LARVAL TREMATODES FROM THE APALACHEE BAY AREA, FLORIDA, WITH A CHECKLIST OF KNOWN MARINE CERCARIAE ARRANGED IN A KEY TO THEIR SUPERFAMILIES[1]

RHODES B. HOLLIMAN,

Department of Biological Sciences, Florida State University, Tallahassee, Florida

II. Introduction and Historical Review

The major objective of this study was to investigate the cercarial fauna in marine mollusks from the littoral zone and shallow waters of Apalachee Bay, Gulf of Mexico. The following general outline of the trematode life cycle indicates the role of cercariae:

Adult digenetic trematodes are common parasites of vertebrates. Most species live in the digestive tract or its appended organs but others are found in various systems of the host. The adult worm produces eggs which escape from the host. A larva, the miracidium, develops within the egg and ultimately gains access to an intermediate host which is usually a mollusk or very rarely an annelid. Within this host larval multiplication occurs by polyembryony and is almost always enhanced by the intermediate generations of germinal sacs known as sporocysts and rediae. These sacs produce cercariae, each of which develops into an adult trematode upon reaching the vertebrate host by one of several ways, either directly or indirectly. Usually, cercariae emerge from the intermediate host to live free for a short time and can be obtained by isolating the host as was done to study most of the species reported here. Some cercariae, however, remain in the mollusk to be eaten with it by the definitive host and, in order to study these forms, it is necessary to dissect the mollusk to recover them.

The study of marine cercariae has lagged behind that of their adults. Furthermore, descriptions of many marine cercariae are inadequate for purposes of comparison. It is recommended that the features of cercarial morphology, behavior, reactions to vital dyes and germinal sac morphology be recorded in all future descriptions of cercariae to facilitate comparisons. Prior to the present study, cercariae have been separated primarily by comparative morphology, and many closely related forms are difficult to separate on this basis alone. The present study has shown that features of behavior, reaction to dyes and germinal sac morphology are relatively constant for a given species, and differ sufficiently between species to be of systematic value.

Because research on marine cercariae has been done mostly near marine laboratories, great areas of continental coastlines remain unexplored. The present study is the most extensive investigation of its kind from the Gulf of Mexico. A similar study is that of Cable (1956a) for Puerto Rico.

Life history studies have shown that morphologically dissimilar cercariae may be closely related within a single family. Therefore, the obvious solution to a natural system of classification of cercariae lies not only in the study of comparative morphology but in the elucidation of the life cycles of larvae, particularly in families whose taxonomic position is uncertain.

A secondary objective of this study was to provide information on local marine cercariae that would be of value in future life history investigations. That the basis of classification of digenetic trematodes should be founded on life history studies and embryonic development has been supported by the work of LaRue (1938, 1957), Stunkard (1940, 1953b), Hussey (1941, 1943), Kuntz (1950, 1951, 1952), Cable (1956a) and others.

While surveying the literature of marine cercariae of the world, the need for a key to these larvae became increasingly apparent. The latter part of this volume is an attempt to fulfill this need, using LaRue's (1957) scheme of classification as a basis for a key to Superfamilies. An attempt has been made to accumulate a complete bibli-

[1] This study was submitted to the Graduate School of The Florida State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

ography on marine cercariae of the world through December, 1959.

The first description of a cercaria was published by Swammerdam in 1773 from the fresh water snail, *Paludina vivipara.* In 1773, Otto F. Müller first used the term *Cercaria* as a generic name for tailed microscopic animals. He placed them in the Infusoria and described the first marine species, *Cercaria inquieta,* a biocellate form found in a plankton sample. The second, *Cercaria setifera,* was described by Johannes Müller (1850). This trichocercous larva has probably been the most completely investigated marine cercaria; over 15 other names have been considered as synonyms by various authors.

Diesing (1855) published a revision of cercariae known at that time, and described 5 new marine species. He recognized 9 genera and 20 species, and regarded these forms as zoologically distinct and free living but corrected that mistake in 1858 when he recognized cercariae as trematode larvae.

An extensive but artificial system of classification of cercariae was proposed by Lühe (1909). He used external morphological characteristics, such as stylets, collars, spines and caudal form as his basis of taxonomy. He introduced many new descriptive terms for "groups" or "types" of cercariae (e.g., trichocercous, microcercous, cystocercous, leptocercous). Lühe pointed out that the cercariae of closely related forms show a very striking similarity of structure. Consequently, he believed that his classification of cercariae would be correlated with the taxonomy of adults. The morphological terms introduced by Lühe, although of less taxonomic importance than he assumed, are still useful as descriptive terms.

Lebour (1911) advocated a "natural" scheme of classification of cercariae separating them into two groups based on the type of germinal sacs (rediae or sporocysts) in which they develop. Within each group she proposed smaller groups of apparently related forms based on morphological characteristics. Her system is no longer accepted because allocreadioids, opisthorchioids and other groups are known to develop in both sporocysts and rediae.

The major contributions to morphology and taxonomy of marine cercariae in the twentieth century have been the studies of Lebour (1904-1923) and Rothschild (1935-1941) in England and Scotland; Palombi (1924-1942), primarily in the Gulf of Naples; H. M. Miller (1925-1930) at Puget Sound, Washington, and Dry Tortugas, Florida; Martin (1938-1956) at Wood's Hole, Massachusetts, and the California coast; Cable (1934-1956) at Wood's Hole, Massachusetts, and Puerto Rico; and the investigations of Stunkard (1929-1959) at Wood's Hole, Massachusetts, and at Roscoff, France.

The cercariae in the present work are arranged in categories corresponding to families or superfamilies. Allocation has been based on a comparison with cercariae whose life cycles are known. Family and superfamily names are used to designate cercarial types. For example, the larvae known to belong to the Microphallidae will be referred to as microphallids, and those in the Opisthorchioidea as opisthorchioids. The morphological terms introduced by Lühe (1909), Sewell (1922), and others will be used occasionally in a descriptive sense (*e.g.,* cystophorous hemiuroid, pleurolophocercous heterophyid).

Although the term *Cercaria* was introduced as a generic name, it obviously encompasses a much larger category than that of a genus. The term is, however, a convenient group name for larvae whose relationships to adult trematodes are unknown, and it is used in this manner herein.

The author wishes to express gratitude to Dr. Robert B. Short of Florida State University under whose direction this study was done, and to Drs. George R. LaRue, Raymond M. Cable, and Franklin Sogandares-Bernal for reading the manuscript and for many helpful suggestions.

III. Materials and Methods

The mollusks examined were collected along the coast of Apalachee Bay, Gulf of Mexico, from St. Marks lighthouse to St. Teresa, Florida, with the exception of three lots obtained at the jetties at Panama City, Florida. A total of 69 collections were made from the Apalachee Bay area from September 1956 to September 1959.

Mollusks were taken by hand from salt marshes and the littoral zone, and from deeper waters with a beam dredge operated

from a small boat. Identification was based on Abbott's (1954) *American Seashells.*

In the laboratory, mollusks were isolated individually in a small quantity of filtered sea water for 24 hours at room temperature 23°-24° C.). At the end of that period, the water was examined with a stereomicroscope. If no cercariae were observed, the water was replaced and if no cercariae emerged during a second 24 hour period, the mollusk was generally considered negative for cercarial infections and was discarded. If, however, a large number of mollusks from a single collection appeared negative after two examinations, some of these individuals were crushed and examined.

It was found that cercariae would emerge from *Cerithidea scalariformis* Say, an operculate, prosobranch snail of salt marshes adapted to fairly warm water, if that host was first dried on blotting paper for a few hours and then isolated in sea water at 30° to 35° C.

Cercariae which had emerged from a mollusk were transferred to an embryological watch glass with a micro-pipette to study swimming habits, tropisms and longevity. In a few instances where cercariae did not emerge spontaneously, they were found by dissection of the host. Unless otherwise stated descriptions are based on cercariae that emerged naturally.

For microscopic study, cercariae were transferred in a drop of sea water to a slide and a No. 1 coverslip was added. Coverslip pressure was controlled by addition of sea water to the edge of the coverslip or by absorption of water with blotting paper. Numerous preparations of material of each species were examined during the course of making the preliminary drawings. Particular effort was made to discern the excretory tubules and flame cell formulae.

Neutral red and Nile blue sulfate were used as vital dyes at a concentration of 0.5% in sea water. Cercariae in a drop of sea water were added to a drop of the dye in a watch glass and their reactions were recorded.

After each cercaria was studied, its host was crushed and the sporocysts or rediae were examined and drawn. The average number of cercarial embryos per germinal sac was determined by counting the embryos from 20 sporocysts or rediae ruptured by coverslip pressure.

Measurements were made on preserved material which had been fixed according to the method of Talbot (1936): Living cercariae, in 200 ml. of sea water, were dashed into 200 ml. of steaming 10% formalin. Rediae and sporocysts were fixed in the same manner. Cercariae thus fixed were killed in a relaxed and extended position and were rather uniform in shape and size.

Measurements were made on 20 cercariae and 20 germinal sacs of each species and a maximum, minimum and average for each feature is recorded in the descriptions, the average being in parentheses. All measurements are in millimeters.

All preliminary drawings were made free hand from living material under an oil immersion objective. Final drawings, except for habit sketches, were made to scale using preliminary sketches and average measurements.

IV. Results

Over 200 species of mollusks are known from both littoral and deep waters of Apalachee Bay. A total of 16,577 mollusks were examined, representing 29 species. Seven of 19 species of gastropods and 4 of 10 species of pelecypods were infected with larval trematodes. Cercariae belonging to 31 species were found, 21 in gastropods, and 10 in pelecypods. Twenty-eight of these cercariae were studied in detail. Of these cercariae, 24 are described as new and four previously known forms are redescribed. Trematode larvae were found in 2622 individual mollusks, an incidence of infection of 15.2%.

Each of the following descriptions contains a general diagnosis of the group where known, a telegraphic description of the species, a description of larval behavior, and a discussion of affinities including a comparison of the larva with its most closely related form.

A. *Cyathocotylid Cercaria*

One cercaria in the family Cyathocotylidae is reported here as a new species. The general characteristics of cercariae from this family, as given by Cable (1956a), are:

Furcocercous cercariae developing in elongate sporocysts in fresh water and marine gastropods. Oral sucker, pharynx and

ceca well developed, ventral sucker a primordium or lacking. Tail longifurcate with long, slender stem. Tail stem with long setae, furcal fins present or absent. Tail attached dorsally near posterior end of body. Larva rests suspended in water with the tail stem flexed near its middle. Body ventrally concave, covered with spines. Papillae and bristles present. Eyespots absent. Excretory system diagnostic for the family. The thin walled excretory vesicle gives rise to 4 tubules, a median pair and a lateral pair. The median pair converge to form a single tubule which connects, in the anterior region of the body, with the lateral tubules by means of a cross commissure. Posterior to its junction with the lateral tubules, a recurrent collecting tubule joins each lateral tubule and extends posteriorly a short distance to receive an anterior and posterior collecting tubule, each with typically 3 groups of flame cells, although other flame cell patterns have been described. Posterior flame cell group on each side almost always in the tail stem. Encyst in fishes or, rarely, in the molluscan host.

Cercaria leighi, sp. nov.

(Figures 1-6)

Description: body 0.204-0.219 (0.213) long, 0.092-0.099 (0.094) wide at maximum width posterior to midbody. Tail stem 0.296-0.311 (0.305) long, 0.036-0.041 (0.037) wide at base. Furcae 0.209-0.230 (0.221) long, 0.026-0.031 (0.027) wide at base. Dorso-ventral finfolds on furcae, with maximum width of 0.012, extending dorsally and ventrally entire length of furcae and projecting about 0.010 beyond tip. Furcal fins with fine striae and marginal papillae with minute bristles, 6 papillae dorsally and 6 ventrally. Tail stem with diagonal and transverse muscle fibers and scattered nuclei. Surface of tail stem with numerous bristles. Furcae filled with conspicuous vacuolated parenchyma. Body covered with very fine spines and scattered bristles, shorter than those on tail stem. Cephalic region surrounding mouth with short and long bristles, and anterior half of oral sucker with concentric rows of spines slightly heavier than those elsewhere. Oral sucker resembling protrusible cephalic organ with weak sucking capacity, 0.045-0.051 (0.049) long, 0.029-0.030 (0.029) wide in maximum width; mouth terminal. Fourteen penetration glands found in oral sucker whose ducts open around circumference near midlevel of sucker. An additional set of 4 penetration glands imbedded deeply within sucker, their ducts opening symmetrically around mouth. Prepharynx short; pharynx 0.018 in diameter. Esophagus short, ceca wide, sinuous and empty. Numerous cystogenous glands opening on body surface in anterior third of body. Granular cystogenous glands, irregular in shape, scattered throughout body. Two primordia evident, anterior to excretory bladder in posterior half of body; smaller anterior mass probably representing developing acetabulum, larger posterior mass representing the developing tribocytic organ or reproductive system. Medial excretory tubules encompassing both primordia and converging just anterior to smaller one. Minute excretory concretions found in single medial tubule, cross commissure, in anterior ends of lateral tubules and in bifurcated projections of lateral tubules anterior to junction with cross commissure. Excretory bladder with island of Cort. Caudal excretory tubule supported in tail stem by transverse fibers, bifurcating and discharging through pores at tips of furcae. Excretory formula $2[(3+3+3)+(3+3+3)]=36$; the last group of 3 flame cells on each side widely separated in anterior 2/3 of tail stem. Development in elongate, motile, cream-colored sporocysts with prominent circular muscle bands giving sporocyst a segmented annelid-like appearance. Ninety-two sporocysts counted from branchial region of one host. Sporocyst 1.995-2.610 (2.361) long, 0.210-0.270 (0.249) wide. Anterior end more pointed, surrounded by minute bristles, birth pore subterminal. Thirty-five to 24 embryos per sporocyst: in all stages of development. Flame cells very numerous, grouped in each circular muscular band of body.

