Pharynx : 0.023 mm de diamètre.
Stylet : 0.021 mm de longueur.
Ocelles : 0.014 mm de diamètre.



Le tube digestif débute par un court prépharynx qui précède le pharynx globuleux. L'œsophage se bifurque au niveau antérieur de l'acétabulum pour donner deux cæcums peu visibles, qui atteignent vers l'arrière l'extrémité antérieure de la vessie.

Les glandes de pénétration sont au nombre de six : trois de chaque côté du corps, dans une zone comprise entre le pharynx et l'acétabulum. Ces cellules lobées, ont un cytoplasme granuleux et un gros noyau réfringent. De chaque côté, les canaux des deux glandes les plus latérales sont entre les ocelles et le bord du corps alors que les canaux des glandes les plus internes passent entre le pharynx et les ocelles.

L'appareil excréteur peut être schématisé par la formule suivante :

$$2\ [(3+3+3+3) + (3+3+3+3)] = 48$$

De chaque groupe de trois flammes part un canal qui se jette dans les canaux collecteurs latéraux. De chaque côté du corps, au niveau acétabulaire, les collecteurs antérieurs et postérieurs donnent un canal qui se jette, latéralement, dans la partie antérieure de la vessie. Celle-ci, tubulaire, contractile, a sa paroi constituée par de grosses cellules d'aspect granuleux. Elle s'ouvre à l'extérieur à la limite du corps et de la queue.

La métacercaire (Pl. : fig. 5).

La cercaire après avoir quitté le Mollusque nage à la recherche de son hôte et va pénétrer puis s'enkyster dans le petites larves d'Ephémères du genre *Caenis*. Les métacercaires se localisent dans la cavité générale dans la région thoracique. Elles sont ocellées et enfermées dans une très fine membrane kystique qui se déchire à la moindre pression. A l'intérieur du kyste on retrouve souvent le stylet de la cercaire. Une fois dékystée, on observe les papilles cuticulaires qui caractérisent l'adulte de *Macrolecithus*. La métacercaire présente souvent les premières ébauches des organes génitaux. Son système excréteur est conforme à celui de la cercaire et de l'adulte soit :

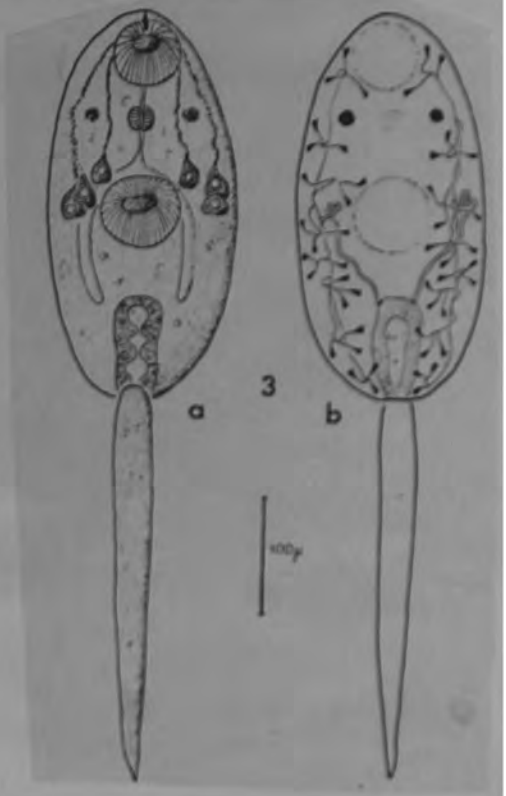
$$2\ [(3+3+3+3) + (3+3+3+3)] = 48 \text{ protonephridies.}$$

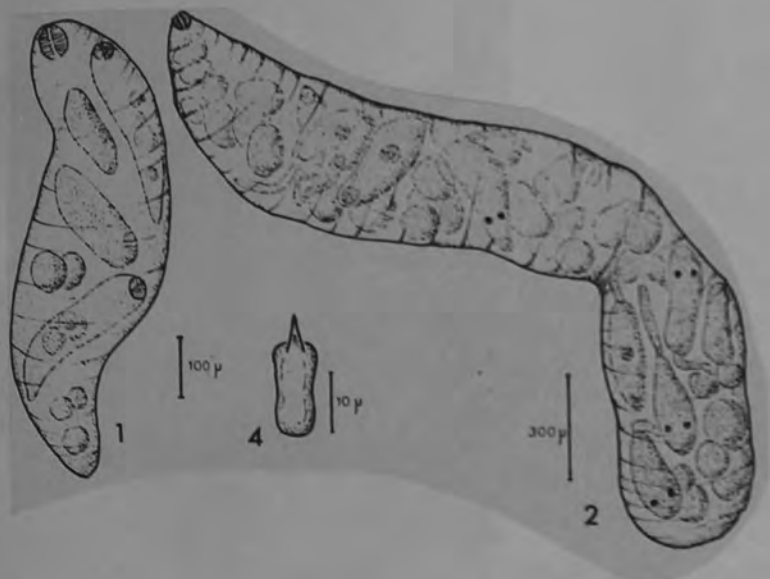
La vessie est volumineuse et dilatée par les produits d'excrétion.

De nombreuses métacercaires dékystées ont été récoltées dans le tube digestif de l'hôte définitif.

Les différents stades du cycle évolutif, tels que nous venons de les décrire ont été observés dans les conditions naturelles, dans la station de Bonnevaux qui constitue un « épidémiotope fonctionnel ».

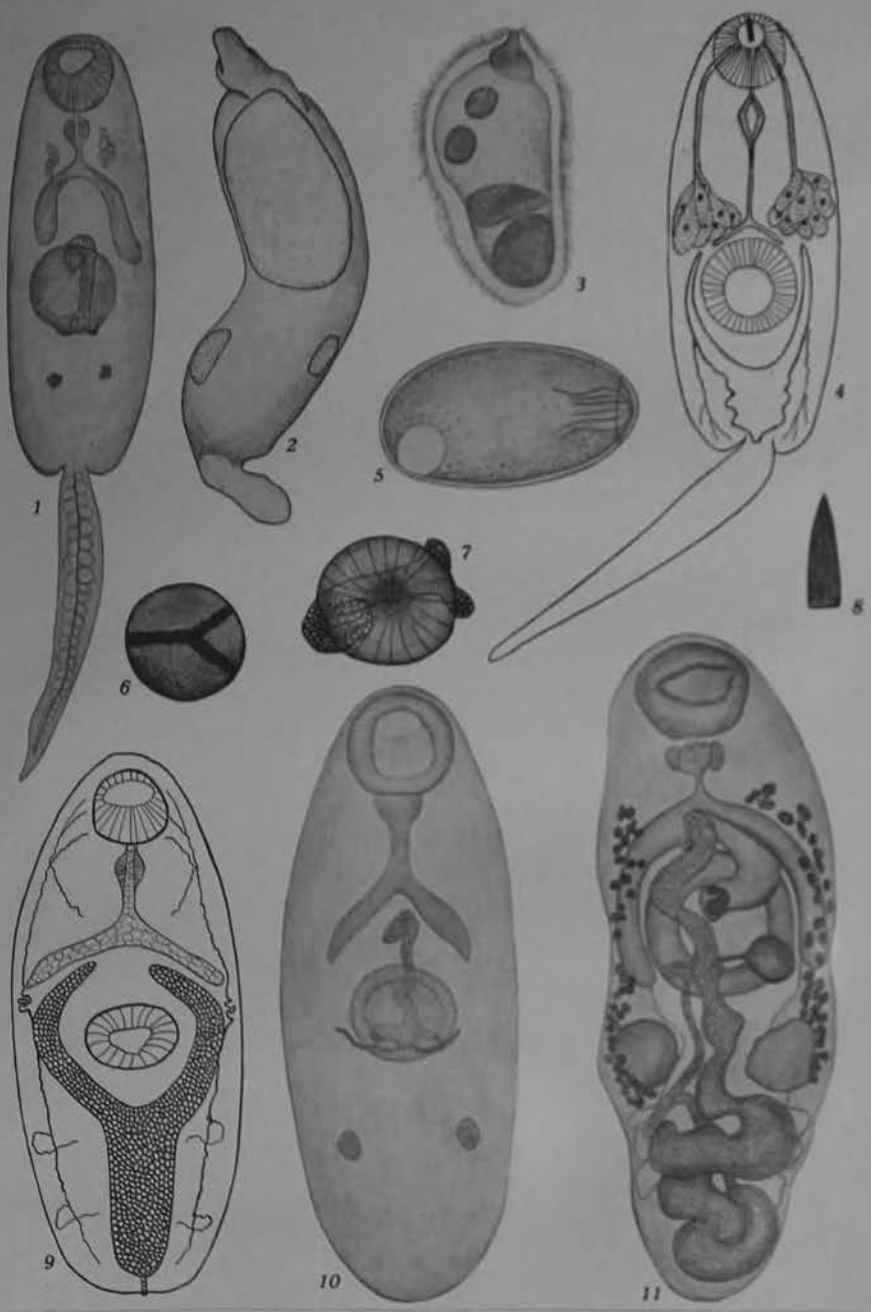
From LAMBERT, 1974





Plagiorchidae
Reniferinae

Zeugorchis syntomentera Sumwalt, 1933 -- Life Cycle



The life-history and structure of the stages of *Zeugorchis syntomentera* Sumwalt have been presented.

Physa gyrina Say was found to be the parthenita host. The eggs hatch only after they have been ingested by the molluse.

The cercariae of *Z. syntomentera* penetrate the skin and become metacerariae in the tadpoles of *Hyla regilla; Rana aurora*, and even in the western newt, *Triturus torosus*. They attack the adults of *Hyla regilla* but cannot penetrate the skin.

When the infected tadpoles are fed to young garter snakes, *Thamnophis ordinoides*, the young flukes continue to develop in the alimentary tract. The adult fluke lives in the mouth, and its eggs probably leave the host by way of the mouth.

Plagiorchioidea

Telorchis medius Stunkard, 1916

Adults in turtles.
Cercariae (xiphidiocercariae) develop in long snake-like sporocysts in a snail, Physella integra.

Reference: McMullen, Donald B. 1934.
Jour. Parasit., 20:

In working with several species of stylet cercariae the author has found what seems to be a correlation between the strength of the stylet and the type of second intermediate host. The Xiphidiocercariae with heavy stylets use insect nymphs and other arthropods. Those with weak stylets penetrate into soft-bodied animals, usually larvae of Amphibia. The cercaria of *C. medius* is of the latter type. Tadpoles serve as the second intermediate host. The cercariae were found to penetrate actively through the skin and to encyst in the underlying tissues. While encysted the metacercaria increases somewhat in size and the anlagen of the reproductive organs can be seen. The ruff of heavy spines around the oral sucker is quite noticeable.

Experimentally infected tadpoles were fed to the painted turtle, *Chrysemys picta*, and to species of *Thamnophis*. A week after feeding, developing forms were found in both hosts. A month after feeding, those found in the garter snake were much smaller and development had been retarded. Other developmental stages up to the adult, which develops in about 6 months, were recovered from experimental turtles. The stem and arms of the excretory bladder become quite long. In the very early stages the ovary is found developing at the posterior right-hand margin of the acetabulum. The testes at the same time are oblique and

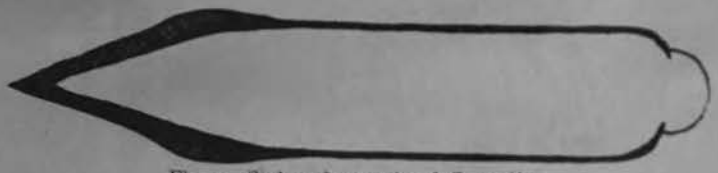


Fig. 2. Stylet of cercaria of *C. medius*.

not at the extreme posterior end of the body. This arrangement of the reproductive organs at this stage is like that found in adults of the Plagiorchidae. As development continues and the postacetabular region elongates the organs rapidly take the positions normally found in telorchids, *i.e.*, ovary median and just in front of the bifurcation of the bladder and the testes in the posterior end of the body and tandem. The characteristic spination of the cercaria and metacercaria is also found in the adult. This has not been previously described and after examining type specimens of *Cercorchis medius* and several other species of *Cercorchis*, it is believed that a study of the spination is important in determining species.

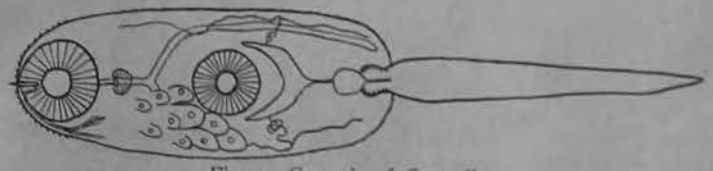


Fig. 3. Cercaria of *C. medius*.

