

ON THE LIFE CYCLE STAGES OF *PROCTOECES MACULATUS*
(DIGENEA:FELLODISTOMIDAE) IN MUSSELS AND
FISHES FROM GALVESTON BAY, TEXAS

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ABSTRACT—*Cercaria brachidontis* Hopkins, 1954, previously known from Louisiana, is reported from its type host, the hooked mussel *Ischadium recurvum* (Raf.) collected in Galveston Bay, Texas. The metacercarial stage of *C. brachidontis* is reported from both *I. recurvum* and the platform mussel *Mytilopsis leucopheata* (Conrad) and the parasite is referred to *Proctoeces maculatus* (Looss, 1901) Odhner, 1911. An adult fluke of the same species is reported from the hindgut of the sheepshead, *Archosargus probatocephalus* (Walbaum) (Osteichthyes, Sparidae), collected from Galveston Bay.

Microcercous cercariae of the genus *Proctoeces* (Odhner, 1911) are known to develop in marine bivalved molluscs (Stunkard and Uzmann, 1959; Canzonier, 1972). Unencysted, and often progenetic, functionally adult metacercariae have been found in both bivalve (Fujita, 1925; Palombi, 1926; Uzmann, 1953; Freeman and Llewellyn, 1958) and gastropod (Dollfus, 1964; Dolgikh, 1965; Ichihara, 1965; Looss-Frank, 1969) molluscs. Adult *Proctoeces* have been reported from the hindgut of tropical and subtropical shallow water bottom feeding marine fishes belonging to several different families, primarily Sparidae and Labridae (Dollfus, 1964). Freeman and Llewellyn (1958) suggest that some of the *Proctoeces* found in molluscs are true adults and that no vertebrate hosts are needed for the completion of their life cycles. This phenomenon may be related to temperature (Prevot, 1965) and is apparently more important in northern latitudes where fishes have not been found to harbor adult *Proctoeces*.

The taxonomic status of the species of the genus *Proctoeces* has been the subject of considerable discussion due to the difficulty of identifying suitable sets of constant characteristics for species. Members of the genus are notoriously variable as to body form, size and internal structure, with considerable variation occurring even within members of the same population living in different hosts (Freeman, 1962).

MATERIALS AND METHODS

Host organisms were collected from various localities within the Galveston Bay System, Texas (Fig. 1) and were dissected in seawater in order to ascertain the presence of *Proctoeces*. Parasites, when found, were isolated in seawater for observation, and measurements were made on active living specimens during periods of relaxation, under light cover glass pressure. Parasites were fixed in hot A.F.A., stained in Semichon's carmine, dehydrated, cleared, and mounted for further study. All measurements given are in millimeters unless otherwise indicated. Single measurements indicate means and paired measurements indicate ranges obtained from 10 specimens.

RESULTS

Hooked mussels, *Ischadium recurvum* (Rafinesque) (= *Brachidontes recurvis*), were collected from ten stations in Galveston Bay, Texas. Of these, 188 specimens from nine stations were negative for *Proctoeces*; however, of 17 mussels from Hanna's Reef five contained immature *Proctoeces* metacercariae and a sixth specimen harbored sporocysts and cercariae, the latter being morphologically similar to the metacercariae.

Platform mussels, *Mytilopsis leucopheata* (Conrad) (= *Congeria leucopheata*), were collected from five stations in Galveston Bay. Of these mussels, 254 specimens from four stations were negative, but of 10 specimens from West Bay (of