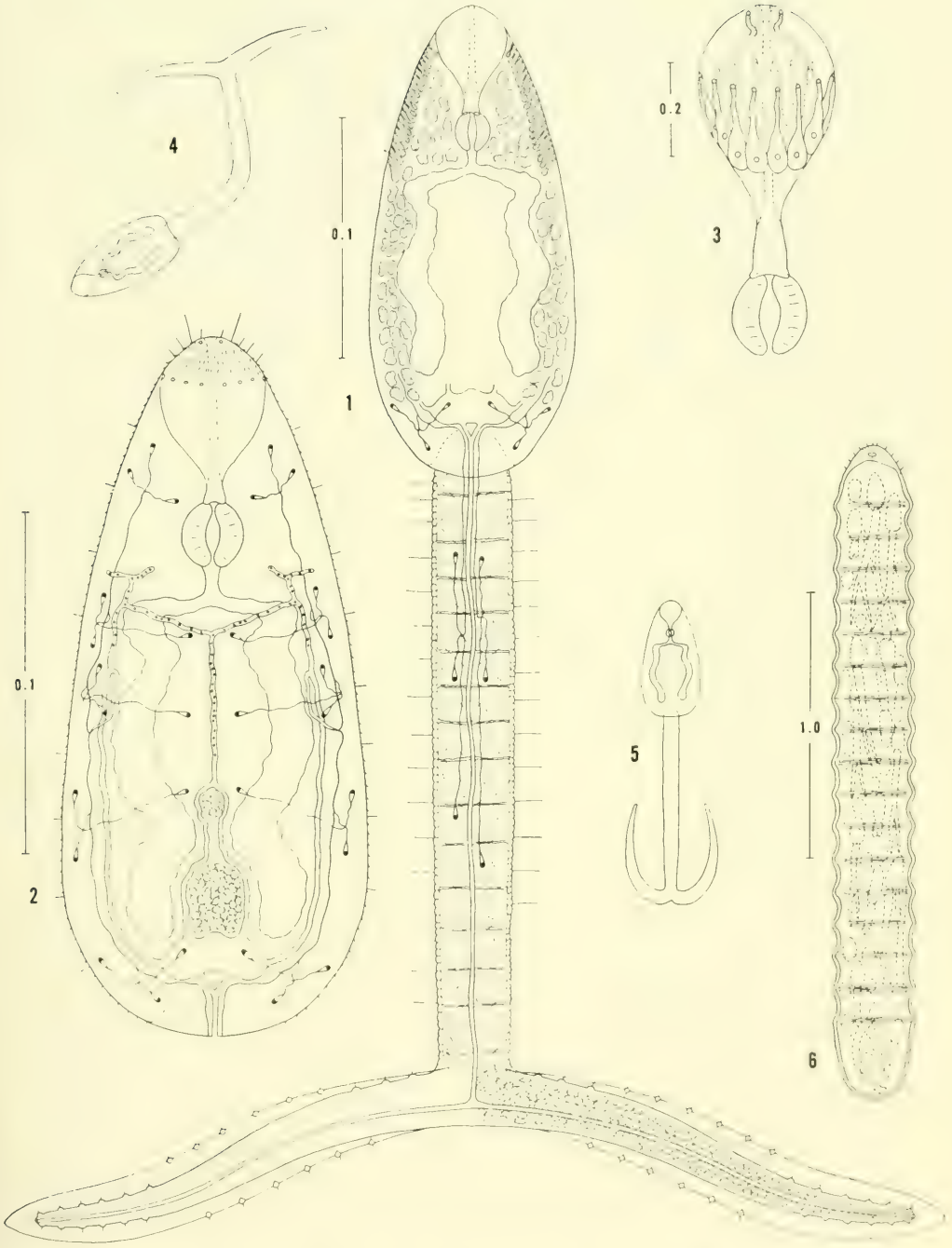
Host: Cerithidea scalariformis Say.

Incidence of infection: One of 5,508 snails.

Locality: Salt marsh, St. Marks Light, Wakulla County, Florida.

This cercaria is named in honor of Dr. W. Henry Leigh, who introduced the author to the discipline of helminthology.

Cercariae of this species emerged at any time provided the infected snail had been



Figures 1-6. **1.** *Cercaria leighi*, sp. nov., ventral view showing details of body and tail. **2.** Same, cercarial body, ventral view, showing details of excretory system, digestive system and primordia. **3.** Same, ventral view of cephalic organ showing penetration glands and ducts. **4.** Same, swimming posture. **5.** Same, creeping posture. **6.** Same, sporocyst.

dried prior to isolation. No phototropisms were observed. Cercariae are strong, energetic swimmers starting with a dash over an erratic path followed by a rest period. They swim in response to a light tap on the wall of the vessel. At rest, they are suspended, body downward at various levels in the water, with the tail stem flexed laterally at an angle of about 120° with the body and the furcae widely spread. After about 10 hours of swimming and rest periods, this larva settles to the bottom where creeping movement was observed for a period of about 14 hours. The life span of this cercaria is about 24 hours following emergence.

Neutral red is highly toxic, stimulating the release of penetration gland secretions and cystogenous fluids. The ceca are filled with a concentration of this stain and are readily visible. Nile blue sulfate, not as toxic as neutral red, stains the contents of the penetration glands and cystogenous glands readily.

This cercaria is most closely related to *C. caribbea* LI Cable, 1956, but differs from it in the shape of the oral sucker, presence of concretions in the excretory tubules, relative positions of flame cells in the tail stem, extent of the furcal finfold, point of convergence of the medial excretory tubules, extent of the cystogenous glands, host, and other less apparent features.

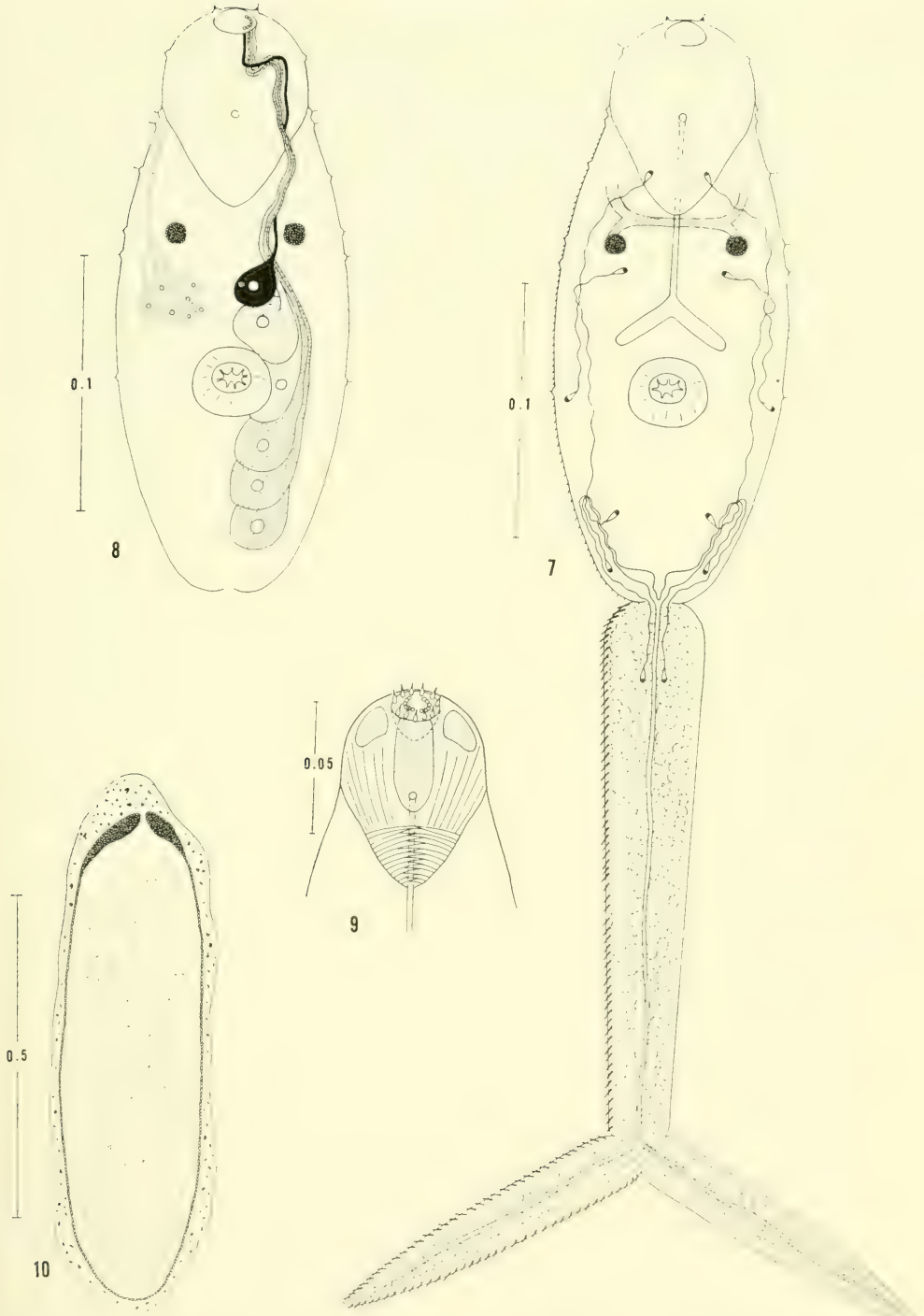
B. *Schistosome Cercaria*

A single new cercaria of the family Schistosomatidae was found. Its larval type is characterized by the fololwing general diagnosis:

Apharyngeate, distome cercariae with oral sucker replaced by a protrusible cephalic organ. Six pairs of penetration glands, one pair being exhausted in the escape from the sporocyst. Pigmented eyespots present or absent. Development in simple sporocysts in gastropods. Cercariae penetrating into final host and living as adults in the blood vascular system. Parasites of birds and mammals.

Cercaria of *Austrobilharzia penneri* Short and Holliman, 1961 (Figures 7-10)

Description: body 0.209-0.250 (0.232) long, 0.071-0.102 (0.087) wide at midbody. Tail stem, measured from body-tail junction to base of furcae on lateral surface of stem, 0.179-0.240 (0.215) long, 0.031-0.051 (0.041) wide at base. Stem and furcae filled with small vacuolated parenchyma and minute, scattered refractile granules. Body and entire tail covered with spines, those on tail coarser. Papillae and bristles on body and penetration organ; papillae on anterior tip of organ with bristles mounted on minute nipples. Penetration organ pyriform, 0.078-0.098 (0.086) long, 0.046-0.063 (0.052) wide at widest point, with distinct longitudinal and circular muscles and three indistinct granular glands (?), one elongate and medial, other two reniform to oval, and lateral. Mouth minute, ventral, subterminal; esophagus narrow; ceca short, terminating anterior to acetabulum. Cecal contents staining well with neutral red. Acetabulum 0.023-0.029 (0.024) long, 0.027-0.033 (0.030) wide, located just posterior to midbody. Six large, overlapping, granular penetration glands on each side extending from level just posterior to eyespots almost to excretory bladder. First gland (escape gland) anterior and ventral, visible only in cercariae dissected from sporocysts; next two glands finely granular; posterior 3 more coarsely granular. Single bundle of gland ducts on each side extending medially to eyespots; then anteriorly to terminal eversible depression, here ducts discharging through individual pores arranged in crescent. Margin of anterior depression ringed with approximately 11 indistinct spines directed anteriorly. Additional penetration (?) glands consisting of an undetermined number of poorly defined cells on each side, with ducts extending forward lateral to eyespots and appearing to open dorsally on cephalic organ. Right and left halves of excretory bladder separate, each half giving rise to posterior excretory duct; these converging at junction of body and tail stem, forming single duct extending through tail stem. Island of Cort absent. Caudal excretory duct bifurcating at furcal junction and discharging at tips of furcae. Main excretory tubule, on each side of body, short, receiving long anterior collecting tubule and extremely short posterior one. Flame cell formula $2[(1+1+1) + (1+1+1)] = 12$, with one pair of flame cells in base of tail. Flame cell activity increased by addition of neutral red. Eyespots circular, 0.008 in di-



Figures 7-10. **7.** Cercaria of *Austrobilharzia penneri* Short and Holliman, 1961, ventral view, showing details of body and tail. **8.** Same, ventral view of cercarial body showing small penetration glands and ducts on left side only, and large glands and ducts on right only. **9.** Same, ventral view of cephalic end showing details of penetration organ. **10.** Same, sporocyst.

ameter, each composed of small, spherical, brown granules. Cephalic ganglia readily stained with Nile blue sulfate and neutral red. Cross commissure dorsal to gut and penetration gland ducts and anterior to eyespots. Development in cream-colored, oval to cigar-shaped sporocysts in liver of snail. Sporocyst 0.357-1.29 (0.832) long, 0.180-0.300 (0.230) wide. Sporocyst wall composed of small spherical cells surrounded by granular paletot; birth pore terminal. Eight to 50 embryos per sporocyst in various stages of development.