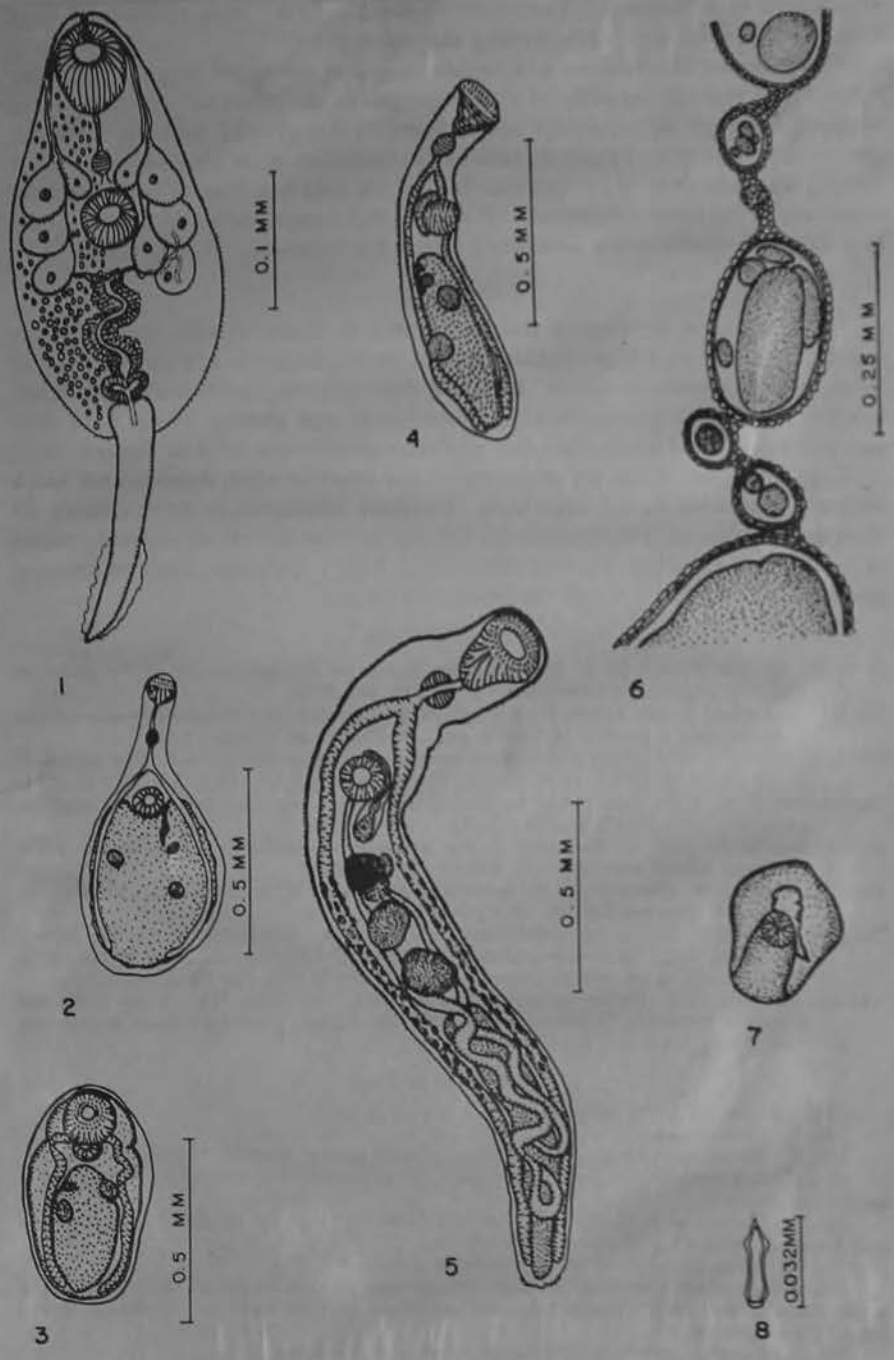
The relationship of the telorchids to the other groups of trematodes has been somewhat speculative. Various authors have suggested that they are related to the Opistorchidae, Echinostomidae, Bunoderidae, and Plagiorchidae. No really definite conclusion is possible until the life cycles of the species are known. The life cycle of *Cercorchis medius* supports the view that the telorchids are related to the Plagiorchidae.—Donald B. McMullen, *Department of Biology, Monmouth College.*

Plagiorchidae or
Macroderoididae

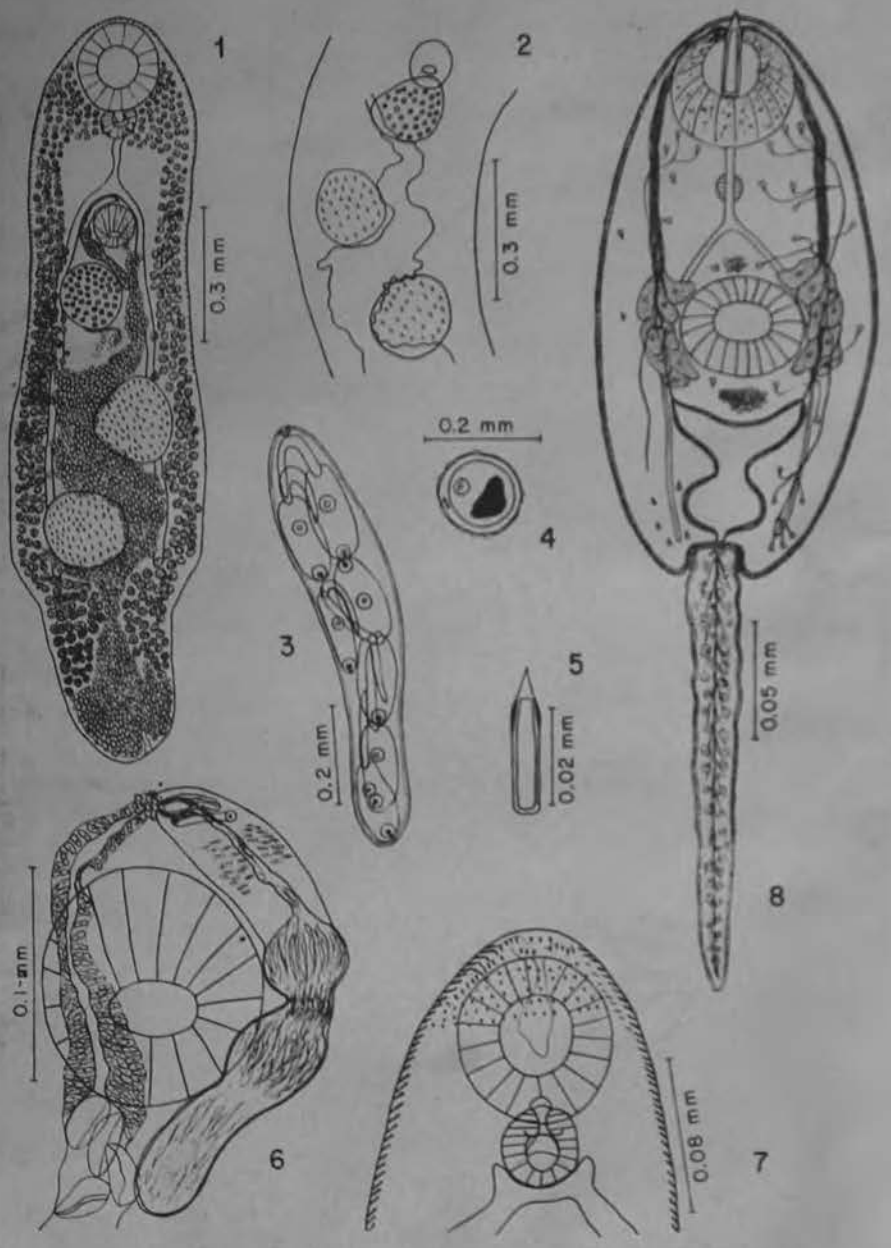
Paramacroderoides echinus Venard, 1941

From Leigh & Holliman 1956

Final host: Lepisosteus platyrhincus, Florida gar
First intermediate host: Helisoma duryi
Second intermediate host: small fishes, usually Gambusia affinis
Ref. J. Parasit., 42 (4):400-407.



Plagiorchis dilimanensis Velasquez, 1964



FIGURES 1–8. *Plagiorchis dilimanensis*. 1. Experimental adult, 10 days old, from mouse, ventral view. 2. Adult, partly contracted specimen showing the relative position of acetabulum, ovary, and testes; note the triangular shape of the ovary overlapping acetabulum. 3. Sporocyst. 4. Metacercaria encysted under cover slip. 5. Stylet of cercaria. 6. Showing glandular metraterm, cirrus sac, and its relative position to the acetabulum in the mature worm. 7. Mature worm showing cuticular spines at anterior region, contracted esophagus, and prepharynx. 8. Cercaria, from living specimens; free hand to scale, ventral view.

ABSTRACT: This paper presents the life history of *Plagiorchis dilimanensis* sp. n. Its cercaria belong to the Polyadena group of Sewell (1922) and is the first xiphidiocercaria to be reported from the snail *Lymnaea philippinensis* Nevill in the Philippines. The development of the adult was traced by feeding metacercariae from experimentally infected culicine mosquito larvae to a mouse.

From: Velasquez, C.C., 1964 J.P. 50: 557-563 See reprint.

Plagiorchidae

Plagiorchis jaenschii Johnston & Angel, 1951

Final host: Hydromys chrysogaster var. fulvolateralis
water rat in Australia
Snail host: Lymnaea lessoni

Cercariae develop in mosquito larvae, also in Crustaceans of which Cherax, the yabbie, is believed to be the normal second intermediate host. Cercariae rarely encyst in the liver of the snail host.

Reference: Johnston, T.Harvey & Angel, L. Madeline 1951
Trans/Roy. Soc. S. Aust. 74 (1):49-58

THE LIFE HISTORY OF PLAGIORCHIS JAENSCHI, A NEW TREMATODE FROM THE AUSTRALIAN WATER RAT

By T. Harvey Johnston and L. Madeline Angel *

[Read 12 October 1950]

Summary

1. An account of the anatomy of *Plagiorchis jaenschi* from the Australian water rat, *Hydromys chrysogaster* Geoff., var. *fulvolateralis* Gould, is given.
2. Two apparently distinct forms are shown to be the same, the differences being attributable to the state of preservation of the material.
3. Infection of *Lymnaea lessoni* was accomplished experimentally. This is believed (but not proved) to follow ingestion of the eggs.
4. The various stages in the life cycle, excluding the miracidium, are described.
5. The cercaria encysts in mosquito larvae, and also in crustaceans, *Daphnia*, *Chiltonia* and *Cherax*, of which the last-named, the yabbie, is believed to be the normal secondary intermediate host. Similar cysts have been found in yabbies from Tailem Bend. The cercaria also encysts, though rarely, in the liver of the host snail.
6. Natural occurrences of the cercaria are recorded from Wood's Flat and Bow Hill; but it has not been found at Tailem Bend.

The type as well as other representatives of the adult and larval stages have been deposited in the South Australian Museum. Acknowledgment is made of the generous assistance rendered by Messrs. G. G. and B. Jaensch of Tailem Bend and J. Brook of Bow Hill. The investigation was carried out in connection with the Commonwealth Research Grant to the University of Adelaide.

(over)

The excretory system is seen best with the aid of basic fuchsin in normal saline. Cercariae will live all day in good condition for examination in very dilute solutions. Horse serum in addition is also helpful. The posterior part of the Y-shaped excretory bladder opens into the vestibule, from which the excretory pore opens on to the surface of the body. The main excretory tubes open into the cornua of the bladder at the tips, but we had considerable trouble in determining

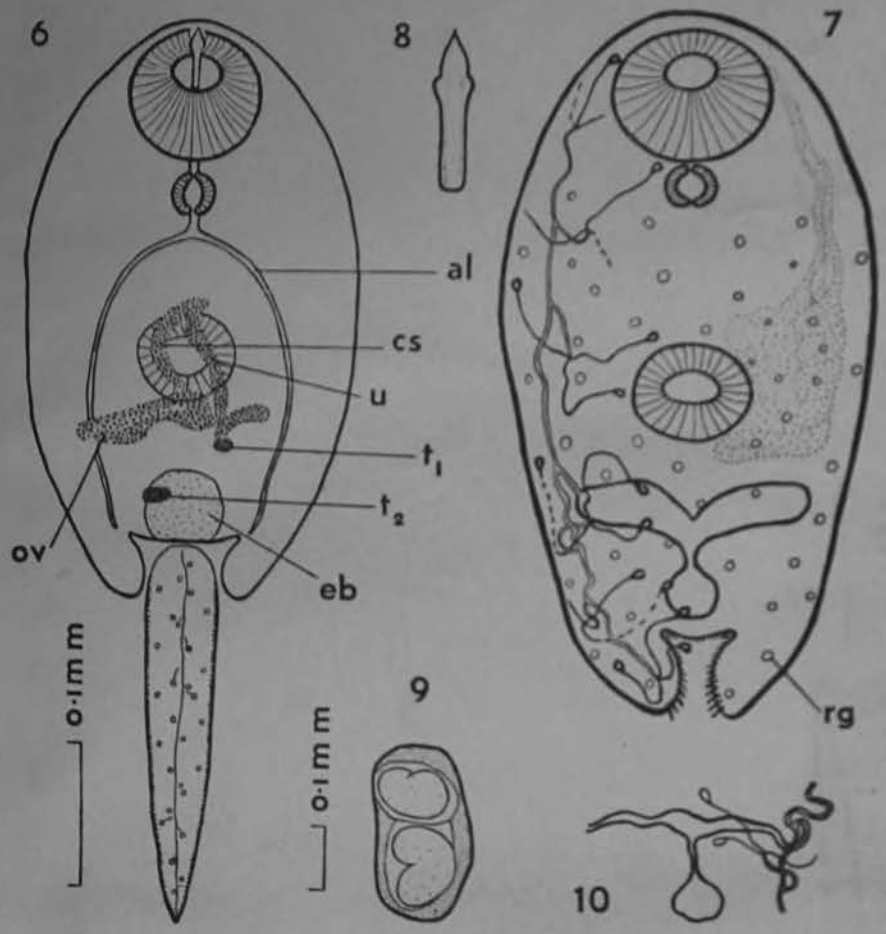


Fig. 6, 7, cercaria; 6, fixed specimen stained with borax carmine in lacto-phenol; 7, details from living specimens. Fig. 8, stylet; 9, two cysts in common envelope; 10, one of the variations in the shape of the bladder.
Fig. 6, 7, to same scale; 8, sketch; 10, sketch.

this because of the presence of cystogenous cells and refractile granules in the area, the twisting of the main and accessory excretory tubes, often over the end of the cornua, and the variability in shape and definition of the arms of the bladder. We mention this to illustrate that in some cercariae, without prolonged study too much reliance cannot be placed on the supposed point of entry of the main excretory tubes.