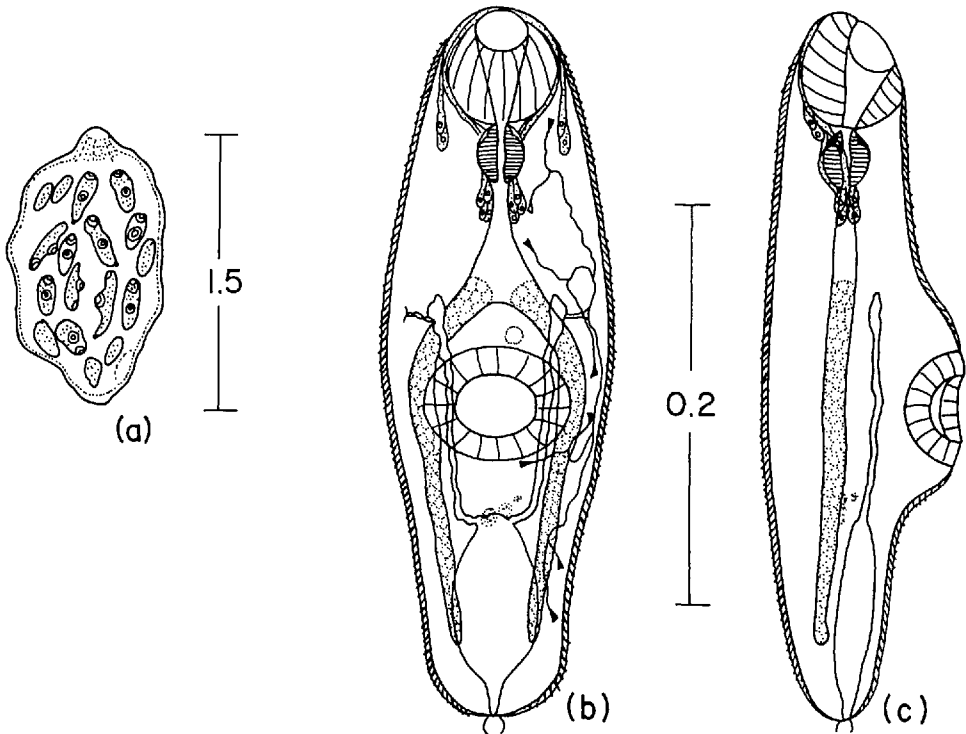


Figure 1. Sporocyst and cercaria of *Proctoeces maculatus* from *Ischadium recurvum*: a, Sporocyst; b, Cercaria, ventral view, details of excretory system omitted from right side; c, Lateral view, details of excretory system omitted.

Galveston Bay), two contained metacercariae identical to those found in *Ischadium*.

An adult specimen of *Proctoeces* was obtained from the hindgut of the sparid fish *Archosargus probatocephalus* (Walbaum) taken by seine near the locality where the *Mytilopsis leucopheata* harboring the *Proctoeces* metacercariae were collected. The fish measured 35.5 cm in standard length. The stomach was empty, hence no record of recent feeding on *Ischadium* or *Mytilopsis* could be obtained.

Sporocysts and Cercariae Figure 1

Diagnosis.—Sporocysts (Fig. 1a) occupying gonadal area of host, imparting gross orange hue to tissues which are normally bright yellow or brown. Orange-pigmented sporocysts, several hundred in number, measuring up to 0.5 in length and 0.2 in width, each containing up to 45 discernible cercariae in various stages of development.

Cercaria (Fig. 1b and c) elongate to oval, 0.33 to 0.40 long, 0.15 wide, oral sucker 0.075, mouth ventral and subterminal. Ventral sucker 0.10 and located near body midpoint. Prepharynx absent, pharynx pyriform, 0.045 by 0.038. Intestine bifurcating anterior to ventral sucker into furcae extending posteriad almost to end of body. Intestinal crura staining pink with neutral red stain. Four pairs of cephalic glands, located on each side of esophagus just posterior to

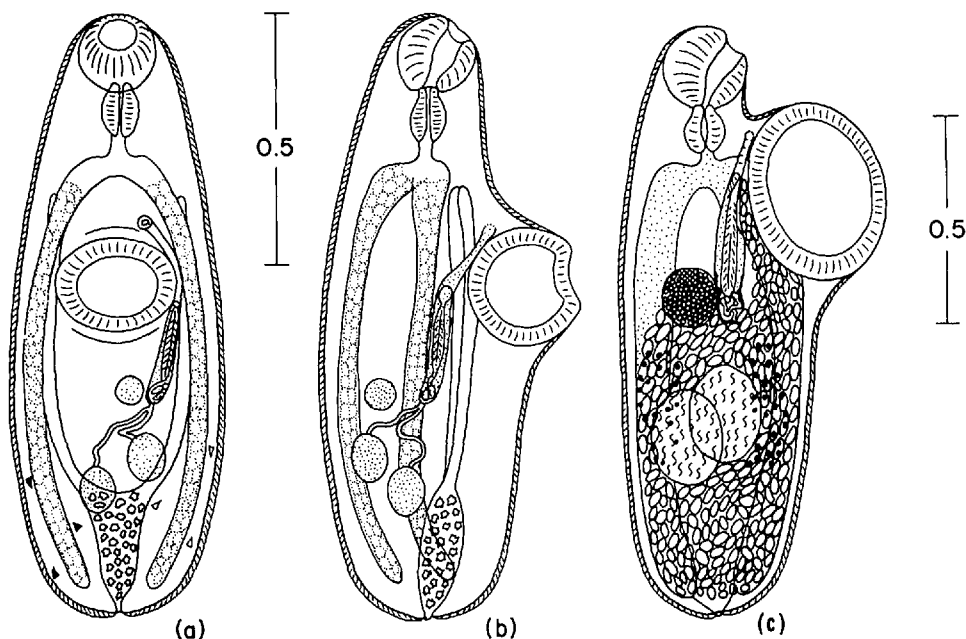


Figure 2. Metacercaria of *Proctoeces maculatus* from *Ischadium recurvum*: a, Ventral view; b, Ventro-lateral view; c, Adult *Proctoeces maculatus* from *Archosargus probatocephalus*, ventro-lateral view.