Host: Cerithidea scalariformis Say

Incidence of infection: 24 of 10,510 snails.

Locality: Salt marsh, Shell Point, Wakulla County, Florida.

This cercaria is the larval form of *Austrobilharzia penneri* Short and Holliman, 1961, adults of which were recovered from experimentally infected chicks, parakeets and pigeons (Short and Holliman, 1961).

The cercaria swims tail first with a rapid vibration of the tail, and comes to rest on the surface of the water, dorsal side up, with tail stem held relatively straight. It has a life span at room temperature of about 36 hours. Cercariae emerged at any time after the snail had been dried for a few hours on blotting paper. No phototropisms were observed. Nile blue sulfate is toxic and neutral red slightly toxic.

This cercaria can cause a severe dermatitis in man, as the author demonstrated. Cercariae, transferred to the skin of the forearm and abdomen in a water film by a wire loop, penetrated within 5 minutes, as the water evaporated. Cercariae likewise penetrated from a vessel of seawater taped to the medial surface of the upper arm. Here again, penetration was apparently accomplished in about 5 minutes accompanied by another 5 minutes of severe itching. Formation of papules at sites of penetration was noticeable about 3 hours after exposure. About 48 hours was required for maximum dermatitis to develop. Papules remained, accompanied by itching, for a week, and were still visible at the end of 2 weeks.

The cercariae of 4 species of *Austrobilharzia* are known: *Austrobilharzia variglandis* (Miller and Northup, 1926) Penner, 1953; *Austrobilharzia terrigalensis* Johnston, 1917, as described by Bearup (1956); *C. littorinalinae* Penner, 1950; and probably *C. caribbea* XLIX Cable, 1956. *Cercaria penneri* is most closely related to C. *variglandis,* but differs from it in the relative size of cuticular spines, presence of cephalic spines, position of the tail when at rest on the surface film, and possibly in the form of the main excretory bladder ducts and bladder. *C. variglandis,* as illustrated by Stunkard and Hinchliffe (1950), has spines of uniform size covering the body and tail, with no cephalic spines around the openings of the ducts of the penetration glands. That species also rests on the surface film but the tail curves anteriad beside the body; furthermore, the main excretory ducts in the caudal end of the body are in contact; they separate in the base of the tail and then fuse to form a single caudal excretory tubule. Small, diffuse penetration glands were not reported in this cercaria.

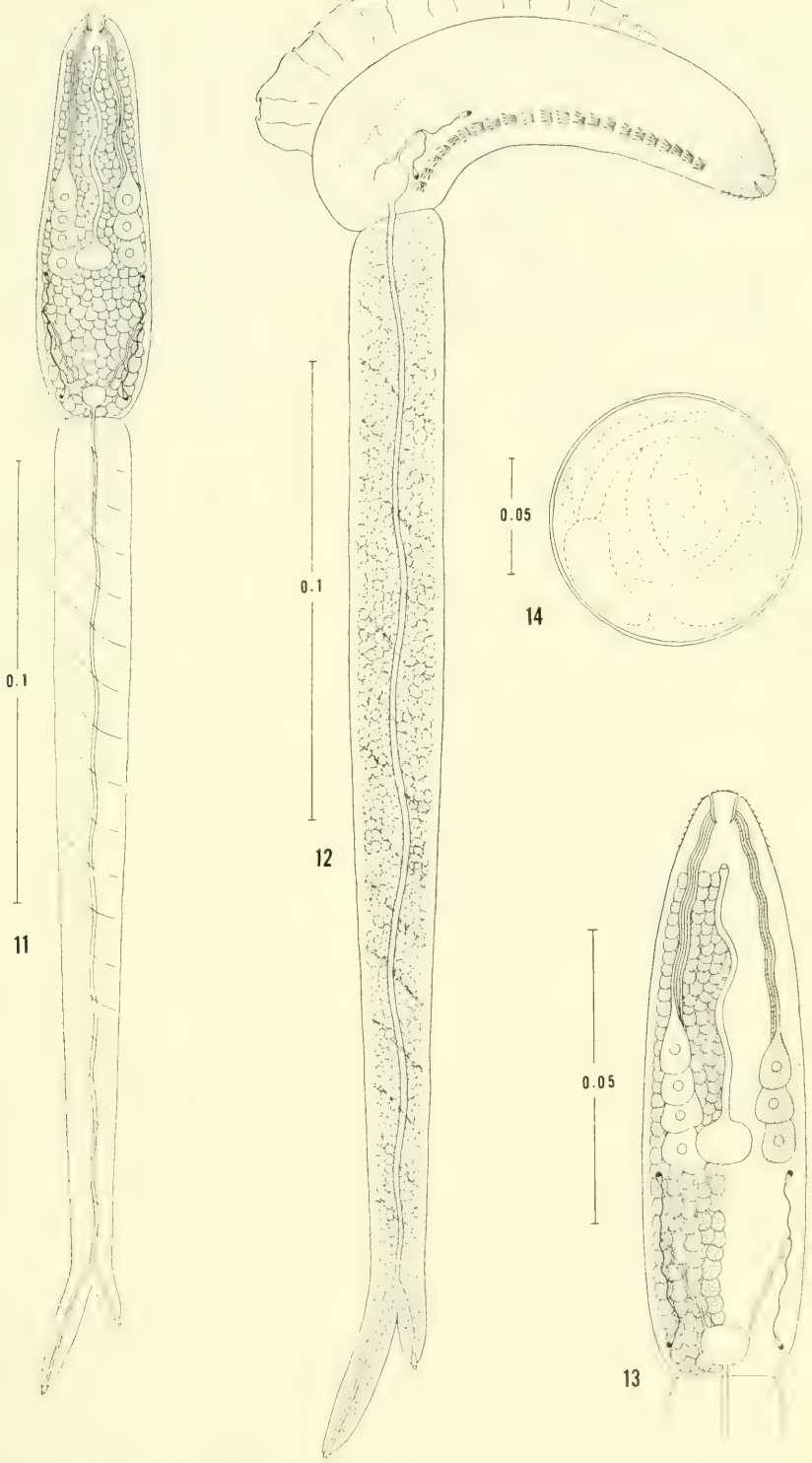
C. *Aporocotylid Cercariae*

Cercariae of the family Aporocotylidae were found. Marine larvae of that group have the following general diagnosis:

Apharyngeate, non-ocellate, brevifurcate cercariae developing in marine lamellibranchs and annelids. The tail is variously modified with symmetrical or asymmetrical furcae, no furcae, or reduced to a small pointed structure. Finfold present or absent on the dorsal body surface and on the furcae. Cephalic organ reduced or lacking; penetration gland ducts discharge through pores on spinous anterior end of body. Acetabulum absent except in *C. hartmanae* Martin, 1952. Cercariae penetrate the definitive host and develop to adult worms in the blood vascular system or rarely in the coelom of fishes.

Cercaria asymmetrica sp. nov.
(Figures 11-14)

Description: body 0.092-0.121 (0.112) long, 0.025-0.032 (0.027) in maximum width posterior to midbody. Tail stem 0.219-0.265 (0.247) long, 0.020-0.028 (0.023) in maximum width. Right furca 0.033 long; left furca 0.010 long. Body with plicated, dorsal finfold, 0.090 long and 0.008 wide. Anterior tip of body encircled with parallel rows of minute spines; cuticle of body and tail smooth with exception of a row of 22-24 groups of retrorse



Figures 11-14. **11.** *Cercaria asymmetrica,* sp. nov., ventral view showing details of body and tail. **12.** Same, lateral view showing arrangement of ventrolateral row of body spines. **13.** Same, ventral view of cercarial body. **14.** Same, sporocyst.

spines, 3 or 4 spines per group, extending most of length of each ventrolateral surface of body; spines in each group diverging from bases set close together. Body filled with granular cells making observation of internal structure difficult. Apparently four overlapping, granular penetration glands on right side and three on left side of midbody, with ducts opening at base of protrusible cephalic papilla terminal in position. Mouth subterminal, ventral; esophagus narrow, slightly sinuous, joining small, sac-shaped cecum located just posterior to midbody. Excretory bladder small, spherical. Main excretory tubules short, each receiving short anterior and posterior collecting tubule. Flame cell formula $2\ (1+1) = 4$. Caudal excretory duct extending through tail stem, bifurcating into furcae and discharging through minute vesicle at tip of each furca. Tail stem and furcae filled with vacuolated parenchyma and scattered nuclei, stem with oblique muscles giving stem spiral appearance. Development in minute, whitish, granular sporocysts in gonad of host. Sporocysts spherical to slightly oval, 0.087-0.128 (0.113) in diameter, each containing 4 to 8 embryos in various stages of development; birth pore not observed.

Host: Donax variabilis Say

Incidence of infection: 8 of 1,763 clams.

Locality: Gulf Beach, Alligator Point, Franklin County, Florida.

The specific name of this cercaria refers to its asymmetrical tail.

Spontaneous emergence of this cercaria from only 2 of the 8 clams was observed; the other 6 were diagnosed by microscopic examination of smears from the gonads, without which it was difficult to detect the presence of the parasite. *Donax variabilis* is a dioecious species in which the testes are cream colored and the ovaries pink. Because sporocysts of this cercaria are cream colored and minute, their presence may be overlooked in the normal male gonad or in the ovary of the heavily infected female. Studies of varying degrees of parasitism in both male and female *Donax* suggest that the clam may be castrated by the infection.

Exposure of infected clams to alternating periods of dark and light, and others to constant light, failed to stimulate emergence of cercariae. Such a stimulus may be concerned with tidal fluctuations, water temperature, currents, or other phenomena which are difficult to duplicate in the laboratory.