In certain areas a small number of snails of the species *Stagnicola emarginata angulata* were found to be infected with a cercaria that was identified as *Cercaria polyadena* Cort, 1914, the type species of the Polyadena group (Sewell, 1922) of Xiphidiocercariae. The morphological details of this species have been described previously by Cort (1914, 1919). Average measurements, in this case obtained from cercariae that had been killed with heat, are as follows: body 0.240 × 0.092 mm., tail 0.190 × 0.027 mm., oral sucker 0.053 mm. in diameter, acetabulum 0.038 mm. in diameter and the stylet 0.030 mm. in length. The species is distinguished from the two previous species by the clearness of the body, due to the scarcity of concretion granules. Slight differences in dimensions, which will be found by comparing this species with the other two, are not useful in routine identification.

The average size of the sporocyst of this species is intermediate to the other two species, 1.021 × 0.243 mm. In appearance and in general structure it is quite similar to the other species.

The cercariae penetrate actively into chironomid, dragonfly, mayfly naiads and mosquito larvae. It will also penetrate into tadpoles, snails and small fish but the metacercariae were found to die soon after encystment. In the insect hosts the metacercariae must mature several days before they become infective, so it is probable that the other animals do not serve as natural vectors. In one snail, however, metacercariae were found in the sporocysts containing cercariae of this species. It is probable, therefore, that this species also has the precocious development of the metacercariae in the sporocysts without emerging from the snail, as in *P. muris*. The mature, infective cysts measure about 0.13 mm. in diameter and resemble those of *P. micracanthos* so closely that it is impossible to distinguish them unless the metacercariae are excysted. The cuticular spines on the body of the metacercaria of *P. micracanthos* extend nearly to the posterior end while the spines of *P. proximus* extend over the anterior two thirds of the body (fig. 8).

Mice were the only experimental animals that became infected with the adult flukes. Even these hosts seem refractive because never more than six trematodes were obtained, usually only one or two, and often the mice were negative. The few adults obtained were identified as *P. proximus* Barker, 1915. Two muskrats, out of several captured in the region, had very light infections of the same species. The egg is in the same stage as that seen in the other species.

With the completion of this life cycle it should be stated that *Cercaria Plagiorchis proximus* (= *Cercaria polyadena* Cort, 1914) is the type species of the Polyadena group of the Xiphidiocercariae. This type of Xiphidiocercaria seems to be characteristic of the members of the genus *Plagiorchis* and closely related genera. A complete discussion of the taxonomy of these three species, and others whose life histories are known to have Xiphidiocercariae, follows in a later paper.

Comparison of the Xiphidiocercariae of *Plagiorchis muris* and *P. proximus* (Trematoda: Plagiorchiidae)

ring morphological studies on xiphidio-
iae at Douglas Lake, Michigan, difficulty
xperienced in identifying and distinguish-
lagiorchis muris from *P. proximus* on the
of descriptions by McMullen (1937, J.
t. 23: 235–242). Except for the stylet,
leration of the body characteristics did
fford dependable identification. Conse-
ly, stylet shapes and measurements were
ired and were found to be consistently
nt for these two cercariae even when
ted from different populations or species
ails. Measurements taken from 50 na-
turally shed cercariae are given in microns below (average in parentheses). The stylet shape and measurements, when used with other body characteristics, simplify separation of these xiphidiocercariae and may prove useful when applied to others of this group.

Identification of the two cercariae was confirmed by experimental infections in laboratory-reared *Lymnaea palustris* and white mice.

Plagiorchis pro[redacted] (Fig. 1). Stylet: length, 29.6 to 33.1 [redacted]th at base, 4.8 to 6.5 (6.0), width [redacted]4 to 5.2 (5.0), width at wings, 7.0 to [redacted]5 (7.9); tip to wings, 7.0 to 9.6 (8.3); projection of wings, 1.0 to 2.6 (1.9), wing length, 2.6 to 3.8 (3.3).

Long, 1963 - J. Parasit. 49: 84

In the previous report on the life cycle of this species, from Japan, *Lymnea pervia* served as the first intermediate host. One of the most interesting points brought out in the life cycle was the fact that this species has a precocious development of the metacercariae inside the sporocyst, evidently without emergence from the snail. With the cercariae that did emerge experimental infections were obtained in chironomid larvae. Mice were experimentally infected with both types of cysts and wild rodents were found to be naturally infected.

Generally speaking, this author's experiments confirm the life cycle as given by Tanabe. It is desirable to give some additional points on the morphology of the different stages and additional hosts, found in the United States.

In this country the snail, *Stagnicola emarginata angulata*, serves as the first intermediate host. The sporocysts (fig. 2) were found to average 1.08 × 0.25 mm., slightly smaller than those described previously. Numerous cases of precocious development of the metacercariae within the sporocysts were observed. The number of snails having these metacercariae is variable and the controlling factor is unknown. It was observed that if any cysts were found at all the snail was usually heavily infected with them. In one collection, where the percentage of infection with this species of cercaria was high, some 109 snails showing the cercariae of this species were examined. Of this number 24 contained metacercariae, *i.e.*, 22 per cent of the snails giving off cercariae also had metacercariae. Attempts to get the cercaria to penetrate into the snail failed. This fact, coupled with the fact that the metacercariae are found inside the sporocysts, indicates that this condition is due to a failure of the cercariae to emerge.

Observations made on the cercaria (fig. 3) vary in some details from those reported by the previous author. In the method of measurement used in this case the body measures 0.240 × 0.092 mm., the tail 0.190 × 0.027 mm., the oral sucker 0.053 mm. in diameter, the acetabulum 0.033 mm. in diameter and the stylet 0.033 mm. long. The body is filled with a large number of large, refractile concretion granules. These granules make it difficult to see the minute details. The pharynx is visible a short distance posterior to the oral sucker, and in some specimens the intestinal ceca can be seen extending back to the posterior part of the body. The excretory bladder is Y-shaped and thick walled. It is difficult to see the rest of the system but the fragmentary parts that were observed suggest that it is the same as that given for *Cercaria polyadena* Cort (1919). The appearance of the excretory system in the latter stages (fig. 5) tends to confirm this conclusion. The number of stylet glands is difficult to determine but there seem to be seven or eight pairs, rather than the four pairs shown by Tanabe. The bundles of ducts extending to the region of the stylet are large and quite noticeable.

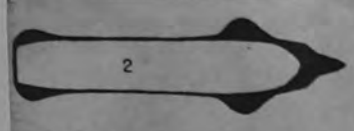
Soon after encystment the concretions collect in the excretory bladder. The mature cyst (fig. 4) measures about 0.2 mm. in diameter. The stylet is no longer attached to the body but remains loose inside the cyst and is often useful in determining the species in this stage. During the process of maturation the metacercaria increases somewhat in size but this and the collection of the concretions in the bladder are the only obvious evidences of development. Metacercariae that are one week old or more are infective.

Fig. 2. Mature sporocyst of *Plagiorchis muris*.
Fig. 3. Cercaria of *Plagiorchis muris*.
Fig. 4. Metacercaria of *Plagiorchis muris*.
Fig. 5. Young *Plagiorchis muris* from pigeon, showing the excretory pattern.
Fig. 6. Adult of *Plagiorchis muris* from mouse, 8 days old.

In the feeding experiments it was found that development took place with facility in man, rat, mouse and pigeon. Cysts from naturally infected snails and experimentally infected insect naiads were both used in the infection experiments. The number of cysts given was never counted but was estimated to be 50 to 250 cysts. In mice 2 to 62 trematodes were recovered from a single feeding. In a rat 170 trematodes were recovered and in pigeons 6 to 17 adults were found. Natural infections of the species have been found locally in the robin, herring gull, night-hawk and spotted sandpiper.

The adults develop rapidly and produce eggs in 7–9 days after infection. The infection seems to remain for about a month, as shown in a previous paper (McMullen, 1937). The eggs are passed in the morula stage and an attempt was made to get fully developed miracidia. Tanabe reports that the fully developed miracidium is produced in 96 hours. Eggs from the American species, from man, kept at about prevailing temperatures of August and September did not produce miracidia in less than 24 days. At the end of that time the yolk cells had been well used up and the cell mass had nearly developed into a miracidium. The cultures containing the eggs were lost at this point and the mature miracidia were never observed.

Morphological differences in the trematodes from these experimental hosts are not obvious. The only noticeable difference is that those from the pigeon average about 0.5 mm. longer than those of the same age in rodents. The structure of the adult (fig. 6) of *P. muris*, as observed by the author, agrees essentially with that described by Tanabe and with the additional notes given by Yamaguiti (1933), but is refigured here to bring out certain details in structure. In fixed, flattened specimens the body averages 2.67 × 0.52 mm., the oral sucker 0.213 mm. in diameter, the acetabulum 0.144 mm. in diameter, the pharynx 0.107 mm. wide, the ovary 0.196 mm. in diameter, the anterior testis 0.231 mm. in diameter, the posterior testis 0.252 mm. in diameter and the eggs 0.038 × 0.019 mm. The intestinal ceca extend to the posterior portion of the body but are difficult to find because the vitellaria are quite numerous. The cirrus is well developed and extends to the left side of the ovary. The testes are placed obliquely in the third quarter of the body or slightly posterior to it. The ovary is on the right side of the body and about half way between the anterior testis and the acetabulum. The uterus is broad, passes between the testes and extends into the posterior region of the body. A metraterm is rather well developed and extends to the posterior border of the acetabulum. The excretory bladder is Y-shaped and by the impregnation of the system with mercurial salts (McMullen, 1936) the pattern was found to be $2(3+3+3)+(3+3+3)$.



~~RE 1. Stylet of Plagiorchis proximus, dorsal~~

RE 2. Stylet of *Plagiorchis muris*, dorsal

Plagiorchis muris (Fig. 2). Stylet: length, 35.7 to 37.4 (36.4); width at base, 6.0 to 8.7 (7.4); width of shaft, 5.2 to 7.0 (6.0); width at wings, 9.0 to 11.6 (9.8); tip to wings, 6.0 to 8.7 (7.6); projection of wings, 1.7 to 3.4 (2.3); wing length, 3.9 to 6.0 (4.9). —BRUCE Z. LANG, *University of Michigan Biological Station at Douglas Lake, and the Department of Parasitology, School of Public Health, University of North Carolina, Chapel Hill.*

See Plagiorchis proximus

In a relatively small number of the same species of snail (*Stagnicola emarginata angulata*) another cercaria, quite similar to that of *P. muris* was found. This cercaria develops in sporocysts which in general appearance look like those of *P. muris* (fig. 2). They are, however, considerably smaller, averaging 0.648 × 0.127 mm. The cercaria (fig. 7) is a rather sluggish swimmer and emerges from the snail in the early morning. It is slightly smaller than the cercaria of *P. muris* but the difference is hardly of use in routine identification. The body is covered with spines which are sparse at the posterior end. It measures 0.232 × 0.082 mm. The tail, typical in form, is 0.144 × 0.023 mm. The oral sucker is larger, 0.044 × 0.049 mm., than the acetabulum, 0.033 mm. in diameter. The stylet is similar in structure to that of *P. muris* but it is shorter, 0.030 mm. The digestive and excretory systems are similar to that seen in *P. muris*. There are eight pairs of stylet glands but the ducts are not as large as in the previous form. The most obvious difference between the two cercariae is the character of the concretions. In this species the concretions are numerous but quite small and they often appear to clump together.