pharynx, with ducts extending antieriad, dorsal to oral sucker. Two additional pairs of cephalic glands located distally, anterior and lateral to pharynx with ducts extending dorsad over oral sucker. Cephalic glands staining yellow with neutral red stain. Anlage of gonopore 0.02 in diameter, located on ventral midline just anterior to ventral sucker. Genital Anlagen located near anterior margin of excretory bladder and posterior to ventral sucker. Excretory bladder oval, 0.08 long, arms extending from anterior lateral margin of bladder to level of bifurcation of intestine, and expanding slightly at this point. Main excretory collecting tubules joining arms of bladder just posterior and lateral to terminal swellings of arms. Flame cell formula $2 [(2+2) + (2+2)] = 16$. Some cercariae showing small (0.01) bulbous vestigial tail, posterior to excretory pore, body cuticle minutely spinose.

The cercariae could not swim and were observed lying on the bottom of the container flexing the body slowly, making little or no directional progress.

Host.—*Ischadium recurvum* (Rafinesque), "hooked mussel."

Locality.—Hanna's Reef, Galveston Bay.

Incidence.—One of 17 mussels (5.8%).

Location in Host.—Gonad.

Metacercaria Figure 2a, b

Diagnosis.—Body of variable size, ranging from 0.45 to 1.53 in length and from 0.15 to 0.78 wide at level of ventral sucker. Remainder of diagnosis based upon morphology of three large (more mature) specimens ranging from 1.12 to 1.53 in

length. Mouth ventral and subterminal, oral sucker round, 0.17 to 0.24 in diameter. Pre-pharynx absent, pharynx pyriform, 0.12 to 0.15 long, 0.08 to 0.12 wide. Esophagus 0.04 to 0.05 long, intestine bifurcating at level of ventral sucker into intestinal crura which extend posterior almost to posterior margin of body. Ventral sucker at midbody level or located in anterior portion of body, projecting slightly from ventral body surface. Ventral sucker round to oval, 0.24 to 0.35 in maximum diameter. Testes paired, oblique, located in posterior half of body, oral 0.08 to 0.11 long by 0.04 to 0.09 wide. Cirrus sac extending from posterior border of ovary, extending anterior around left side of ventral sucker and terminating in hermaphroditic duct ending in gonopore located on left side of body anterior to ventral sucker. Cirrus sac 0.31 long, 0.064 wide, seminal vesicle coiled in posterior portion of sac, pars prostatica occupying middle portion of sac, 0.150 in length. A muscular papilla present anteriolateral to pars prostatica. Ovary located at mid level of body or in posterior portion, round, 0.05 to 0.10 in diameter. Vitellaria, uterus and eggs not developed in specimens examined. Excretory bladder large, "Y shaped," extending from posterior margin of body to level of posterior testis, arms of bladder extending anterior to level of gonopore. Cuticula moderately thick, slightly opaque and aspinose.

Hosts.—(1) *Ischadium recurvum* (Rafinesque), "hooked mussel" from Hanna's Reef, Galveston Bay, 5 of 17 mussels (29%). (2) *Mytilopsis leucopheata* (Conrad), "platform mussel" from West Bay, Galveston, Texas, 2 of 10 mussels (20%).

Location in Host.—Digestive gland.

A comparison of metacercariae from *Ischadium* to those from *Mytilopsis* revealed no significant differences in internal morphology. Overall size was similar. Specimens from *Ischadium* bearing reproductive organs sufficiently developed to include a cirrus sac measured 1.12 and 1.47 in total length whereas the single such specimen from *Mytilopsis* measured 1.53 in length. The remaining metacercariae from both *Ischadium* and *Mytilopsis* were morphologically intermediate between the more mature metacercariae and the cercariae. They differ from cercariae in being larger (0.454 to 0.750 total length) and in the presence of moderately developed testes and ovary. They differ from the more mature metacercariae in that the cirrus sac is as yet undiscernible and the ventral sucker is located at or near the body mid-level as in the cercariae.