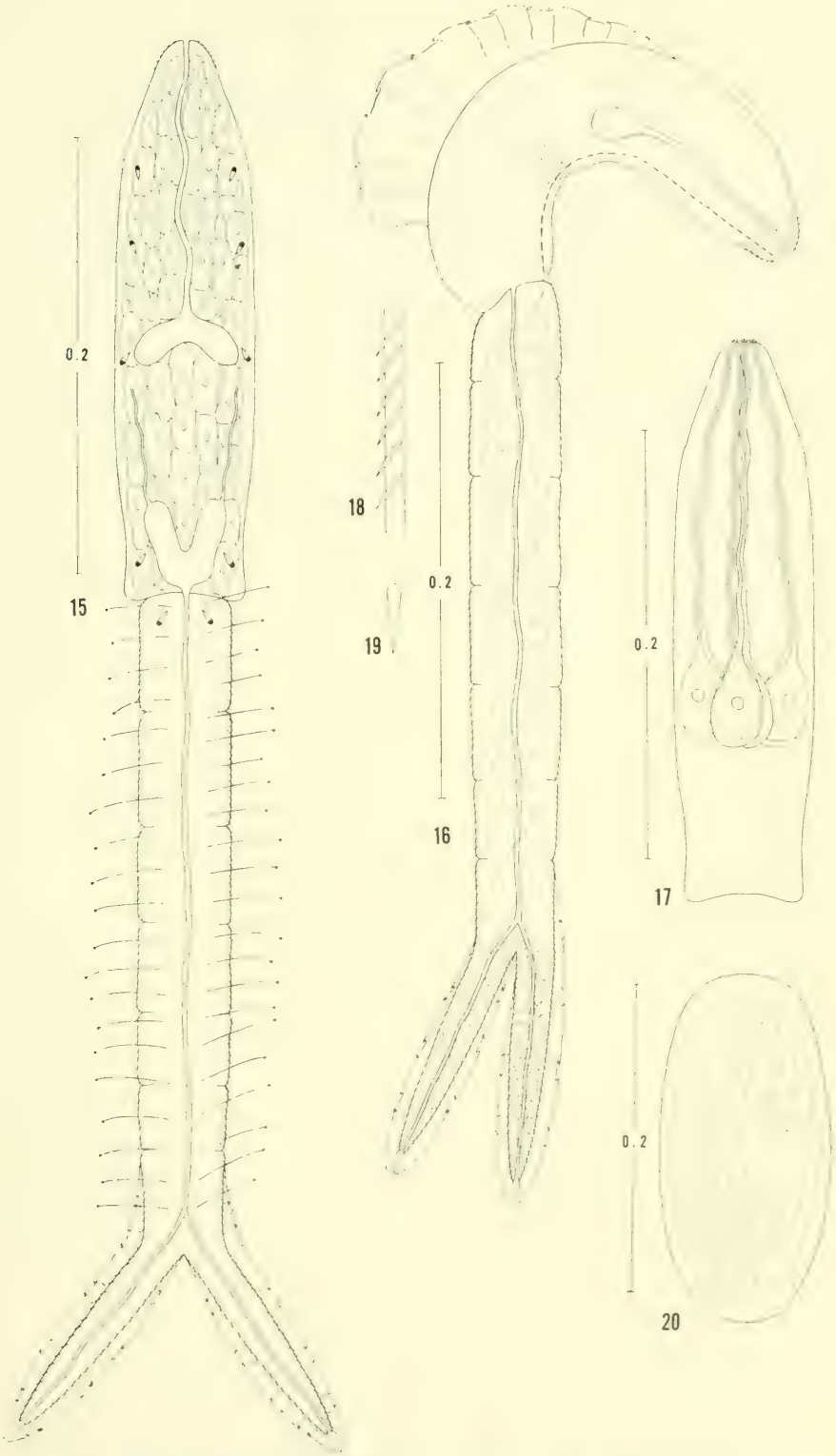
This cercaria swims with a rapid vibratory motion followed by a rest period during which it slowly sinks, with the body flexed ventrally, the tail stem straight and at a right angle to the body axis, and the furcae together. The body is capable of extension and contraction, during which time the cephalic papilla is protruded and retracted. The life span is about 12 hours. No phototropisms were observed. Neutral red stains the penetration glands and nuclei in the tail and is relatively non-toxic. Nile blue sulfate also stains the penetration glands and is toxic.

Cercaria asymmetrica does not closely resemble any of the other 4 reported species of marine aporocotylid larvae. The furcae are considerably more asymmetrical than in *C. loossi* as reported by Stunkard (1929). Ventro-lateral rows of spines on the body were reported by Martin (1944a) for *C. solemyae,* but that species has 5 pairs of penetration glands and its tail is reduced to a small, pointed structure.

Cercaria cristulata sp. nov.

(Figures 15-20)

Description: body 0.240-0.275 (0.260) long, 0.028-0.036 (0.033) wide at midbody. Tail stem 0.265-0.316 (0.297) long, 0.029-0.035 (0.032) in maximum width. Furcae 0.063-0.075 (0.068) long, 0.012-0.015 (0.014) wide at base. Plicated furcal finfold extending along entire medial and lateral surfaces of furcae and appreciably onto tail stem; lateral portion of finfold 0.085-0.098 (0.093) long, 0.007 in maximum width at about middle of furca. Dorsal finfold of body plicated, 0.107-0.133 (0.120) long, 0.025-0.029 (0.026) wide at widest point. Anterior tip of body protrusible, encircled with parallel rows of minute spines. Longitudinal row of about 94 spines on each ventro-lateral surface of body. Remainder of body smooth. Tail stem and furcae with minute spines. Body filled with large granular cells, making observation of excretory system and penetration glands difficult. Mouth terminal; esophagus narrow, slightly sinuous, bifurcating into short, wide ceca at midbody. Penetration glands located just posterior to midbody in 4 pairs, 2 lat-



Figures 15-20. **15.** *Cercaria cristulata*, sp. nov., dorsal view showing details of body and tail. **16.** Same, lateral view with ventrolateral row of spines represented by dotted line. **17.** Same, dorsal view of cercarial body showing arrangement of penetration glands. **18.** Same, longitudinal section through cuticle showing arrangement of spines in ventrolateral rows. **19.** Same, surficial view of single spine from row. **20.** Same, sporocyst.

eral, one dorsal and one ventral; their ducts extending anteriorly in four pairs to open symmetrically around mouth. Small genital primordium situated ventrally in posterior half of body. Excretory bladder small, U-shaped. Main excretory tubules discharging into anterior tip of each arm of bladder. Anterior and posterior collecting tubules not discernible. Four pairs of flame cells in body, one pair in anterior end of tail stem. Caudal excretory duct bifurcating into furcae and terminating in small vesicles opening through finfolds at tips of furcae. Dorsal surface of tail stem with right and left submedial longitudinal rows of long bristles appearing to terminate in minute knobs. Tail stem with oblique muscle fibers and scattered nuclei. Furcae filled with vacuolated parenchyma. Development in minute, oval, whitish, granular sporocysts in gonad of host. Sporocysts 0.204-0.286 (0.227) long, 0.071-0.128 (0.102) wide; each with 4 to 8 tightly packed embryos in various stages of development. Birth pore not observed.

Host: Chione cancellata Linné

Incidence of infection: One of 120 clams.

Locality: Bay mouth sand bar, Alligator Harbor, Franklin County, Florida.

The specific name of this cercaria is taken from the Latin *cristulatus,* meaning "with a small crest" and refers to the body finfold.

Naturally emerging cercariae swim with an extreme vibratory motion for a short interval followed by a rest period with gradual settling to the bottom where the tail stem is held straight and the body flexed ventrally. Creeping movement occurs only occasionally. Emergence occurs during either the day or night; life span of cercaria about 12 hours.

This larva is killed quickly with Nile blue sulfate. Neutral red is only slightly toxic and readily stains the penetration glands, their ducts, and the cecal contents. No phototropisms were observed.

This cercaria resembles *C. solemyae* Martin, 1944, and the preceding species in having longitudinal rows of body spines. It differs, however, from *C. solemyae* in almost all other morphological features (*e.g.,* size and shape of tail, number and arrangement of penetration glands, flame cell pattern, and shape of ceca). It differs from all other known marine aporocotylids by having: furcae of equal length with finfolds, 4 pairs of pentration glands and a discernible genital primordium.

D. *Fellodistomatid Cercariae*

The larvae of the family Fellodistomatidae are probably the most widely studied, yet poorly described, of all marine cercariae. The next 5 species described below are larvae in the subfamily Gymnophallinae. Cable (1953) elucidated the life cycle of *Parvatrema borinqueñae,* a marine gymnophalline having a minute, fork-tailed cercaria. He emended the Fellodistomatidae to receive the Gymnophallinae, basing his conclusions on similarities of the excretory systems, host relationships of larval forms, and morphological affinities of the adults. The Gymnophallinae, whose larvae develop in bivalves and become metacercariae in gastropods and bivalves, had formerly been included in the Microphallidae. Members of this family, however, have xiphidiocercariae developing in gastropods and encysting in various other intertebrates; whereas metacercariae of the Gymnophallinae do not encyst, but live between the mantle and shell, commonly in bivalves and rarely in gastropods. Lebour (1908, 1911), Palombi (1924), and others have described these unencysted metacercariae as cercariae, and have thus confused the literature. Giard (1907), Jameson (1902), Jameson and Nicoll (1913), and others have reported pearl formation around gymnophalline larvae in *Mytilus edulis,* due to irritation of the mantle by the metacercariae.

Stunkard and Uzmann (1958) published an excellent review of *Gymnophallus* and *Parvatrema.* They pointed out that many adult gymnophallines are not clearly distinguished by their descriptions, that little correlation has been made between known cercariae, metacercariae and adults, and that many unencysted metacercariae have been mistaken for cercariae. Concerning these two genera, they stated in conclusion that "the situation is chaotic and one of utter confusion."

Four closely related species of minute furcocercous cercariae were found in the present survey; these all probably have adults of the genus *Parvatrema.* A single species of tailless larva was found which is typical of the "cercariaeum" group proposed by

Lühe (1909) and elaborated upon by Sewell (1922) and Dubois (1929). This larva is probably a member of the genus *Gymnophallus.*

Fellodistomatid cercariae are characterized by the following general diagnosis abstracted from Cable (1956a):

Distome cercariae lacking eyespots and stylet. Tail well developed, reduced or lacking; if well developed, either trichocercous, trichofurcocercous, or furcocercous. Suckers well developed, prepharynx short or lacking, ceca varying from short and wide to slender and elongate. Excretory bladder U- or V-shaped, thin walled, with short stem and long arms extending anterior to ventral sucker; bladder more or less filled with refractile concretions. Main excretory tubules ciliated. Flame cells absent from tail stem of furcocercous forms. Caudal excretory tubule conspicuous, extending through tail stem, dividing at furcal junction and opening through pores on furcae. Development in sporocysts in marine lamellibranchs. Metacercariae in invertebrates so far as known; adults in intestines and gall bladders of aquatic birds and fishes.

Cercaria imbecilla sp. nov.
(Figures 21-22)

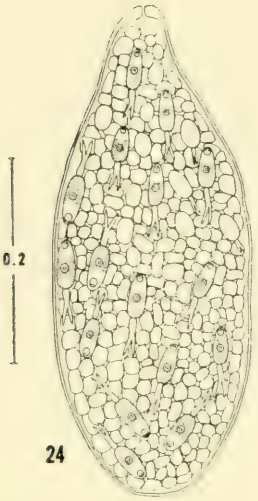
Description: furcocercous gymnophalline larva. Body 0.122-0.133 (0.128) long, 0.036-0.046 (0.040) wide at level of acetabulum. Tail stem 0.037-0.038 (0.037) long from point of attachment to posterior notch between furcae, 0.016-0.017 (0.016) wide at base. Furcae 0.035-0.037 (0.035) long, 0.009-0.010 (0.009) wide at base. Oral sucker 0.028-0.030 (0.029) long, 0.023-0.025 (0.024) wide; mouth subterminal; prepharynx absent; pharynx 0.012-0.013 (0.012) long, 0.010-0.012 (0.011) wide; esophagus long; ceca short, thick walled, extending only slightly posterior to anterior edge of acetabulum. Acetabulum 0.022 long, 0.022-0.024 (0.023) wide, located in posterior half of body, with double row of minute spines in cavity. Entire body and tail spinose; anterior half of body with scattered bristles. Two pairs of submedial penetration glands dorsal to ceca. Anterior gland of each pair just anterior to cecum, overlapping anteromedial border of excretory bladder arm; posterior gland overlapping cecum and medial border of excretory bladder arm, conforming to anterior curvature of acetabulum, and only slightly overlapping its anterior border. Two pairs of penetration gland ducts adhering closely to esophagus and pharynx, passing dorsally to oral sucker, and discharging through individual pores on dorsal lip. Excretory bladder U-shaped with arms extending just beyond bifurcation of gut, with spherical to oval concretions. Ciliated main excretory tubules joining anterolateral margins of arms, extending anteriorly a short distance and receiving anterior and posterior collecting tubule. Excretory tubules and flame cells visible only after staining with Nile blue sulfate. Flame cell formula $2[(1)+(1)]=4$. Caudal excretory pores on posteromedial surface of each furca near tip. Body filled with indistinct, large, lightly granular cells. Tail with many minute nuclei. Development in cream colored, saccular sporocysts infiltrating gonad of host; wall composed of minute spherical cells. Sporocysts 0.347-0.719 (0.479) long, 0.133-0.250 (0.190) wide. About 50-300 densely packed embryos in all stages of development per sporocyst; birth pore terminal.

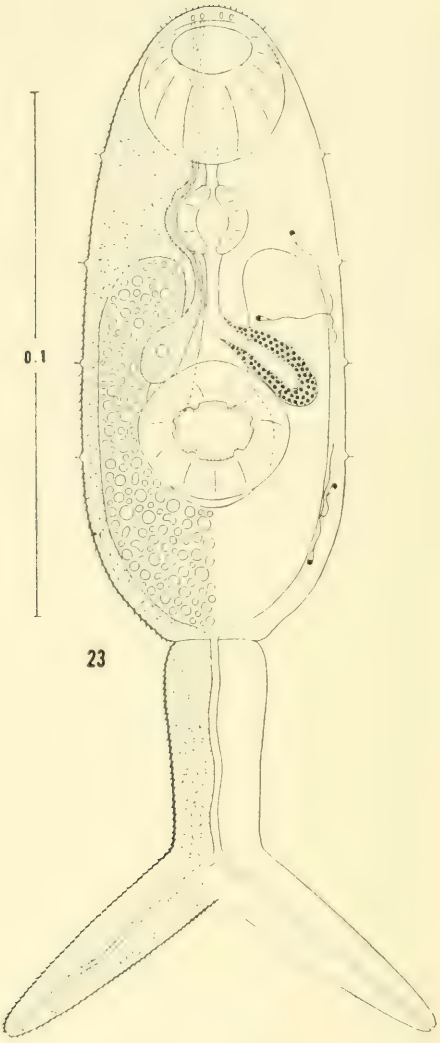
Host: Mulinia lateralis Say
Incidence of infection: 30 of 446 clams.
Locality: Salt marsh, St. Marks Light, Wakulla County, Florida.