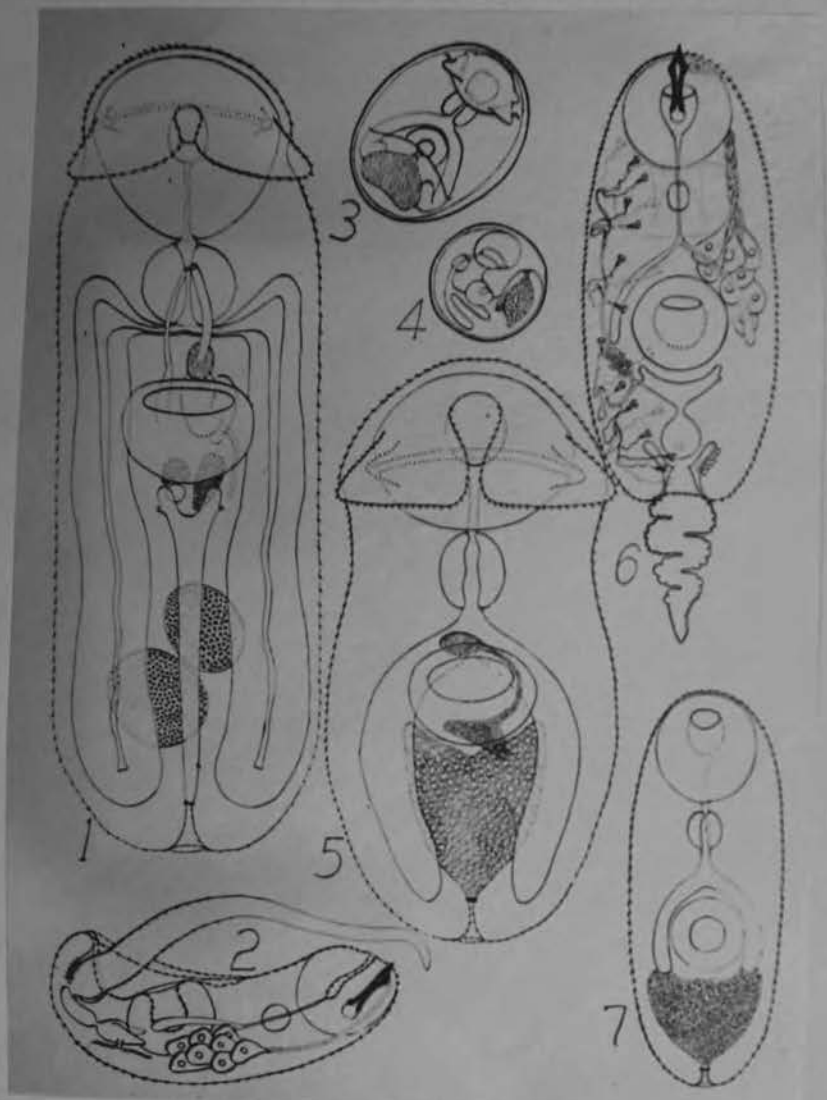
The cercariae were found to penetrate actively into insect larvae, as in the former case, but encystment within the sporocyst has never been found. The cysts increase somewhat in size as they mature but there is no noticeable change in the organs, except that the bladder becomes filled with concretions (fig. 8). Metacercariae that are at least a week old were found to be infective. These mature cysts measure about 0.13 mm. in diameter. The somewhat smaller size of the cyst and the presence of a smaller stylet serves to distinguish this metacercaria from the preceding species.

Mature metacercariae were fed to mice, rats and pigeons and adult flukes were recovered from mice 16 days after infection. Repeated attempts to infect rats and pigeons gave negative results. In two experimental mice, fed a hundred or more cysts and left long enough for the trematodes to reach maturity, there were 55 and 69 adults respectively. These adults were identified as *Plagiorchis micracanthos* Macy, 1931, described from bats. The eggs are in the morula stage, as they were in *P. muris*.

To date a natural infection in local bats has not been found. The rather low incidence of the infection in the snails that were collected in the region seems to indicate that the infection in the bats is rather light. Further host examinations will probably show naturally infected definitive hosts.

Auridistomum chelydrae (Staff., 1900) Staff., 1905 Plagiorchioidea
Telorchiinae (?)

Tetrapapillatrema concavocorpa (Sizemore, 1936)

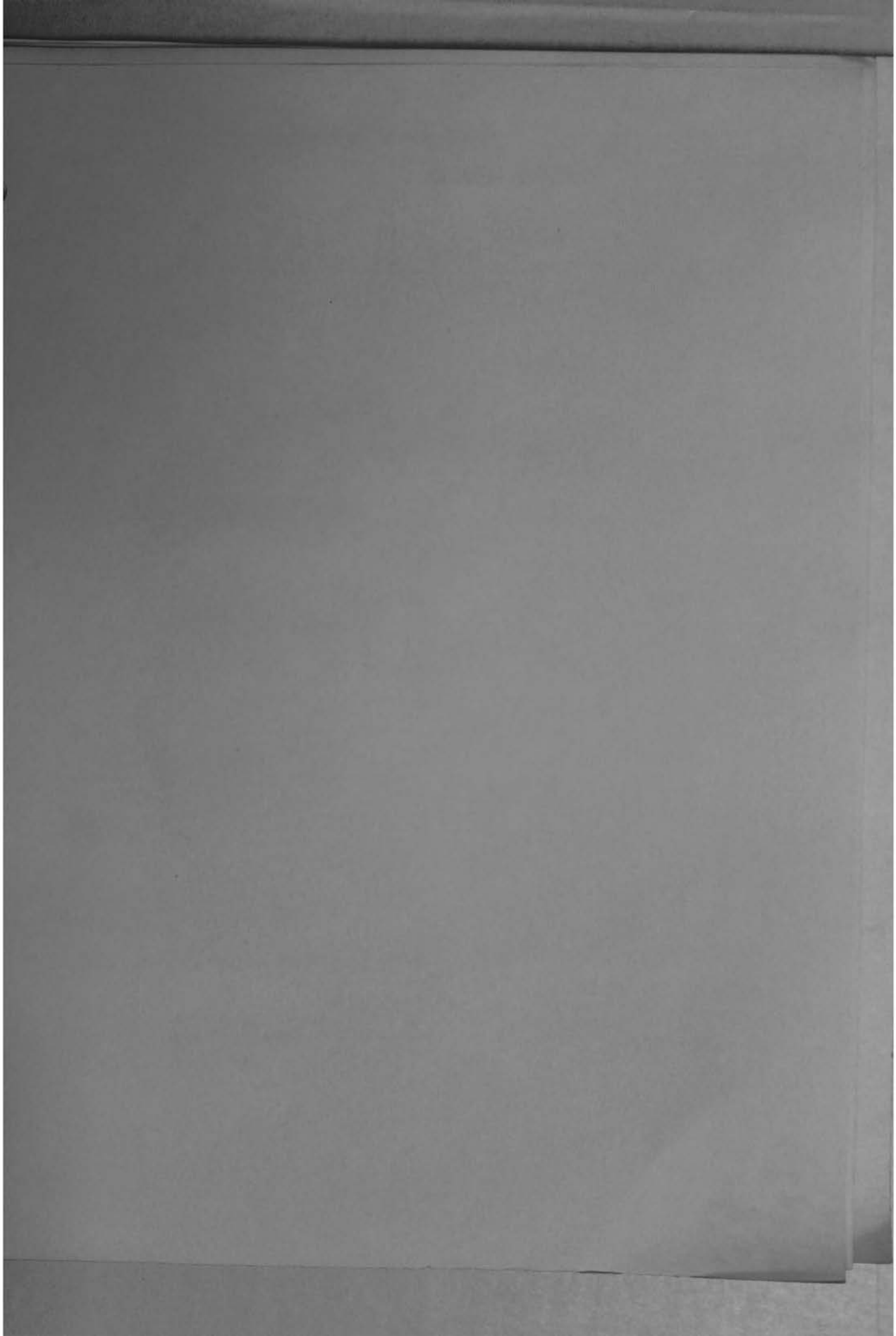


Final host: Chelydra serpentina (experimental)
Intermediate hosts: 1. Helisoma trivolvis
2. Rana catesbeiana (exp.)

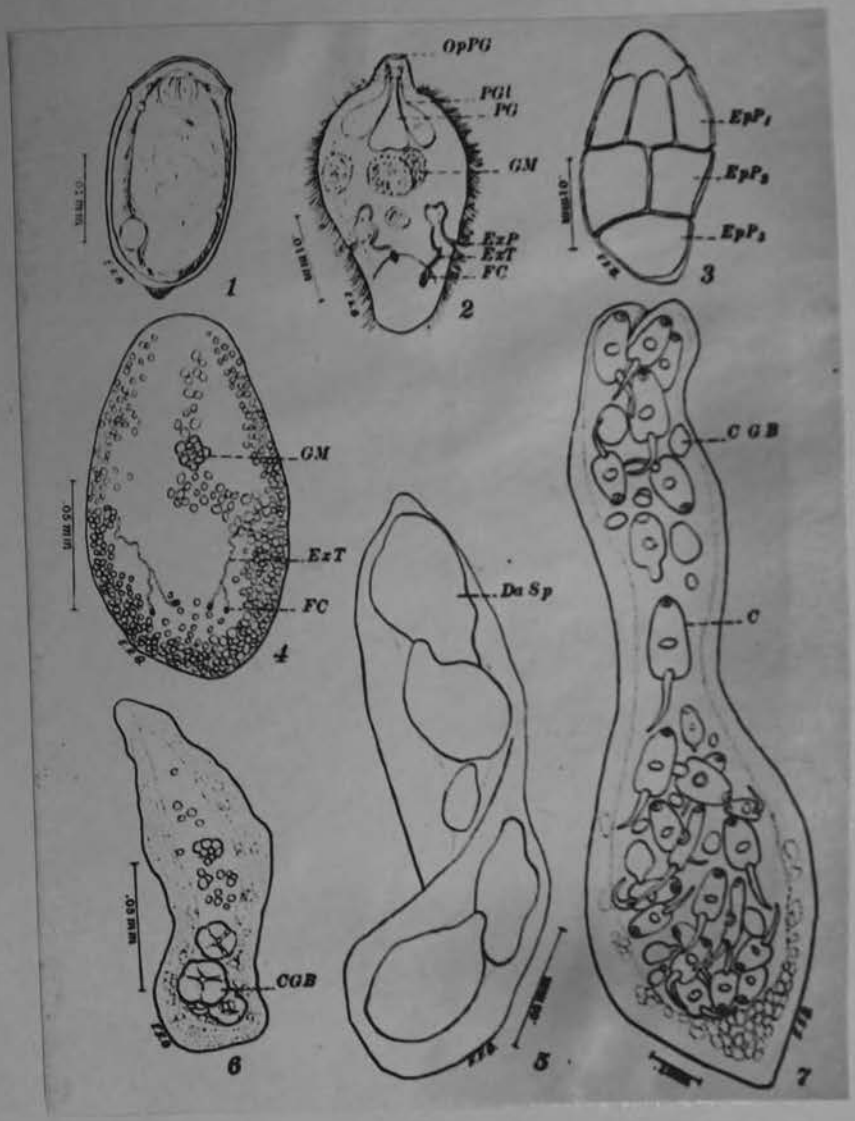
Notes: Cercariae develop in parthenitae with rudimentary pharynx in liver of snail. Cercaria belongs to Polydena group of "cercariae armatae"; xiphidiate; brevicaecate. Metacercariae encyst in various tissues of tadpoles.