Adult Figure 2c

Diagnosis.—Body (of the single specimen available) 1.44 long, 0.6 wide at level of ventral sucker. Body 0.46 wide posterior to ventral sucker. Mouth ventral and subterminal. Cuticula moderately thick and aspinose, oral sucker round, 0.23 in diameter. Pre-pharynx absent, pharynx pyriform, 0.14 long, 1.2 wide. Esophagus 0.03 long, ending at level of ventral sucker. Intestinal crura extending posterior almost to posterior margin of body. Ventral sucker in anterior half of body, oval, 0.48 long, 0.33 wide, projecting slightly from ventral surface of body. Testes paired, oblique, located in posterior half of body, oval, 0.24 long, 0.19 wide. Cirrus sac extending anterior from level of ovary through hermaphroditic duct to gonopore located on left side of body anterior to ventral sucker, 0.45 long, 0.07 maximum width. Seminal vesicle coiled, in posterior portion of sac; pars prostatica occupying middle portion of sac, 0.24 long. A muscular papilla located anteriolateral to pars prostatica. Ovary located at mid level of body, round, 0.15 in diameter. Eggs in uterus oval, 0.040 to 0.045 long, 0.017 to 0.022 wide. Uterus

packed with eggs, occupying most of posterior half of body to level of ovary and extending anteriorly on left side of cirrus sac to hermaphroditic duct. Vitellaria in paired irregularly-follicular masses posterior to ovary and extending posteriorly lateral to testes, terminating at posterior level of testes. Vitelline masses 0.28 to 0.30 long, 0.09 to 0.11 wide. Excretory pore terminal, posterior excretory bladder and arms not observed due to presence of eggs in uterus.

Host.—*Archosargus probatocephalus* (Walbaum), "sheepshead."

Locality.—West Bay, Galveston, Texas.

Incidence.—One of 1.

Location in Host.—Rectum.

DISCUSSION

Life Cycle

The similarity in morphology and habitat between the cercaria from *Ischadium recurvum* and the metacercariae from the same host species and from *Mytilopsis leucopheata* indicates that they are probably stages of the same species. The adult *Proctoeces* from *Archosargus probatocephalus* also agrees morphologically with these metacercariae excepting in size and sexual development, as would be expected. The adult specimen corresponds ecologically in that it was found in a fish known to feed on both *I. recurvum* and *M. leucopheata*, taken from the same station where infected molluscs were found. Darnell (1958) reports that 19% of the stomach content of 11 *A. probatocephalus* (as *A. oviceps*) from Louisiana consisted of these two mussel species.

Since no progenetic metacercariae were found in the molluscan hosts, the cycle in Texas apparently differs from that reported for more northerly latitudes in which the cycle is completed entirely within the molluscan host. Prevot (1965) found *P. maculatus* metacercariae in annelids and gastropods in the Mediterranean Sea. It is possible that other invertebrates may harbor the metacercariae in Galveston Bay, but no systematic search for these stages in other invertebrates was made during the present study.

Identity

As has been pointed out by several researchers (Freeman and Llewellyn, 1958; Stunkard and Uzmann, 1959; Freeman, 1962; Dollfus, 1964; Lang and Dennis, 1976), specific identification in the genus *Proctoeces* is often quite difficult due to the great variability found in the taxonomic characters commonly employed. Therefore, the status of many of the previously described species is in question and many have subsequently been synonymized with the type species, *P. maculatus* (Looss, 1901) Odhner, 1911, which is apparently worldwide in distribution in tropical and temperate waters.

The sporocysts and cercariae found in the present study are identical to those described as *Cercaria brachidontis* Hopkins, 1954, and develop in the same host species. Hopkins (1954) considered the differences in development of the tail and in the morphology of the gland cells sufficient to separate *C. brachidontis* specifically from the other *Proctoeces* type cercariae, *Cercaria milfordensis* Uzmann, 1953, and *C. adranocerca* Stunkard and Uzmann, 1959. *Cercaria tenuans* Cole, 1935, described from *Mytilus edulis* in England, was originally reported to differ from the above cercariae in the possession of short, sac-like intestinal crura

and in the lack of a tail even in immature cercariae. Canzonier (1972), however, has re-discovered *C. tenuans* in Italy in its type host and has found it to have long crura and to possess a tail in its immature forms. Canzonier stopped short, however, of synonymizing *C. tenuans* with any of the similar cercariae from the western Atlantic. Although *C. brachidontis* differs from *C. milfordensis* and *C. tenuans* (which appear to be identical) in being slightly larger and in the possession of a minutely spinose (rather than aspinose) cuticle, these differences appear insignificant in view of the wide morphological variation seen among metacercaria and adult *P. maculatus*. These differences, therefore are not considered to be of sufficient degree to permit specific separation of these forms. It is considered that *Cercaria tenuans*, *C. milfordensis* and *C. brachidontis* are conspecific and are the cercarial stage of *Proctoeces maculatus*, since *C. milfordensis* was determined to be the larva of *P. maculatus* by Stunkard and Uzmann (1959).

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