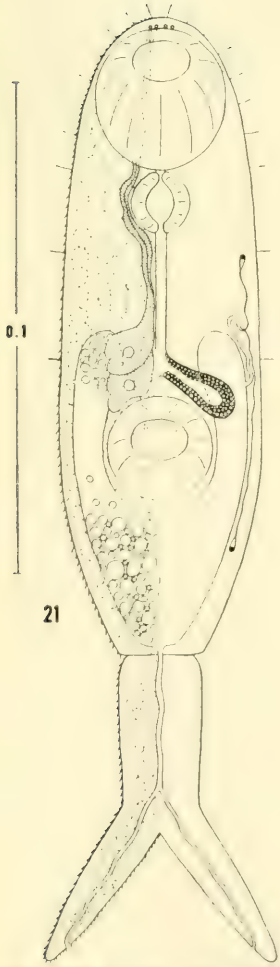
The specific name of this cercaria is taken from the Latin *imbecillus,* meaning "feeble" and refers to the swimming ability of the species.

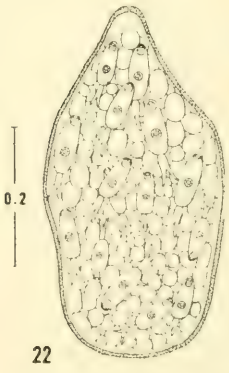
This minute species emerges at all hours and displays no phototropisms. The life span is about 18 hours. Neutral red is slightly toxic and stains the granular cells of the cecal walls and the penetration glands. Nile blue sulfate, which is more toxic and kills cercariae in about 10 minutes, stains the penetration glands, stimulates flame cell activity, and causes the enlargement of the excretory tubules. Swimming is typical of small furcocercous gymnophalline larvae; the tail lashes feebly from side to side with the body flexed ventrally and hanging downward. Periods of swimming alternate with creeping on the bottom with the furcae held together.

This cercaria differs from any previously described larvae of its type in having the combined features of 2 pairs of penetration glands, 2 pairs of flame cells, excretory pores









Figures 21-24. **21.** *Cercaria imbecilla*, sp. nov., ventral view showing details of body and tail. **22.** Same, sporocyst. **23.** *Cercaria fragosa*, sp. nov., ventral view showing details of body and tail. **24.** Same, sporocyst.

on posteromedial surfaces of furcae and uneven distribution of concretions in the excretory bladder. It resembles *C. pusilla* (described below); both have the same excretory formula, same number of penetration glands, similar digestive system and similar location of excretory pores but differ in respects that will be given in discussing *C. pusilla.*

Cercaria fragosa, sp. nov.
(Figures 23-24)

Description: furcocercous gymnophalline larva. Body 0.110-0.125 (0.118), long, 0.041-0.053 (0.048) wide at level of ventral sucker. Tail stem 0.044-0.048 (0.047) long from point of attachment to posterior notch between furcae, 0.018-0.016 (0.017) wide at base. Furcae 0.044-0.047 (0.046) long, 0.009-0.010 (0.010) wide at base. Oral sucker 0.025-0.030 (0.028) in diameter; mouth subterminal; prepharynx very short. Pharynx 0.012-0.014 (0.012) long, 0.014-0.016 (0.014) wide; esophagus 0.012 long; ceca short, thick walled, conforming to and only slightly overlapping anterior margin of acetabulum. Acetabulum 0.025-0.031 (0.028) long, 0.027-0.032 (0.030) wide, in posterior half of body. Several rows of minute spines lining cavity, with six papillae around opening of sucker. Entire body and tail spinose. Cephalic region with fine bristles. Body surface between posterior margins of oral and ventral suckers with scattered short bristles set in papillae. Two pairs of penetration glands, submedial and dorsal to ceca. Anterior glands overlapping medial border of excretory bladder arm and cecum; posterior glands overlapping medial border of bladder arm and anterior border of acetabulum; their ducts as in preceding species. Excretory bladder U-shaped, each arm with short median bulge at anterior margin of ventral sucker, with anterior extension of arm barely or not quite reaching level of pharynx. Spherical, oval and reniform concretions filling excretory bladder. Excretory tubules not visible; four pairs of flame cells. Flame cell formula probably $2[(2) + (2)] = 8$. Caudal excretory pores at furcal tips. Body filled with indistinct, lightly granular cells. Tail with many minute nuclei. Development in whitish, saccular sporocysts with thin, smooth walls in liver and gonad of host. Sporocyst 0.315-0.735 (0.500) long, 0.120-0.270 (0.194) wide. About 50-150 densely packed embryos in all stages of development per sporocyst; birth pore terminal.

Host: Donax variabilis Say

Incidence of Infection: 18 of 1763 clams.

Locality: Gulf beach, Alligator Point, Franklin County, Florida.

The specific name of this cercaria is taken from the Latin *fragosa,* meaning "fragile."

This species was not observed to emerge spontaneously. It may do so and reenter the molluscan host, which would account for the large number of metacercariae found in the mantle chambers of *Donax variabilis* that did not harbor sporocysts. To recover mature cercariae for this study, sporocysts were teased from the gonad of the host, and only those cercariae which freely emerged from the sporocysts were used. No phototropisms were observed. Neutral red, only mildly toxic, stains the granular ceca and their contents, and the penetration glands. Nile blue sulfate, also only mildly toxic, stimulates flame cell activity and stains the ceca, their contents and the penetration glands. The swimming movements of this form are typical for the group.

This cercaria appears to be most closely related to the cercaria of *Parvatrema donacis* Hopkins, 1958, from *Donax variabilis* collected at Mustang Island, Texas. The following table is a comparison of certain features of these two forms. The differences indicated are considered to be of specific value.

	Cercaria of *Parvatrema donacis*	*Cercaria fragosa,* sp. nov.
Penetration glands	"too inconspicuous to count"	2 pairs
Flame cells	3 pairs on each side	$2[(2) + (2)] = 8$
Papillae and bristles	none noted	on body
Embryos per sporcoyst	6	50-150

Cercaria pusilla, sp. nov.
(Figures 25-26)

Description: furcocercous gymnophalline larva. Body 0.122-0.153 (0.139) long, 0.046-0.056 (0.052) wide at level of acetabulum. Tail stem 0.036-0.040 (0.037) from point of attachment to notch between furcae, 0.015-0.017 (0.016) wide at base. Furcae 0.046-0.053 (0.051) long, 0.009-0.010 (0.010) wide at base. Oral sucker 0.023-0.026 (0.025) in diameter; mouth subterminal; prepharynx extremely short; pharynx 0.015

0.017 (0.015) long, 0.012-0.014 (0.013) wide; esophagus long; ceca short, with thick, granular walls only slightly overlapping anterior margin of ventral sucker. Ventral sucker 0.023-0.025 (0.024) in diameter, in posterior half of body and with several rows of minute spines inside its cavity. Body and tail entirely spinose except narrow perimeter around mouth. Body, anterior to ventral sucker, with short bristles, densest and slightly shorter in cephalic region. Two pairs of small penetration glands in close proximity to esophagus. Anterior glands just overlapping anterior arms of excretory vesicle; posterior glands overlapping anteromedial borders of excretory arms, and reaching level of gut bifurcation; their ducts extend anteriorly, passing around pharynx and dorsal of oral sucker to open individually on dorsal lip. Genital primordium medial, just anterior to acetabulum. Excretory bladder U-shaped with arms extending slightly anterior to gut bifurcation; filled with spherical concretions. A short ciliated main excretory tubule joining the anterolateral region of each arm, and extending anteriorly to receive anterior and posterior collecting tubule, each draining one flame cell. Flame cell formula $2[(1) + (1)] = 4$. Caudal excretory pores on the posteromedial surfaces of furcae. Body filled with indistinct, large, lightly granular cells. Development in cream colored, saccular sporocysts in gonad of host; their walls thin and smooth. Sporocysts 0.420-0.735 (0.570) long, 0.120-0.180 (0.146) wide. About 40-200 densely packed embryos in all stages of development per sporocyst; birth pore terminal.

Host: Chione cancellata Linné

Incidence of infection: 3 of 120 clams.

Locality: Bay mouth sand bar, Alligator Harbor, Franklin County, Florida.

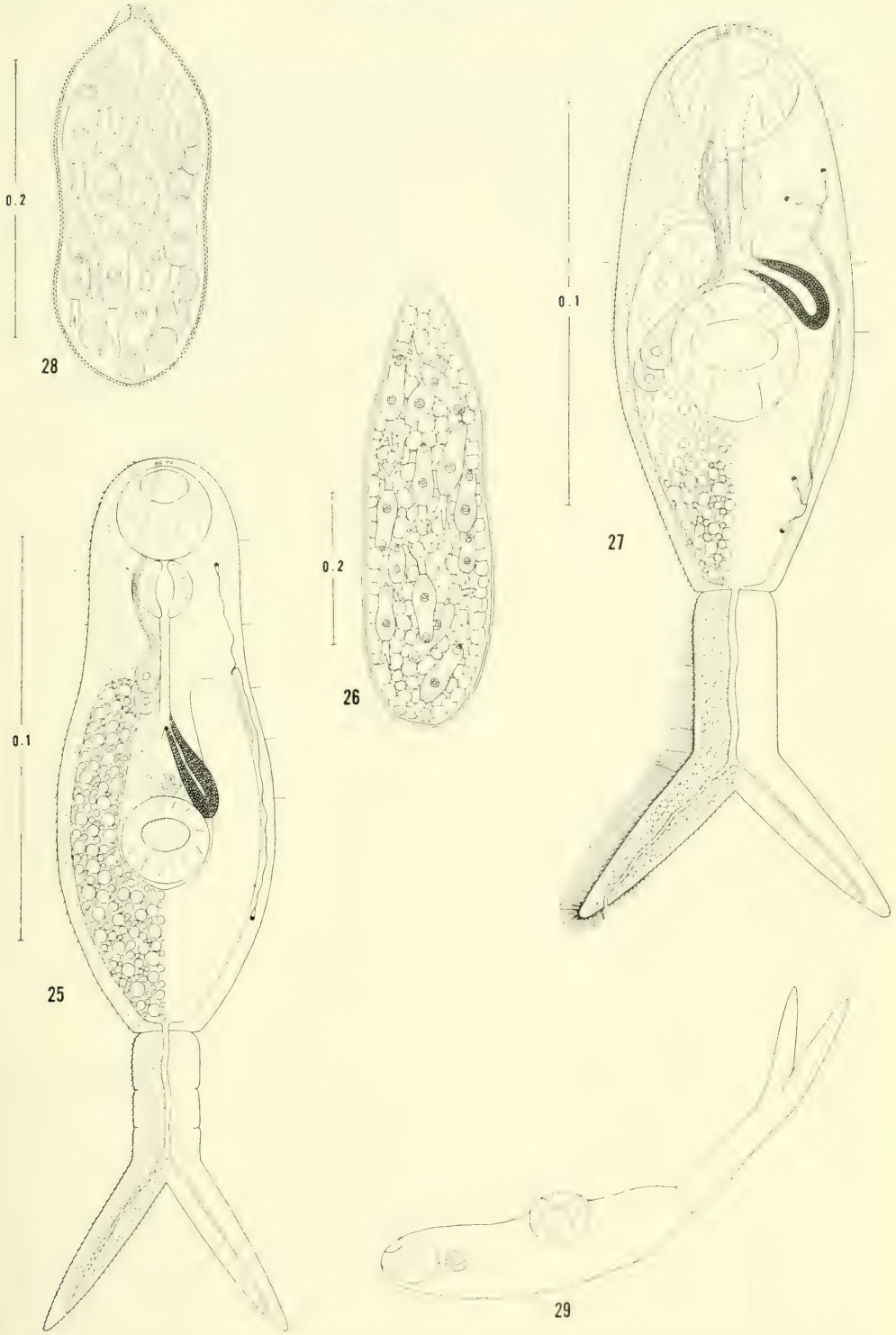
The specific name of this larva is taken from the Latin *pusillus,* meaning "weak" or "very small."

This cercaria emerges at any hour in small numbers, and displays no phototropisms. Neutral red is moderately toxic and stains the walls of the ceca. Nile blue sulfate is very toxic and also stains the ceca. The penetration glands do not react to either stain. The swimming movements are typical for this group.

This cercaria resembles *Cerceria imbecilla* but differs from it in the size, position and staining reaction of the penetration glands, host, presence of the genital primordium, distribution of concretions in the excretory vesicle, and the position of flame cells. *C. imbecilla* and *C. pusilla* are both closely related to the larva of *Parvatrema borinqueñae* Cable, 1953, but differ from it in having 2 pairs of pentration glands instead of one pair, and by lacking medial bulges of the excretory bladder arms.