Reference: Ralph, P.H. 1938. Trans. Amer. Micros. Soc., 57:376-382

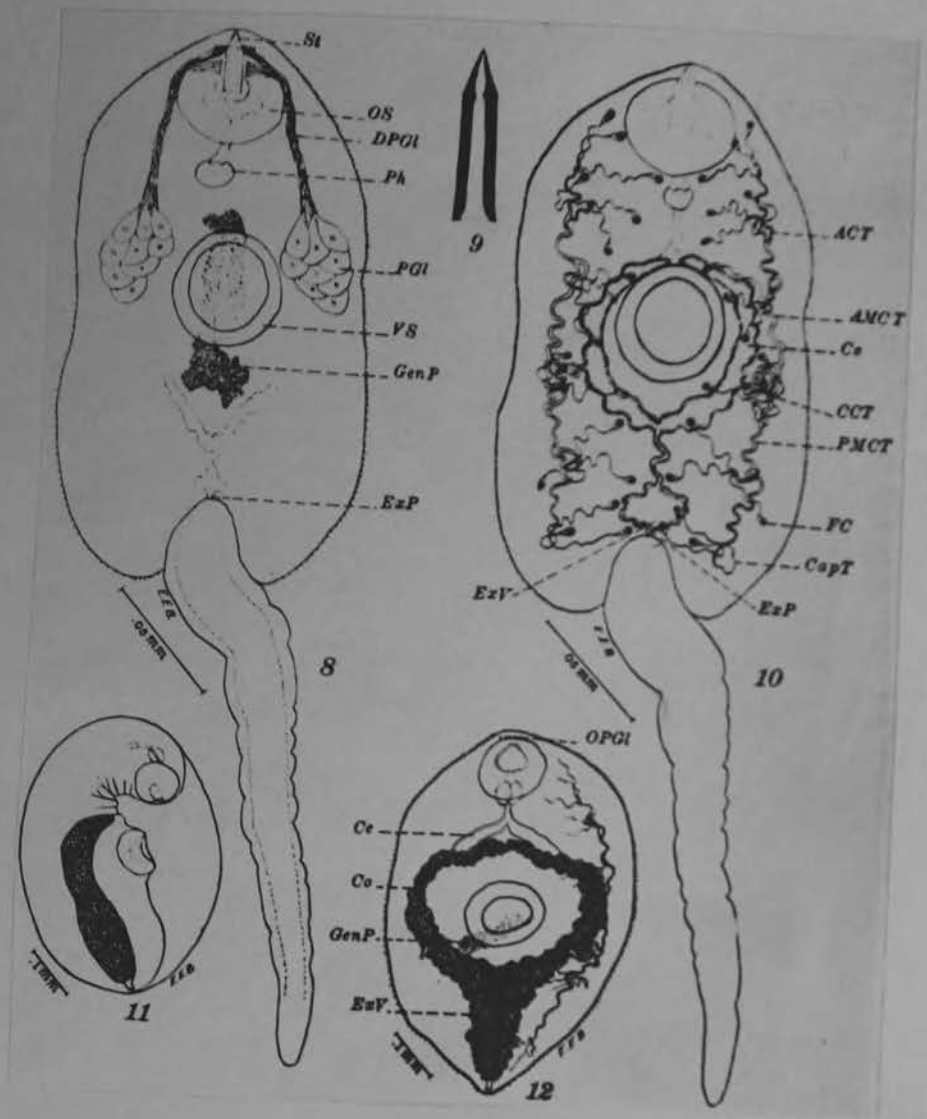
Wharton (1940 J.P. 26:516) considers this genus a synonym of Auridistomum and probably this species as A. chelydrae. Other synonyms: Pterygotomachaloe Stunkard, 1924.



Renifer aniarum



Renifer aniarum (Leidy,1890)

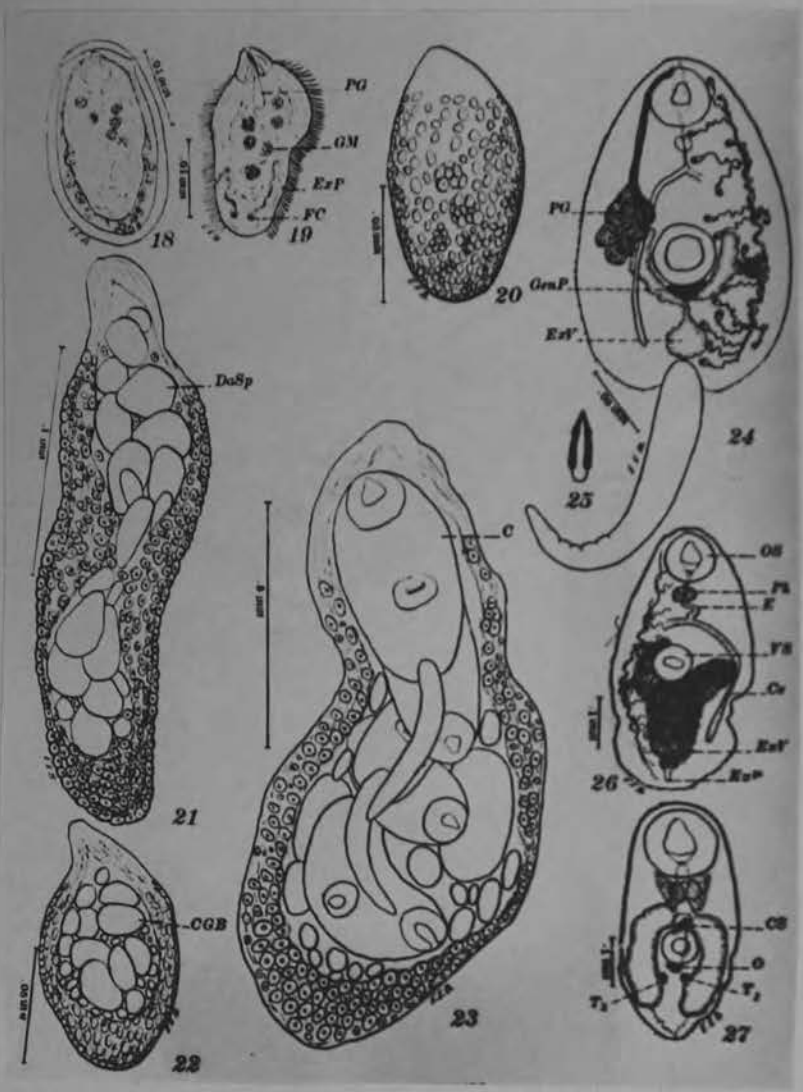


Final hosts: Natrix sipedon fasciata; N.s.erthryogaster; N.rhombifer; N.cyclopion

Intermediate hosts: 1. Physa helei
2. tadpoles of Rana catesbiana; R.clamitans; Hyla cinerea; Pseudacris occidentalis.

Notes: Eggs hatch after eaten by snail. Miracidium with 3 (?) rows of plates (?-6-4-2). Cercariae encyst in tadpoles.

Dasymetra villicaeca Byrd, 1935



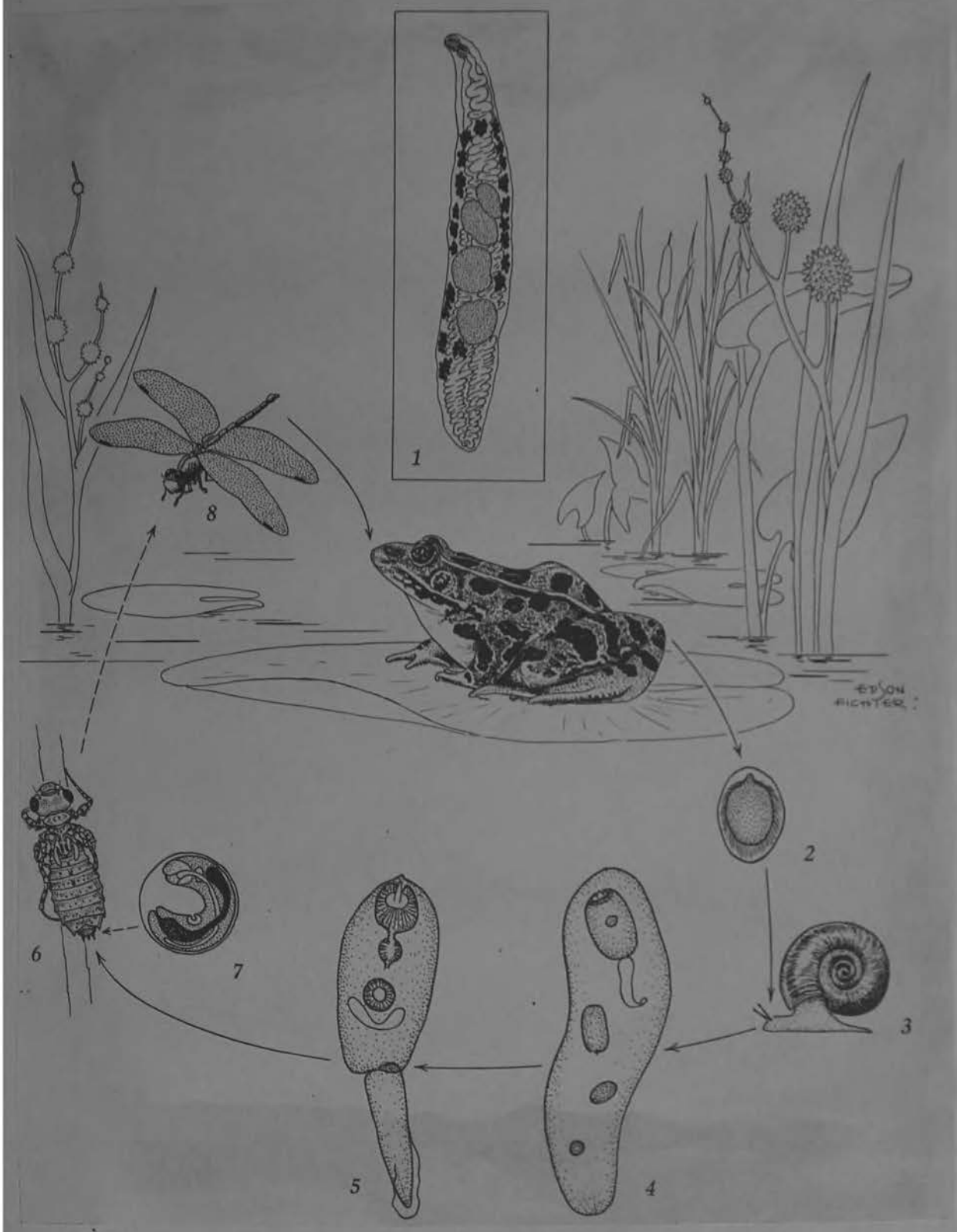
Final hosts: Natrix sipedon fasciata; N.s.erthryogaster; N.rhombifera; N.cyclopion.

Intermediate hosts:

1. Physa helei
2. Tadpoles of Rana catesbiana; R.clamitans; Hyla cinerea; Pseudacris occidentalis.

Notes: Eggs hatch after eaten by snail.
Plates not seen on miracidium.
Xiphidiocercariae develop in sporocysts; penetrate and encyst in tadpoles.

Reference: Byrd, Elon E. 1935. Trans Amer. Micros. Soc., 54:196-225.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EDSON
RICHTER

Alloglossidum corti (Lamont, 1921)

Snail host: Helisoma campanulata

Cercariae emerge and penetrate and encyst in dragonfly and mayfly nymphs. Metacercariae develop in bull heads.

Final host: Ameiurus nebulosus, bullhead

Synonyms of this species are: Plagiorchis ameiurensis McCoy, 1928. McCoy found the cercariae developing in Helisoma trivolvis and that they encysted in dragonfly nymphs and in crayfish.

Alloglossidium kenti Simer, 1929 is another synonym.

Reference: McMullen, 1935

At Oneida Lake, this trematode was found in the following fishes:

Schilbeodes gyrinus
S. miurus
Ictalurus punctatus
Ameiurus natalis
A. nebulosus
Ambloplites rupestris

Plagiorchidae

Macroderoides typicus (Winfield, 1929) VanCleave & Mueller, 1932

Synonym: Plesiocreadium typicum Winfield, 1929

Snail hosts: Helisoma trivolvis
H. campanulata

Cercariae develop in small rounded sporocysts. Penetrate into tadpoles.

Final host: Amia calva

Reference: McMullen, 1935

Reprinted from THE JOURNAL OF PARASITOLOGY, June, 1934, Vol. XX, No. 4

THE LIFE CYCLE OF THE TURTLE TREMATODE, *CERCORCHIS MEDIUS*

Cercorchis medius was first described by Stunkard (1916) as *Telorchis medius*. The characteristics of the two genera, *Telorchis* Looss (1899) and *Cercorchis* Lühe (1900), were not clearly defined. Stunkard considered them synonymous. Perkins (1929) redefined the two genera and definitely separated them, transferring all North American species of *Telorchis* to *Cercorchis*.

The cercaria of *C. medius*, a Xiphidiocercaria, was found in *Physella integra*, collected in the region of the University of Michigan Biological Station on Douglas Lake. It develops in long snake-like sporocysts, measuring about 1.5 ×

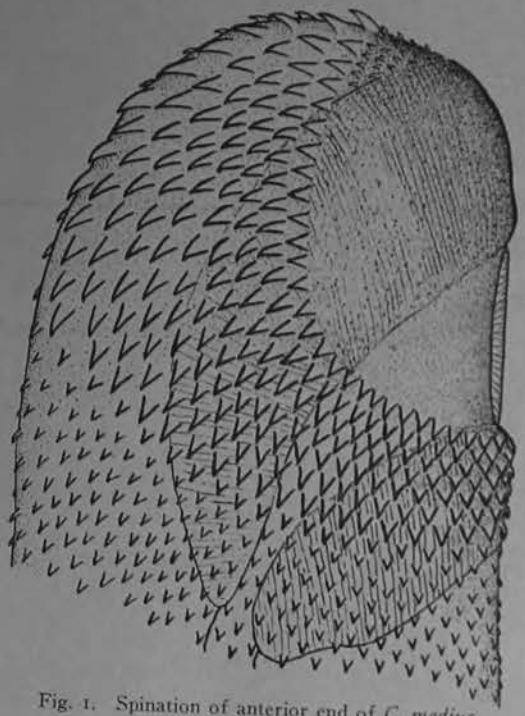


Fig. 1. Spination of anterior end of *C. medius*.

0.13 mm. The body of the cercaria is covered with fine spines, with a ruff of several rows of heavier spines around the oral sucker. The stylet is weak, has a small shoulder and measures 22 μ in length. It has been impossible to get an accurate count of the number of stylet glands but there are about 10 pairs. The oral sucker is larger than the acetabulum. Prepharynx and esophagus are both present and have about the same length. The intestinal ceca extend almost to the posterior end of the body. The tail is long and without a fin fold. At the base of the tail are two lateral rows of large spines. The excretory bladder is large, Y-shaped, with the arms extending to the posterior border of the acetabulum. The excretory tube enters the arm of the bladder posterior to the tip; at

the lateral margin of the body it branches into an anterior and a posterior tubule. The flame cells and smaller tubules have not been seen.

In working with several species of stylet cercariae the author has found what seems to be a correlation between the strength of the stylet and the type of second intermediate host. The Xiphidiocercariae with heavy stylets use insect nymphs and other arthropods. Those with weak stylets penetrate into soft-bodied animals, usually larvae of Amphibia. The cercaria of *C. medius* is of the latter type. Tadpoles serve as the second intermediate host. The cercariae were found to penetrate actively through the skin and to encyst in the underlying tissues. While encysted the metacercaria increases somewhat in size and the anlagen of the reproductive organs can be seen. The ruff of heavy spines around the oral sucker is quite noticeable.

Experimentally infected tadpoles were fed to the painted turtle, *Chrysemys picta*, and to species of *Thamnophis*. A week after feeding, developing forms were found in both hosts. A month after feeding, those found in the garter snake were much smaller and development had been retarded. Other developmental stages up to the adult, which develops in about 6 months, were recovered from experimental turtles. The stem and arms of the excretory bladder become quite long. In the very early stages the ovary is found developing at the posterior right-hand margin of the acetabulum. The testes at the same time are oblique and

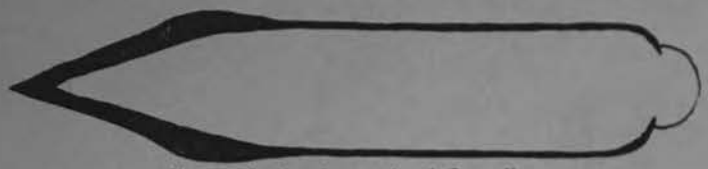


Fig. 2. Stylet of cercaria of *C. medius*.

not at the extreme posterior end of the body. This arrangement of the reproductive organs at this stage is like that found in adults of the Plagiorchidae. As development continues and the postacetabular region elongates the organs rapidly take the positions normally found in telorchids, *i.e.*, ovary median and just in front of the bifurcation of the bladder and the testes in the posterior end of the body and tandem. The characteristic spination of the cercaria and metacercaria is also found in the adult. This has not been previously described and after examining type specimens of *Cercorchis medius* and several other species of *Cercorchis*, it is believed that a study of the spination is important in determining species.

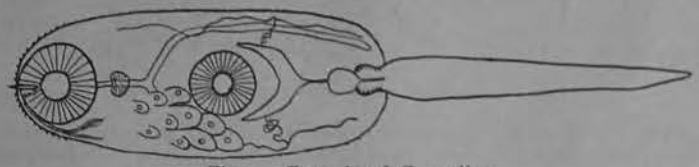


Fig. 3. Cercaria of *C. medius*.

The relationship of the telorchids to the other groups of trematodes has been somewhat speculative. Various authors have suggested that they are related to the Opistorchidae, Echinostomidae, Bunoderidae, and Plagiorchidae. No really definite conclusion is possible until the life cycles of the species are known. The life cycle of *Cercorchis medius* supports the view that the telorchids are related to the Plagiorchidae.—Donald B. McMullen, *Department of Biology, Monmouth College.*

Plggiorchidae

Opisthtioglyphe ranae

from Baer, 1958. Bull.Soc.Neuchatel Sc1.nat. 81:85-111.

Summary

The life-cycle of the trematode *Opisthioglyphe ranae* (Fröl.) from the gut of amphibians has been followed over a period of 10 years in the village of Charmes situated in the center of France (Allier). The following observations are therefore of local value from an epidemiological standpoint.

The classical life-cycle involving 3 hosts may be condensed to 2 hosts *viz* : the cercariae encyst : *a.* within the mouth of larval amphibians and excyst, to enter the gut, during metamorphosis ; *b.* in the gut wall of adult amphibians when the latter enter the water to reproduce. The metacercariae excyst after a short time and grow into adult trematodes.

This life-cycle is influenced by epidemiological and ethological factors that affect both the hosts and the parasites.

L. ovata is the principal larval reservoir, remaining infested during the Winter. Development of cercariae is retarded or inhibited when the temperature drops, but is resumed in the Spring. Only adult snails are able to conserve the larval forms and the latter die off in young snails.

In the 3-host cycle, it is found that cercariae encyst in several aquatic animals. For these to become potential intermediate hosts they must be able to conserve viable metacercariae long enough for the amphibians to become infested but must also represent the latter's normal prey. Favourable and unfavourable definitive hosts are discussed and proved experimentally. The Tree-frog, *Hyla arborea*, is a very favourable experimental host in captivity in which the parasites have been found to remain active for more than 311 days. Premunition is shown to exist and re-encystment of metacercariae has been observed under certain circumstances that are discussed.

Plagiorchiidae

Brachycoelium mesorchium Byrd, 1937

The developmental cycle of Brachycoelium mesorchium ***Byrd, 1937 (Trematoda: Brachycoeliinae).*** **H. E. Jordan and E. E. Byrd,** Department of Pathology and Parasitology, School of Veterinary Medicine and Department of Zoology, University of Georgia, Athens.

Among the several species of terrestrial mollusks exposed to the eggs of *Brachycoelium mesorchium* Byrd, 1937 only *Triodopsis carolinaensis* (Lea) and *Mesodon inflectus* (Say) served satisfactorily as the first intermediate hosts, while these and all other snails exposed served as the second intermediate hosts. The miracidium escaped from the egg capsule only after being ingested by the snail and it shed its ciliated epidermal plates (two rows of three plates each) at or just after penetrating the intestinal epithelium. The remaining syncytial mass of cytoplasm containing eight nuclei entered a blood vessel and after one week in this habitat it had produced a loose mass of 32 to 64 cells. After three weeks in the snail this primary mass was large enough to cause multiple herniations in the wall of the blood vessel, giving the parasite and the host's defensive cells the general appearance of a multilocular compartmentalized cyst. Embryos were present among the cells in some of the "compartments." These embryos developed in situ as the parasitic cells continued to "push" into more and more of the available space. After six weeks in the host, the parasite occupied a considerable area and was represented by many compartments, growing areas of "mother" cells, developing embryos, and enveloping host tissue. The embryos of the third week had developed into elongated masses of parasitic cells and a second generation of embryos. Parasitic cells and embryos were partly contained in a net-like wall of parasitic cells and host tissue. These embryos were contained in individual membranes, consisting of a few very flat cells. They developed in situ into sporocysts possessing a mass of cells at one end which developed into a glandular-like adhesive organ (an oral sucker). By the ninth week of development, mature cercariae were present in these sporocysts, the host's tissue, and were being shed from the snail. On emergence the cercariae were encapsulated individually in a thin, jelly-like film (of survival value), were tail-less and devoid of a stylus. On being ingested by the snail (several species of terrestrial mollusks) they penetrated into the tissues and encysted as true metacercariae in the region of the heart. When such metacercariae were force-fed to the larval, aquatic stages of the host salamanders, *Desmognathus fusca fusca* Rafnesque and *Eurycea bislineata cirrigera* (Green), young trematodes of the species were recovered from the intestine during the three weeks such larvae were kept in the laboratory.

TRANS. AM. MICR. SOC. 86: 67

Z. f. Parasitenkunde 29, 61—84 (1967)

The Life Cycle of *Brachycoelium mesorchium* Byrd, 1937 (Trematoda: Digenea: Brachycoeliinae)

Helen E. Jordan

Institute of Comparative Medicine and Department of Pathology and Parasitology
School of Veterinary Medicine, University of Georgia

Eliza E. Byrd

Zoology Department, University of Georgia

Received April 3, 1967

Summary. The terrestrial mollusks *Triodopsis cardinensis* (Lea) and *Mesodon inflectus* (Say) served satisfactorily as the first intermediate hosts for *Brachycoelium mesorchium* Byrd, 1937. They, along with the other species exposed, served as second intermediate hosts. On losing its ciliated epidermal plates the miracidium became transformed into a syncytium having eight, large nuclei (the primary mass). The primary mass entered a blood vessel where all further development occurred. Within three weeks the mass developed into a multilaminated (compartmentalized) cyst-like organism, the compartments of which were incompletely surrounded by fibers and cells of the blood vessel's wall, strengthened by an accumulation of the host's connective tissue (reactive) cells. The "first generation" embryos developed *(in situ)* into elongated, sporocyst-like organisms enclosed in a supporting layer of host tissues. After six weeks the parasitic mass comprised many centers of growth, first generation organisms containing second generation embryos and a conglomerate of parasitic cells. By the ninth week the second generation embryos had developed *(in situ)* into thick-walled, tubular organisms possessing a prominent musculo-glandular, sucking apparatus and had a covering of fibers and cells derived from the host's tissues. As these cells-like forms aged they assumed many different shapes and sizes, although typically they were flask-shaped, with a tubular, neck-like part and a vesicular body; ultimately ranged from flask-shaped forms to individuals having two or more vesicular portions joined by longer or shorter, thick-walled tubular parts. Cercarial embryos filled most of their vesicular portions. The cercaria was tailless, and devoid of a stylus. On escaping from the mollusk it was completely encapsulated in mucous which sustained it for about six days. On being ingested by any of the several species of terrestrial mollusks available, the cercaria penetrated the tissues and excysted as a metacercaria. These metacercariae developed into young flukes (some with eggs) within one, two or three weeks after being fed to larval (aquatic) stages of host salamanders, *Eurycea bislineata cirrigera* (Green) and *Desmognathus fusca fusca* Rafinesque.

Zusammenfassung. Die Landmollusken-Arten *Triodopsis cardinensis* und *Mesodon inflectus* dienen für *Brachycoelium mesorchium* Byrd, 1937, sowohl als erste Zwischenwirte als auch — neben anderen Arten — als zweite Zwischenwirte. Nach dem Verlust der bewimperten Epidermalplatten wandelt sich das Miracidium in ein Syncytium mit acht großen Zellkernen um (sog. primäre Masse). Dieses Stadium wandert in ein Blutgefäß ein, wo die weitere Entwicklung abläuft. Innerhalb

Plagiorchidae

Plagitura salamandra Holl,1928

The following is from Own,1946 J.Parasit.,32:553-562

Adult in Triturus viridescens newt
1st intermediate host: Pseudosuccinea columella
2nd intermediate hosts: dragon-fly larvae and adult aquatic insects

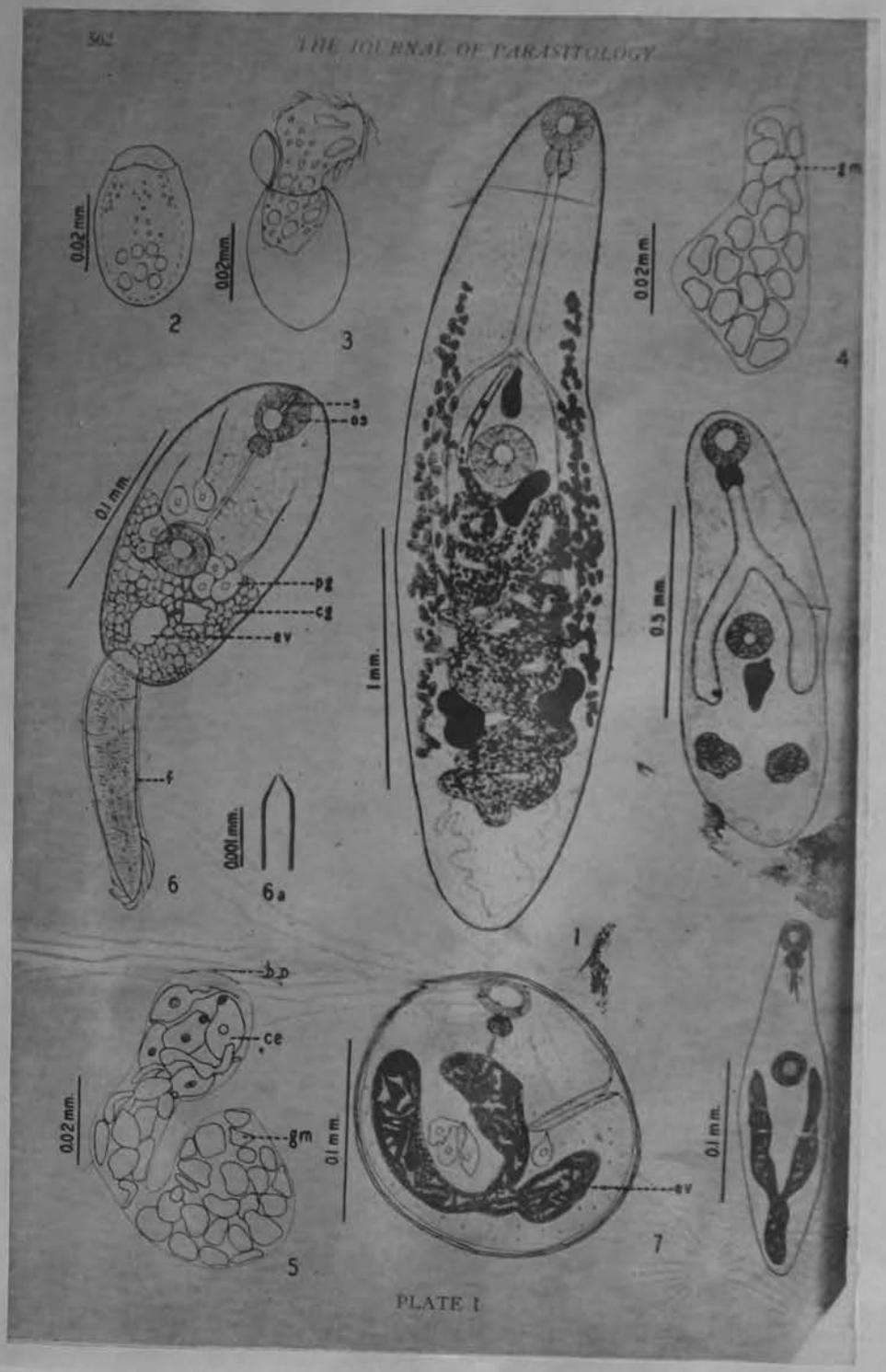


PLATE I

fe Cycles and Host-specificity of the Plagiorchiid Trematodes *chetosoma kansensis* (Crow, 1913) and *O. laterotrema* Byrd and Denton, 1938)