Cercaria fimbriata, sp. nov.
(Figures 27-29)

Description: furcocercous gymnophalline larva. Body 0.128-0.153 (0.140) long, 0.053-0.063 (0.059) wide at level of acetabulum. Tail stem 0.047-0.052 (0.049) long from point of attachment to posterior notch between furcae, 0.018-0.021 (0.019) wide at base. Furcae 0.047-0.051 (0.049) long, 0.012-0.014 (0.013) wide at base. Oral sucker 0.026-0.032 (0.029) long, 0.028-0.035 (0.031) wide; mouth subterminal; prepharynx very short; pharynx 0.013-0.016 (0.014) in diameter; esophagus long; ceca short, thick walled, conforming to anterior curvature of acetabulum but not quite touching it. Acetabulum 0.031-0.037 (0.034) long, 0.030-0.033 (0.031) wide, located just posterior to midbody. Entire body and tail spinose. Anterior half of body with scattered bristles, those at cephalic end of two lengths. Lateral surfaces of tail stem and furcae covered with dense brush-like bristles diminishing in length and disappearing about half way up medial surfaces of furcae. Two pairs of small penetration glands, lateral to acetabulum and overlapping arm of excretory vesicle; their ducts passing anteriorly dorsal to ceca and oral sucker to open separately at pores on dorsal lip. Excretory bladder U-shaped with arms extending to mid-esophageal level; with spherical concretions less numerous in arms than in body of bladder; a ciliated, main excretory tubule joins each arm middorsally, some distance from its anterior end, extends laterally a short distance to receive short anterior and long posterior collecting tubule, both ciliated. Flame cell formula $2[(2) + (2)] = 8$. Excretory system of tail as in preceding species. Body filled with indistinct, lightly granular cells. Development in saccular, white sporocysts in gonad of host, their walls with minute, spherical nuclei imparting a granular appear-



Figures 25-29. **25.** *Cercaria pusilla*, sp. nov., ventral view showing details of body and tail. **26.** Same, sporocyst. **27.** *Cercaria fimbriata*, sp. nov., ventral view showing details of body and tail. **28.** Same, sporocyst. **29.** *Cercaria imbecilla*, sp. nov., *C. fragosa*, sp. nov., *C. pusilla*, sp. nov., and *C. fimbriata*, sp. nov., lateral view showing swimming posture.

ance. Sporocyst 0.219-0.444 (0.278) long, 0.087-0.128 (0.108) wide. About 10-30 embryos per sporocyst in all stages of development; birth pore terminal. Light stimulates movement of immature cercariae within sporocyst.

Host: Semele proficua Pulteney

Incidence of infection: 7 of 9 clams.

Locality: Salt marsh, north of St. Marks Light, Wakulla County, Florida.

The specific name of this larva is taken from the Latin *fimbriatus,* meaning "fringed," as applied to the tail.

This cercaria emerges in response to light, is phorotropic, and has a life span of about 12 hours. Neutral red is not toxic and stains the ceca and their contents, whereas Nile blue sulfate is very toxic, stains the cecal contents, stimulates flame cell activity and causes the enlargement of the excretory tubules; neither stains the penetration glands.

The swimming movements are typical of the group. If the container is tapped gently, the cercariae contract suddenly. After a few seconds they slowly begin to relax and return to swimming. At rest, they sink to the bottom and lie motionless or show creeping movements.

This cercaria resembles *Cercaria fragosa* but differs from it in body and tail bristles, position and size of penetration glands, and distinctness of main collecting tubules.

The insertion of the main excretory tubules on the dorsal surface of the excretory bladder arms has been reported also for the metacercaria of *Parvatrema borinqueñae* Cable, 1956, and for the cercaria of *Parvatrema donacis* Hopkins, 1958.

Cercaria granosa, sp. nov.
(Figures 30-32)

Description: tailless gymnophalline larva. Body 0.230-0.255 (0.243) long, 0.102-0.143 (0.126) in maximum width slightly anterior to level of ventral sucker. Oral sucker 0.059-0.070 (0.064) long, 0.066-0.076 (0.072) wide including pair of large lateral papillae; mouth subterminal with 8 surrounding papillae; prepharynx absent; pharynx 0.018-0.023 (0.022) long, 0.021-0.026 (0.023) wide; esophagus very short; ceca short, voluminous, filling body to posterior margin of acetabulum, and containing spherical and rod-shaped granules and large hyaline globules. Acetabulum 0.028-0.035 (0.031) in diameter, with 5 papillae bordering its cavity. Dorsal body surface with parallel rows of small spines; those on ventral surface even smaller; bristles scattered over body surface, those in cephalic region set in papillae. Additional papillae on anterior rim of oral sucker. Nine small penetration glands on each side of pharynx and along posterior edge of oral sucker, some separate and some in groups with their arrangement laterally from pharynx apparently being 3, 1, 2, 1, 1, 1, with ducts opening at anterior end of body. Excretory bladder Y-shaped with short stem and canal with pore at posterior end of body, and long arms extending to sides of oral sucker. Bladder filled with spherical concretions of various sizes. A short anterior and long posterior collecting tubule joining to form short, ciliated main tubule discharging into lateral margin of bladder arm. Flame cell formula $2[(2+2)+(2)]=12$. Primordium of ovary between anterior margin of acetabulum and bifurcation of ceca; testicular primordium on each side of excretory vesicle occupying indentations in the margins of vesicle. Primordia best observed when stained with neutral red. Indistinct, lightly granular cells in body obscured by contents of ceca and excretory vesicle. Development in light-orange, thin walled sporocysts in gonad of host. Sporocyst 0.306-0.403 (0.355) long, 0.112-0.194 (0.148) wide. Not more than 4 embryos per sporocyst in various stages of development. Birth pore not observed.

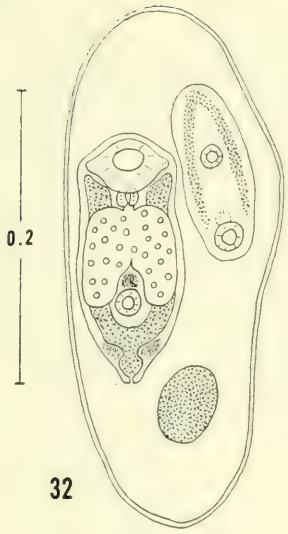
Host: Mulinia lateralis Say

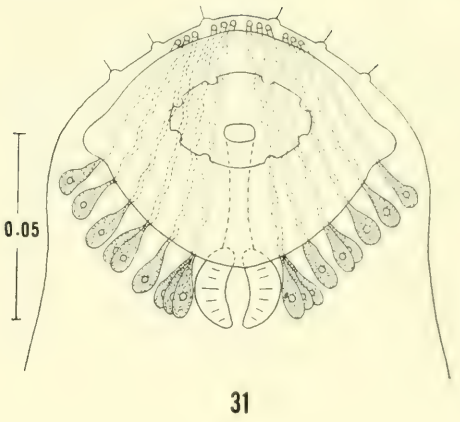
Incidence of infection: 56 of 446 clams.

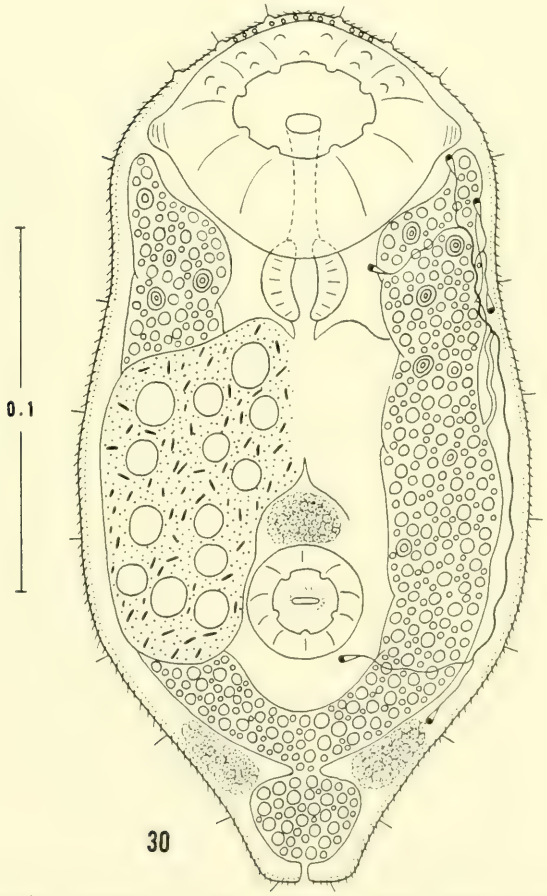
Locality: Salt marsh, St. Marks Light (type locality), and Live Oak Point, Wakulla County, Florida.

The specific name of this cercaria is taken from the Latin *granosus,* meaning "full of grains" and refers to the contents of the ceca and excretory vesicle.

Spontaneous emergence of this larva from the host was not observed. The above description is based on cercariae that freely emerged from sporocysts teased from the gonad of the host. Although lacking a tail and unable to swim, this species creeps on the bottom, using the suckers for holdfasts. No phototropisms were observed. Neutral red, only slightly toxic, stains the cecal contents and the genital primordia. Nile blue sulfate, which is more toxic,







Figures 30-32. **30.** *Cercaria granosa*, sp. nov., ventral view showing details of body. **31.** Same, ventral view of cephalic end showing cephalic glands and ducts. **32.** Same, sporocyst.

stains the pentration glands and their ducts.

This larva probably becomes the metacercaria found unencysted on the mantles of *Cerithidea scalariformis* in the same localities. Almost all these snails are infected with this metacercaria that appears slightly larger than *Cercaria granosa,* and has a greater development of the genital primordia..

Cercaria granosa resembles *C. cambrensis* Cole, 1938, from *Cardium edule,* but differs from that species in respects summarized as follows:

Cercaria cambrensis Cole, 1938	*Cercaria granosa* sp. nov.
Testicular primordia present, ovarian absent	Testicular and ovarian primordia present
Oral sucker small, lateral papillae absent	Oral sucker large, with lateral papilla
Two anterior flame cells 4 posterior	Four anterior flame cells, 2 posterior
Ceca thick walled, anterior to acetabulum	Ceca thin walled, extending behind acetabulum

The relationship of cercariae of this type to the adults of the genus *Gymnophallus* has been established by Jameson (1902), Lebour (1908, 1911), Dollfus (1912), and Jameson and Nicoll (1913).

E. *Bucephalid Cercaria*

A single representative of this group is reported here.

Cercariae of the family Bucephalidae are characterized by the following general diagnosis:

Modified furcocercous cercariae with short, wide tail stem and furcae of complex structure that are long and extensile. Mouth ventral, near midbody, opening through pharynx into rhabdocoele intestine. Cephalic organ glandular, not associated with digestive tract. Development in branched sporocysts in marine and fresh water lamellibranchs.

Cercaria apalachiensis, sp. nov.
(Figures 33-36)

Description: body 0.153-0.209 (0.193) long, 0.051-0.061 (0.057) wide at midbody. Basal portion of tail stem 0.056-0.066 (0.061) long, 0.112-0.143 (0.130) wide. Furcae about 1.53 long, 0.015-0.020 (0.017) wide at base. Cephalic organ 0.044-0.058 (0.052) long, 0.030-0.037 (0.033) wide, with subterminal, mouth-like depression into which open ducts of undetermined number of penetration glands contained in organ. Cephalic organ slightly protrusible through depression, latter surrounded by 5 lips. Pharynx spherical, located just posterior to midbody, 0.012-0.016 (0.014) in diameter; cecum short, thick walled, with its free end pointing anteriorly. Cuticle of body spinose. Excretory bladder saccular, extending about half way from posterior end of body to pharynx; excretory pore at junction of body and basal portion of tail. Excretory tubules obscured by dense cystogenous cells. Six flame cells on each side, 2 pairs just behind cephalic organ, 4 pairs posterior to pharynx. Genital primordium medial, just posterior to pharynx. Oval, granular cystogenous cells in body so arranged to cause clear longitudinal area, devoid of cells on each side. Tail stem crenate and anteriorly granular, with numerous muscle fibers and scattered nuclei; posterior area of stem with many minute nuclei. Furcae granular, with rough cuticle. Development in whitish, granular, greatly branched sporocysts infiltrating gonad and liver of host. Sporocysts not measured.