Ochetosoma kansensis and *O. laterotrema* were removed from the mouth of a cottonmouth snake [*Agkistrodon piscivorus* (Lacépède)] collected near Norco, Louisiana. Eggs recovered from these worms were incubated at monitored room temperature, ranging from 27 to 28 C, in dechlorinated tap water for 1 week. After this time, medium-sized laboratory-born and -reared *Physella anatina* (Haldeman) were placed singly in small stender dishes each containing dechlorinated tap water and about five eggs each of *O. kansensis* or *O. laterotrema*. The dishes containing the snails were observed with the aid of a dissecting microscope to assure that all of the trematode eggs had disappeared from the bottom. The snails were then removed to 2-oz ointment jars containing dechlorinated tap water where they were fed on lettuce and maintained at room temperature. Xiphidiocercariae were first observed to emerge from these snails on day 28. Single tadpoles, obtained from artificial fertilization of *Rana pipiens* Schreber eggs in the laboratory, were exposed to about five cercariae of *O. kansensis* or *O. laterotrema*. These tadpoles were kept at room temperature in 7- by 2-cm finger bowls containing aged dechlorinated tap water and were fed boiled lettuce. On 26 January 1970 approximately 25 metacercariae of *O. kansensis* in tadpoles were force-fed to 72- and 74-cm *Natrix c. cyclopion* (Dumeril and Bibron). Again on 12 May 1970 these same snakes were each exposed to approximately 70 metacercariae of *O. laterotrema*. On this same day the mouth of a baby 37-cm cottonmouth snake was observed to be negative for trematodes. Since this snake had been maintained in the laboratory for at least 6 weeks it was judged to be uninfected with ochetosomes. It was then exposed to about 25 metacercariae of *O. laterotrema* in tadpoles. Six weeks later all snakes were killed and examined for ochetosomes. Both *Natrix c. cyclopion* were refractory to infection with *O. kansensis* and *O. laterotrema*. The control cottonmouth snake was infected with egg-bearing flukes, demonstrating the infectivity of the *O. laterotrema* metacercariae. In other experiments adult *O. kansensis* and *O. laterotrema* removed from the mouth of cottonmouth snakes and transferred to *Natrix* spp. did not survive, again suggesting a strong species-specificity of *O. kansensis* and *O. laterotrema* for the cottonmouth snake.

This study supported in part by research grants (GB-5235 and GB-7938) from the National Science Foundation.

Franklin Sogandares-Bernal and Howard Grenier, Laboratory of Parasitology, Department of Biology, Tulane University, New Orleans, Louisiana 70118

J. Parasit. 57(2):297
1971

Plagiorchiidae

Haplometra cylindracea (Zeder, 1800) Looss, 1899

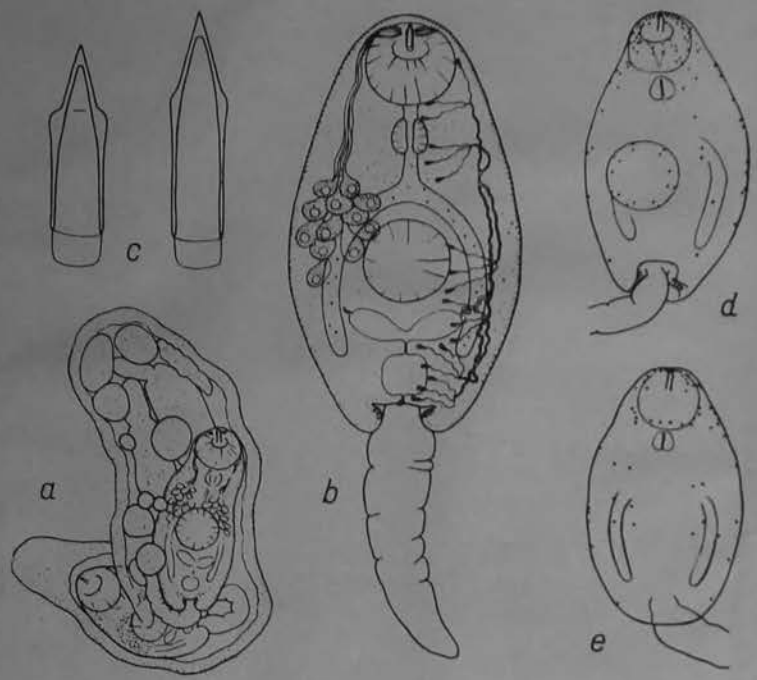


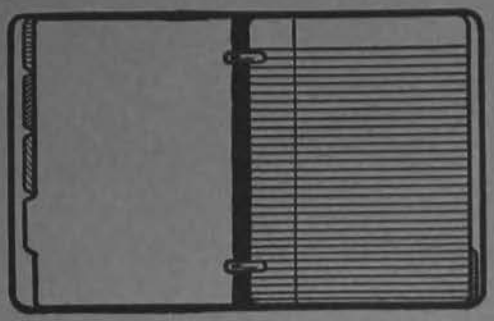
Fig. 1. Developmental stages of *Haplometra cylindracea*. a — sporocyst, b — cercaria, c — various types of stylet, d — arrangement of sensillae, ventral side, e — arrangement of sensillae, dorsal side

From Grabda-Kazubska 1970

SEE REPRINT.

PLAGIORCHIODEA

LOOSE LEAF INDEX



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SUBJECTS

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CLASS SCHEDULE

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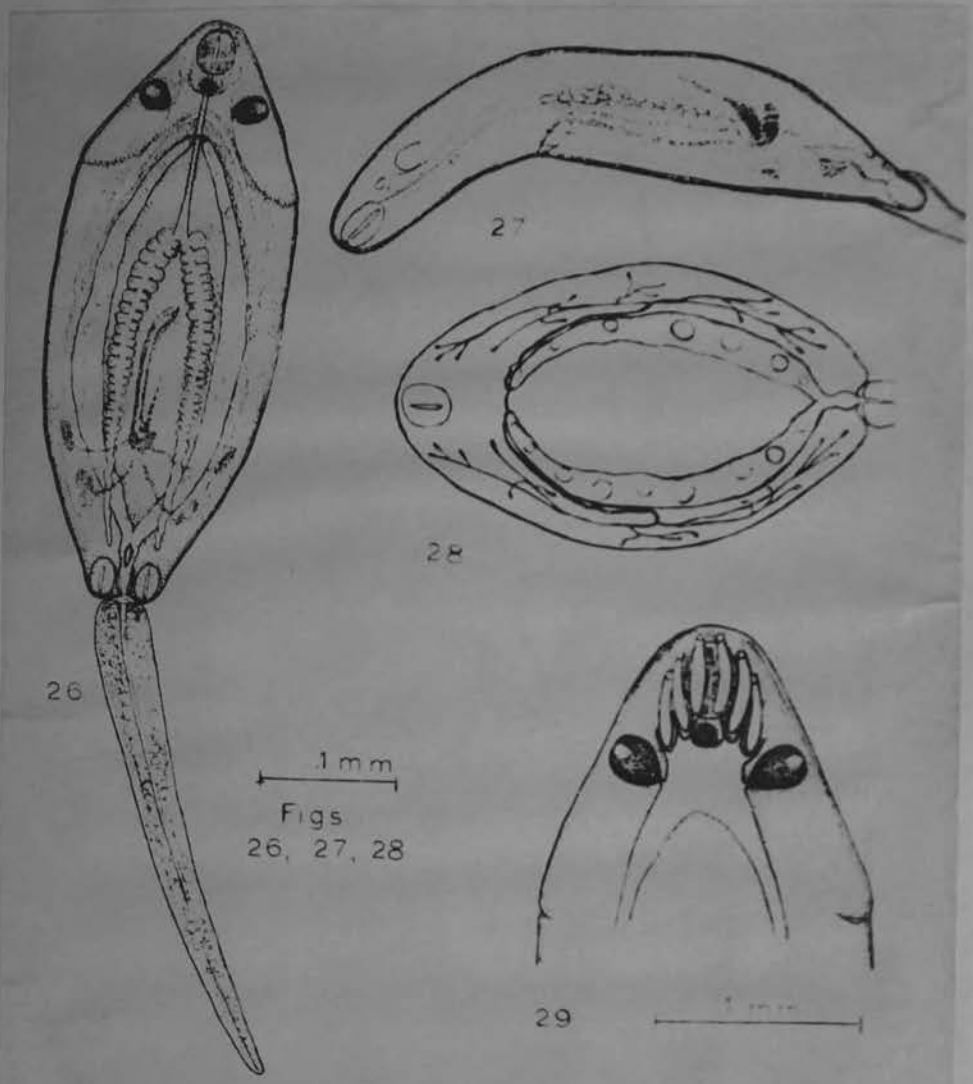
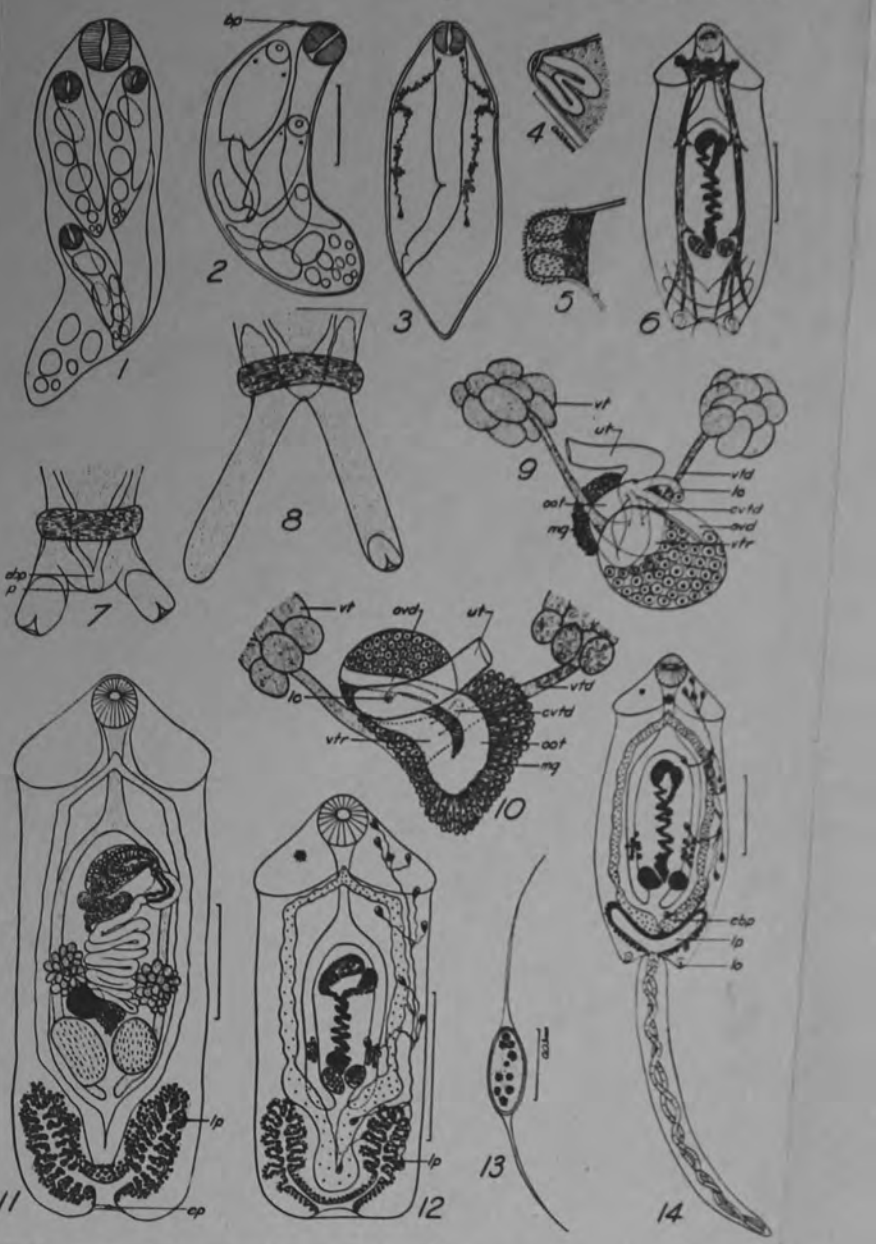
ESDAY	COURSE								
	INSTRUCTOR								
EDNESDAY	COURSE								
	INSTRUCTOR								
HURSDAY	COURSE								
	INSTRUCTOR								
RIDAY	COURSE								
	INSTRUCTOR								
ATURDAY	COURSE								
	INSTRUCTOR								

Pleuroponius malaclemys Hunter, 1961



Figs. 27–29. 27. Composite sagittal section to show relationship of digestive, excretory, and primord of reproductive systems. 28. Schematic representation of flame-cell pattern in "mature" cercar 29. Detailed relationship of cephalic glands, nervous system, and three eyespots in "mature" cercar

FROM HUNTER, 1967

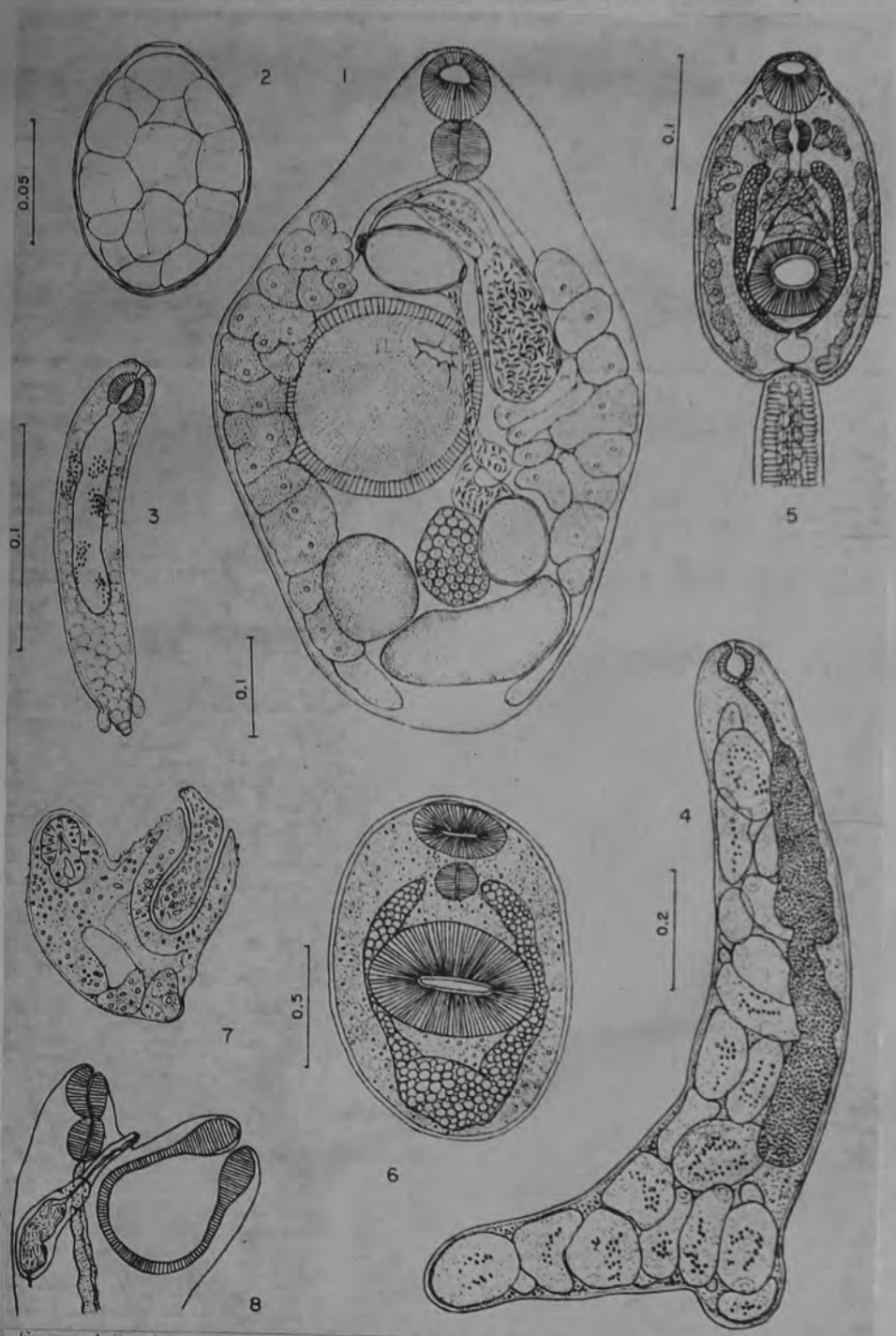


Adults in small intestine of Graptemys geographica (LeSuer), the map turtle.
Cercariae produced in rediae in the snail, Goniobasis livescens (Menke), emerge into the water, soon encyst on surface of opercula of the same species of snail, then eaten by turtle.
Cercaria are monostome, related to Sewell's C. indicae XI and Horsfall's C. infracaudata, agreeing in the main with Sewell's "Ephemera" or Faust's "Trioculate" group.
Reference: Hsu, 1937. Trans. Amer. Micors. Soc., 56:478-504.

PRONOCEPHALIDAE

Psilostomatidae

Astacatrematula macrocotyla Macy and Bell, 1968



FIGURES 1–8. *Astacatrematula macrocotyla*. 1. Mature specimen, whole mount, dorsal view. 2. Egg days of incubation at room temperature. 3. Young [illegible]. 4. Large redia with cercariae. 5. Cercaria Encysted metacercaria. 7. Median section of mature specimen with detached villus held by acetal

ABSTRACT: *Astacatrematula macrocotyla* gen. et sp. n. is erected for a trematode which matured in days in the small intestine of chicks experimentally fed small, oval metacercarial cysts occurring natorally on the gills and sternites of the crayfish *Astacus trowbridgi* collected in four widely separated rivers in northwestern Oregon. The new genus differs from *Sphaeridiotrema* Odhner, 1913, the only other genus in the subfamily Sphaeridiotrematinae, in the location of the genital pore which is posterior to the intestinal fork rather than anterior to it, in the oblique rather than tandem position of the testes, and in the structure of the acetabulum which is saclike with a narrow opening. Rediae and cercariae develop in the snail *Flumenicola virens* (Lea).

FROM MACY AND BELL, 1968

-OVER-

Life cycle

Preredial larvae

Because of the limited number of eggs produced, only a few were placed in a hanging drop preparation. They died after 8 days of segmentation. No sporocysts were found in snails harboring *Astacatrematula* infections.

Redia (Figs. 3, 4)

Mature rediae, from snail elongate sacciform, variable in shape, with two ventral lobes about three-fourths body length from anterior end. Length of ten rediae containing nearly mature cercariae from 1,062 to 1,534 mm long by 165 to 295 wide; pharynx 48 (45 to 54) long by 48 (45 to 60) wide. Each redia with 12 to 20 cercariae. Saclike gut extends to midregion of body, sometimes to ventral lobes, with orange-colored contents. Daughter rediae not seen. Smallest immature rediae 164 to 190 long by 27 to 34 wide; pharynx 14 in diameter; ventral lobes near posterior end, more slender than those of mature rediae.

Cercaria (Fig. 5)

Diagnosis: Body flattened, ovoid, 228 (198 to 271) long, 146 (123 to 177) wide; cuticle thick, aspinose. Tail 531 (435 to 609) long, 52 (45 to 60) wide; margin clear; narrow, simple, with double row of globules extending nearly full length. Oral sucker terminal with subterminal opening; 40 (36 to 48) long, 47 (42 to 54) wide. Acetabulum large, postequatorial; 56 (48 to 66) long, 64 (54 to 75) wide, anterior margin averaging 122 from anterior margin of body. Prepharynx short. Pharynx 27 (25 to 28) in diameter. Esophagus bifurcating just anterior to midbody. Excretory bladder thin-walled, subspherical when distended, main excretory ducts extending anterior from bladder to level midway between intestinal fork and pharynx, filled with rounded, refractile granules. Dense, cystogenous gland cells, dorsolateral, in a lateral row on either side of body from pharynx to posterior tip; similar glands medial, from anterior margin of ventral sucker to anterior level of main excretory tubules. Flame cell pattern obscured by density of body.

Host: Flumenicola virens (Lea).

Remarks

Cercariae of *Astacatrematula macrocotyla* resemble those of echinostomes in the presence of granules in the main excretory tubules but lack the collar spines. They swim vigorously, progress rapidly through water with the tail describing a figure 8, and are positively phototactic. They show little tendency to creep on the bottom. Shedding from snails is almost entirely diurnal and is sporadic without a clear daily maximum period. Many encyst on the bottom of the container following the loss of the tail, adhering firmly to the glass by a secreted wall. Circulation of water past the gills and sternites of crayfish carries cercariae to these structures on which they also encyst.

Metacercaria (Figs. 6, 9, 10)

Metacercarial cyst oval, 137 to 145 by 98 to 112; inner membrane 3 to 4 thick, outer membrane attached to substrate irregularly thicker. Oral sucker averaging 36 wide by 22 long; pharynx about 18 in diameter. Acetabulum 72 wide by 47 long. Excretory bladder sacciform with arms extending to level of pharynx, filled with highly refractile, rounded granules. Such granules lacking in both cercariae and metacercariae of *Sphaeridiotrema*, according to Macy and Ford (1964), and Burns (1961). Outer cyst membrane, attaching cyst to crayfish gill-filaments, digested by acidic pepsin solution whereas the metacercaria is released only after exposure to trypsin in alkaline solution. Encysted worms on crayfish dead for a week still infective to chicks. Empty, outer cyst walls often occur on crayfish.

Infection experiments

Five small, uninfected crayfish kept at room temperature were placed in a dish containing seven snails shedding the cercariae. Four days later cysts were found on the abdominal sternites. About 100 cysts, 14 days old, from the gills and sternites of these crayfish were fed to a day-old chick. When killed 2 days postinfection 13 immature *Astacatrematula* were found in the small intestine. In a second experiment, 237 cysts 15 days old from the sternites and gills of another experimentally infected crayfish were fed to a 2-day-old chick and 5 days postinfection two mature *Astacatrematula* were found in the small intestine.

To ascertain the longevity of the flukes, each of three 1-day-old chicks were fed 200 viable cysts. Dissection yielded 22 mature flukes in 6 days, one in 7 days, and five in 8 days, respectively. Attempts to obtain flukes after 8 days in chicks were negative.

To determine the relationship between the establishment of worms with and without predigestion of the encysted metacercariae, 400 cysts pretreated in acid pepsin solution for 1 hr were fed to each of four 1-day-old chicks and 400 untreated cysts were fed to each of four additional 1-day-old chicks. No significant difference was found between the two groups.

Repeated attempts to infect day-old ducklings, white mice, rats, and hamsters were negative.

DISCUSSION

Compared to that of *Sphaeridiotrema globulus* (Rudolphi, 1814), the redia of *Astacatrematula macrocotyla* is more slender and the arms of the excretory vesicle of the cercaria are filled with refractile granules lacking in the former species. The metacercaria of *A. macrocotyla* is oval rather than spherical and refractile granules fill the excretory vesicle and its arms.

Rapid decline of infestation of crayfish with *Astacatrematula macrocotyla* at sites of former abundance suggests the temporary absence of infected definitive hosts, perhaps nesting birds.

The life cycle of *Astacatrematula macrocotyla* is similar to that of another psilostome, *Psilotrema spiculigerum* Muling, 1898, as described by Mathias (1925). In this European species, the cercaria has a smaller acetabulum and lacks the median cystogenous glands. The body is spinose but the arms of the excretory vesicle are filled with granules as are those of our species. The redia is similar as is metacercarial cyst except for polar depressions of the wall. Encystment, as in our species, occurs on substrate exterior to the snail host, *Bithynia tentaculata*. This snail is closely related to *Flumenicola circus*. *Psilotrema spiculigerum* matures in birds, especially various species of ducks and experimentally in white rats, whereas our species did not develop in ducks or mice.

The small return of adult worms from chicks indicates that gallinaceous birds probably are not the natural hosts.

FROM MACY AND BELL, 196

PSILOSTOMATIDAE