Host: Mulinia lateralis Say

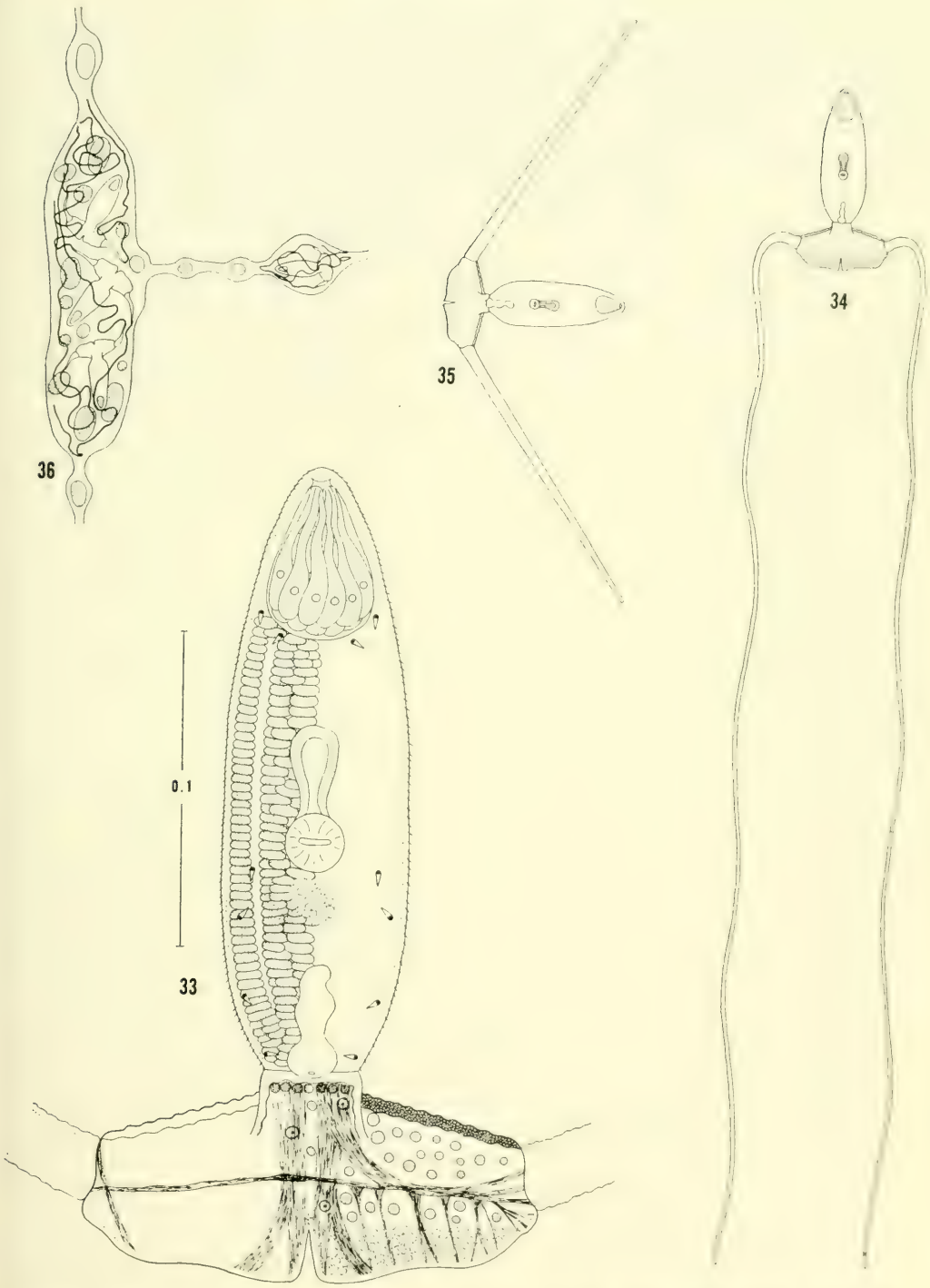
Incidence of infection: 1 of 446 clams.

Locality: Salt marsh, Live Oak Point, Wakulla County, Florida.

The specific name of this cercaria is based on the Indian word *Apalachee,* referring to the type locality.

This species emerges at any hour, day or night, in small numbers, and displays no phototropisms. It has a life span of about 18 hours. Neutral red, which does not seem to impair vitality, readily stains the genital primordium and the penetration glands. Nile blue sulfate is highly toxic and kills the cercaria quickly before stain reactions can be noted. No true swimming movements were observed, although the furcae elongate and contract. When water containing these cercariae is stirred, the furcae are violently contracted to about twice the body length and are temporarily oriented at an angle of about 60 degrees with the body in a rod-like manner (Figure 35). As the turbulence in the water subsides, the furcae slowly extend and form tangled masses. Cable (1956a) described a marine bucephalid cercaria from Puerto Rico that responded to agitation in water as does *Cercaria apalachiensis.*

Most of the published descriptions of marine bucephalid larvae are inadequate for comparison. Cable's (1956a) description of



Figures 33-36. **33.** *Cercaria apalachiensis*, sp. nov., ventral view of cercarial body and tail stem. **34.** Same, ventral view of resting posture. **35.** Same, ventral view, of posture after furcal contraction. **36.** Same, segment of sporocyst.

C. caribbea XLII is an exception. *C. apalachiensis* differs from it in having the combined features of a saccular excretory bladder, location of the genital primordium, and a distinctive tail stem.

F. *Echinostomatoid Cercariae*

The largest group of closely related cercariae recorded in the present study belong to the superfamily Echinostomatoidea. Three species, *C. favulosa, C. fuscata,* and *C. pustulosa* are new. Three species, cercaria of *Parorchis acanthus* (Nicoll, 1906), *Cercaria caribbea* III Cable, 1956, and cercaria of *Himasthla quissetensis* (Miller and Northup, 1926) are redescribed, with new information on their morphology and behavior.

Marine echinostomatoid cercariae are characterized by the following general diagnosis:

Distome cercariae bearing a cephalic collar, well-developed suckers and a non-bifurcated tail. Collar may be armed with a row of spines interrupted by an unarmed ventral space, or unarmed "Echinostomoid" group, Cable (1956a). Prepharynx and pharynx present, esophagus long, bifurcating anterior to ventral sucker. Excretory system with anterior and posterior secondary tubules which join ascending primary tubule at midbody, extend to anterior end of body, turn posteriorly, and empty into ante-chamber or directly into bladder. Rarely, a single secondary tubule may form ascending primary tubule in posterior end of body. Excretory bladder thin walled, spherical or sacculate; refractile concretions sometimes present in bladder and descending primary tubules. Body filled with dense cystogenous glands. Produced by rediae in gastropods. Encystment in snails, lamellibranchs, fishes or on substrate.

The first three cercariae in the following descriptions are placed in the Echinostomatidae and the remaining three in the Philophthalmidae. Philophthalmid cercariae, as have been described for *Parorchis, Philophthalmus* and *Cloacitrema,* have invaginated, glandular tail tips.

a. *Echinostomatid Cercariae*

Cercaria fuscata, sp. nov.

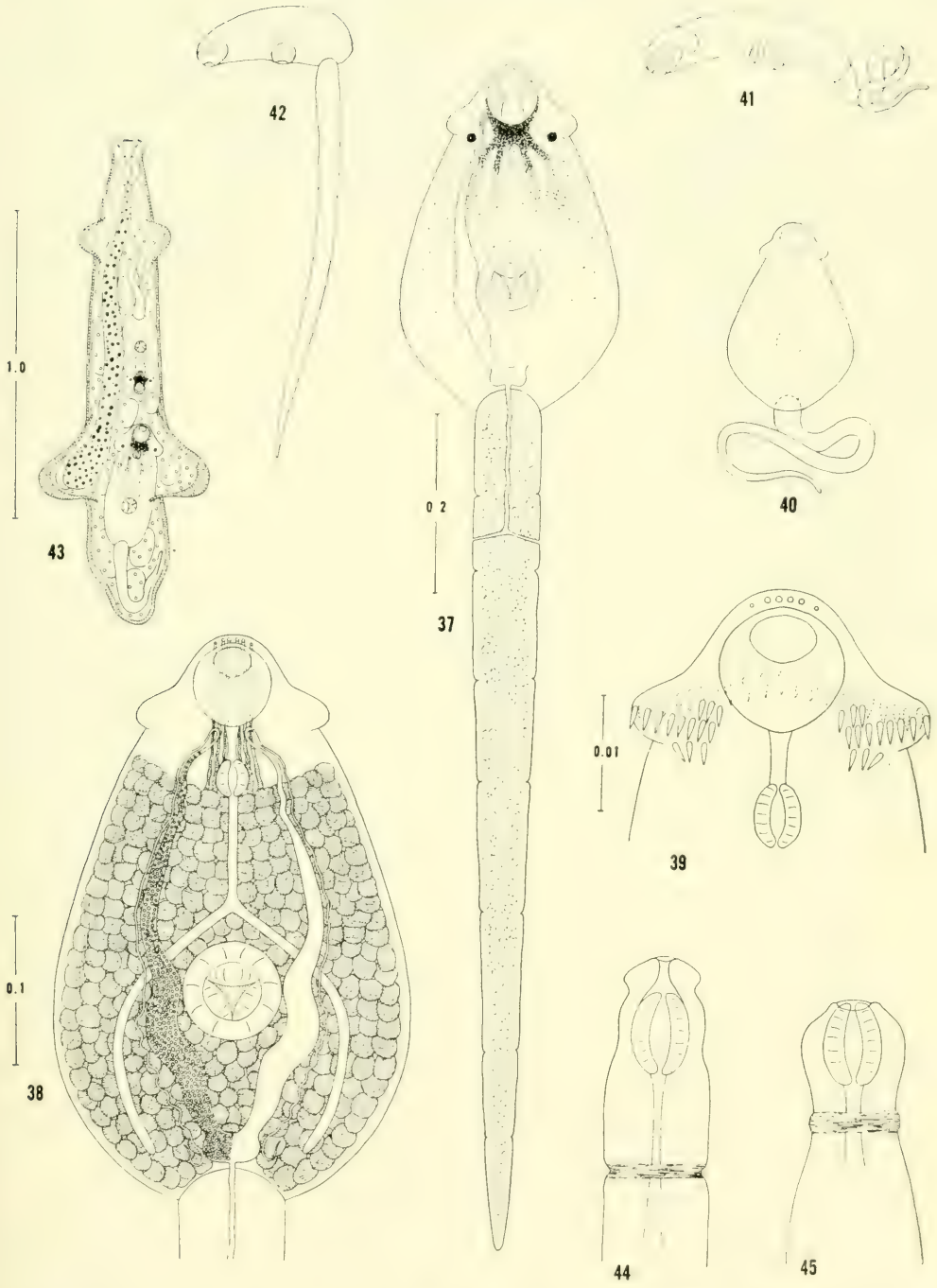
(Figures 37-45)

Description: body 0.306-0.408 (0.376) long, 0.219-0.255 (0.237) wide at posterior margin of acetabulum. Tail 0.870-1.035 (0.942) long, 0.066-0.077 (0.072) wide at base. Oral sucker 0.052-0.062 (0.056) long, 0.051-0.054 (0.052) wide; mouth subterminal; prepharynx 0.012-0.025 (0.022) long; pharynx 0.023-0.028 (0.025) long, 0.015-0.022 (0.018) wide; esophagus long, bifurcating at about 3/4 distance from pharynx to acetabulum; ceca narrow, extending to level of excretory bladder. Acetabulum posterior to midbody, 0.064-0.072 (0.068) long, 0.067-0.071 (0.069) wide. Body and tail smooth; papillae and bristles absent. Collar 0.112-0.128 (0.120) wide with 49 spines 0.015 long, arranged in a single row of 37 interrupted ventrally with 3 anterior and 3 posterior angle spines on each side. Body with dorsal layer of dense, rod-filled cystogenous cells obscuring many internal structures including cephalic ganglia, cephalic glands, and fine details of the excretory system. Cephalic glands poorly defined with ducts close to each side of pharynx and prepharynx, passing dorsally to oral sucker to open at small lateral, and 2 larger and more medial pores. Excretory bladder small, oval, receiving wide, descending limbs originating from narrow, ciliated ascending tubules at posterior margin of the oral sucker; secondary tubules, obscured by cystogenous glands, forming ascending limbs at level of excretory bladder. Bladder and descending limbs filled with small, spherical concretions. Caudal excretory tubule extending 1/6 length of tail to bifurcate and open on sides of tail. Two small eyespots of granular pigment lateral to prepharynx. Anterior 2/3 of body with similar pigment being generally denser anteriorly and concentrated around posterior margin of oral sucker to form dark zone with 4 streaks extending posteriorly to blend with granular pigmentation of forebody. Development in orange-brown rediae parasitizing liver and gonad of host and measuring 1.125-1.815 (1.586) long, 0.225-0.330 (0.282) wide; with appendages well developed; cuticle thick; cecum yellow-orange, granular, reaching level of posterior appendages; average of 10 embryos per redia, in all stages of development. Birth pore dorsal, just posterior to anterior appendages. Flame cells not apparent.

Host: *Cerithidea scalariformis* Say

Incidence of infection: 19 of 5,508 snails.

Locality: Salt marsh, St. Marks Light



Figures 37-45. **37.** *Cercaria fuscata*, sp. nov., ventral view showing body pigmentation and tail structure. **38.** Same, ventral view of cercarial body. **39.** Same, ventral view of cephalic end showing collar spines. **40.** Same, dorsal view showing swimming posture. **41.** Same, lateral view showing swimming posture. **42.** Same, lateral view showing posture when cercaria is killed in formalin. **43.** Same, redia. **44.** Same, cephalic end of redia extended. **45.** Same, cephalic end of redia retracted.

(type locality), and Shell Point, Wakulla County, Florida.

The name of this cercaria is from the Latin *fuscatus,* meaning "dusky" and refers to the pigmentation of the body.

This larva emerges in small numbers after the host has been dried and then immersed. It is positively phototropic, and has a life span of about 24 hours if encystment does not occur. Encystment can be stimulated by evaporation, cover slip pressure and vital dyes. The cyst is very similar to that of *Cercaria favulosa,* except for the brown tint imparted by pigment in *C. fuscata.* Nile blue sulfate is more toxic than neutral red and neither is specific for particular structures.

This cercaria is a strong, active swimmer, lashing the tail from side to side in a figure 8 motion while driving the vibrating body forward through the water either dorsally or ventrally oriented. The body is contracted and slightly flexed ventrally while swimming (Figures 40, 41). At rest, the larva lies on the bottom with body contracted and tail extended, prior to encystment. Cercariae preserved in formalin have the tail extended and at a right angle to the body axis (Figure 42).

This cercaria differs from all other marine echinostomes by having 49 collar spines and pigment scattered throughout the body.

Cercaria of *Himasthla quissetensis*
(Miller and Northup, 1926)
(Figures 46-50)

Description: body 0.418-0.530 (0.468) long, 0.112-0.143 (0.127) wide at level of acetabulum. Tail 0.316-0.352 (0.332) long, 0.031-0.036 (0.033) wide at base. Oral sucker 0.040-0.044 (0.042) in diameter; mouth subterminal; prepharynx 0.020-0.031 (0.024) long; pharynx 0.022-0.025 (0.025) long, 0.017 -0.022 (0.019) wide; esophagus long, bifurcating at about 3/4 distance from pharynx to acetabulum; ceca narrow, extending to level of excretory bladder. Acetabulum 0.063-0.070 (0.067) long, 0.066-0.075 (0.069) wide, just posterior to midbody. Cuticle of body and trail aspinose; anterior half of body with scattered bristles set in papillae. Collar 0.092-0.107 (0.098) wide with 31 spines in single row interrupted ventrally and 2 additional angle spines posterior to each end of row; those in row, 0.010 long; angle spines, 0.007 long. A group of small cephalic glands on each side between levels of pharynx and cecal bifurcation, with 2 ducts passing laterally to oral sucker and opening through individual pores on dorsal lip. One small gland, with no apparent duct, on each side of prepharynx just posterior to oral sucker. Excretory bladder small, oval, with short anterior stem receiving wide, descending limbs originating from narrow, ciliated ascending tubules at level of oral sucker; secondary tubules forming ascending limbs at level of excretory bladder; smaller tubules obscured by cystogenous glands. About 24 flame cells on each side. Descending limbs from junction with bladder stem to level of acetabulum almost filled with oval concretions and with scattered concretions anterior to that level. Caudal excretory tubule short, bifurcating to open at lateral pores on tail. Cephalic ganglia and cross commissure at level of prepharynx. Two genital primordia evident, one just anterior to junction of excretory bladder arms, other just anterior to acetabulum. Body with dorsal layer of dense, rod-filled cystogenous cells. Tail attached subterminally, filled with vacuolated parenchyma; cuticle indented at intervals over tail surface. Development in non-motile, whitish rediae in gonad and liver of host. Redia 1.110-1.455 (1.300) long, 0.225-0.330 (0.278) wide. Birth pore anterior and lateral; cuticle thin; appendages absent, cecum short, narrow, with granular contents. About 45 tightly packed embryos per redia, in all stages of development. Flame cells not apparent. Rediae, fixed in formalin, with posterior third of body bent at obtuse angle to remainder of body (Figure 50).

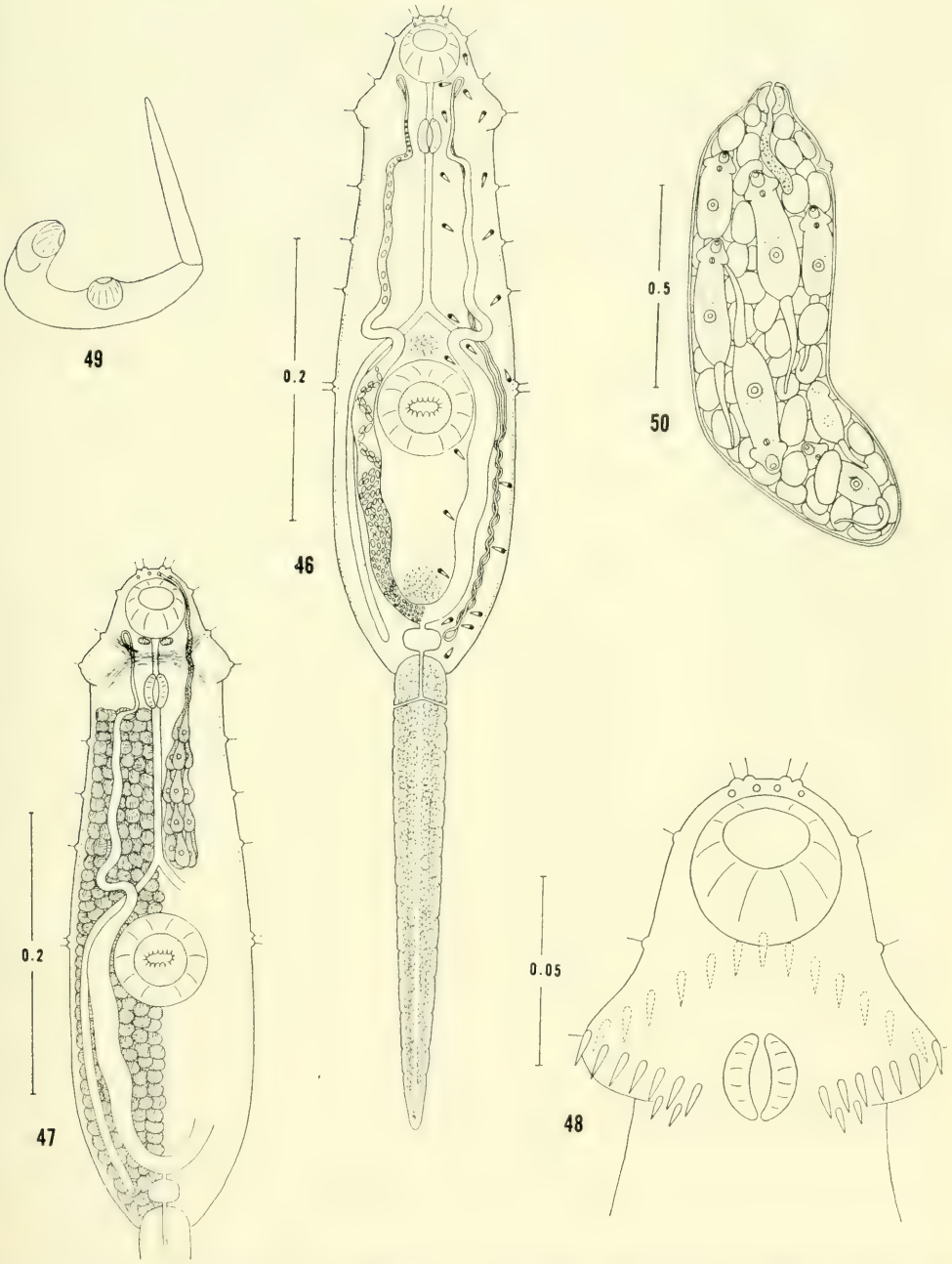
Host: Nassarius vibex Say

Incidence of infection: 40 of 1,083 snails.

Locality: Bay mouth sand bar, Alligator Harbor, Franklin County; sand bar, 3 miles SSW, St. Marks Light, Wakulla County, Florida.

This larva emerges in greatest numbers after dark. It shows no phototropisms and has a life span of about 48 hours; encystment was not observed. Neutral red is not toxic and stains penetration glands and ducts, genital primordia and cecal contents; Nile blue sulfate is very toxic.

This cercaria swims slowly with the body inverted, flexed ventrally between the suck-



Figures 46-50. **46.** Cercaria of *Himasthla quissetensis* (Miller and Northup, 1926), ventral view showing details of excretory system and tail. **47.** Same, ventral view of cercarial body showing cystogenous cells and cephalic glands. **48.** Same, ventral view of cephalic end showing collar spines. **49.** Same, lateral view showing swimming posture. **50.** Same, showing posture when redia is killed in formalin.

ers and with the tail held at a right angle to the body and lashing from side to side causing the body to vibrate vigorously. Cercariae are normally found near the bottom of the vessel, swimming around the periphery, but may creep by use of the suckers.

This larva is identified as the cercaria of *Himasthla quissetensis* (Miller and Northup, 1926), a trematode from the herring gull. The present study extends previous descriptions with respect to number of flame cells and cephalic gland ducts, and records a new host and locality.

Cercaria caribbea III Cable, 1956
(Figures 51-55)

Description: body 0.418-0.536 (0.486) long, 0.179-0.209 (0.192) wide at midbody. Tail 0.413-0.510 (0.472) long, 0.056-0.061 (0.060) wide at base, with dorsal and ventral plicated finfold, 0.372-0.485 (0.442) long, 0.023 wide. Oral sucker 0.052-0.060 (0.056) long, 0.051-0.056 (0.054) wide; mouth subterminal; prepharynx 0.008-0.025 (0.019) long; pharynx 0.025-0.033 (0.030) long, 0.014-0.020 (0.017) wide; esophagus long, bifurcating just anterior to acetabulum; ceca narrow, extending to level of excretory bladder. Acetabulum 0.076-0.085 (0.081) long, 0.076-0.085 (0.080) wide, located at midbody. Body surface finely granular, no distinct spines; tail smooth; short bristles scattered over anterior 4/5 of body surface, those on cephalic end set in papillae. Collar 0.092-0.107 (0.102) wide; with 31 spines, 0.0127 long, in a row interrupted ventrally and 2 additional angle spines on each side. Cephalic glands poorly defined, obscured by cystogenous glands; 4-6 ducts on each side passing laterally to oral sucker and opening at indistinct pores on dorsal lip. Six poorly defined glands within oral sucker opening at 6 pores on dorsal perimeter of oral sucker. Excretory bladder small, oval, with short anterior stem receiving wide, descending limbs originating from narrow, ciliated ascending tubules at sides of oral sucker; secondary tubules, obscured by cystogenous glands, forming ascending limbs at level of excretory bladder. Descending limbs filled to level of esophagus with irregular concretions. Caudal excretory tubule bifurcating, with lateral pores on tail. Cephalic ganglia and cross commissure at level of prepharynx. Body filled with granular cystogenous cells, obscuring flame cells. Tail with vacuolated parenchyma and few nuclei. Development in granular, yellow to whitish rediae parasitizing liver of host and measuring 0.870-1.590 (1.265) long, 0.225-0.405 (0.320) wide; birth pore lateral, just behind anterior appendage; area around mouth with minute bristles. Young redia whitish with well developed appendages, containing 12-15 embryos; cecum reaching posterior appendages. Old redia yellow, with less evident appendages and containing 20-25 cercariae in all stages of development. Flame cells not apparent.

Host: Cerithidea scalariformis Say

Incidence of infection: 1 of 5,508 snails.

Locality: Salt marsh, Shell Point, Wakulla County, Florida.

This larva emerges after the host has been dried prior to isolation. Cable (1956a) stated that this cercaria develops in and reenters the same species of snail to encyst, a finding not confirmed in the present study. The life span is about 24 hours and no phototropisms were observed. Neutral red, only slightly toxic, does not stain any feature well. Nile blue sulfate is very toxic and stains only the cephalic ganglia.

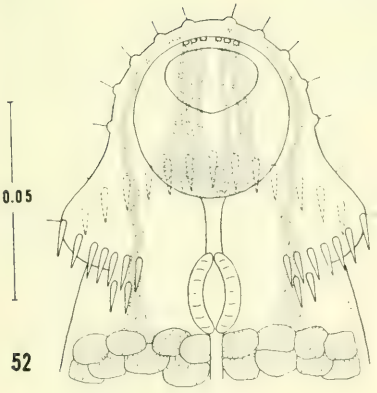
This cercaria swims rapidly near the surface by lashing the tail from side to side in a figure 8 motion with the body inverted and sharply flexed ventrally. Swimming direction can be abruptly changed from forward to backward. When at rest, the larva settles to the bottom in the attitude shown in Figures 53 and 54.

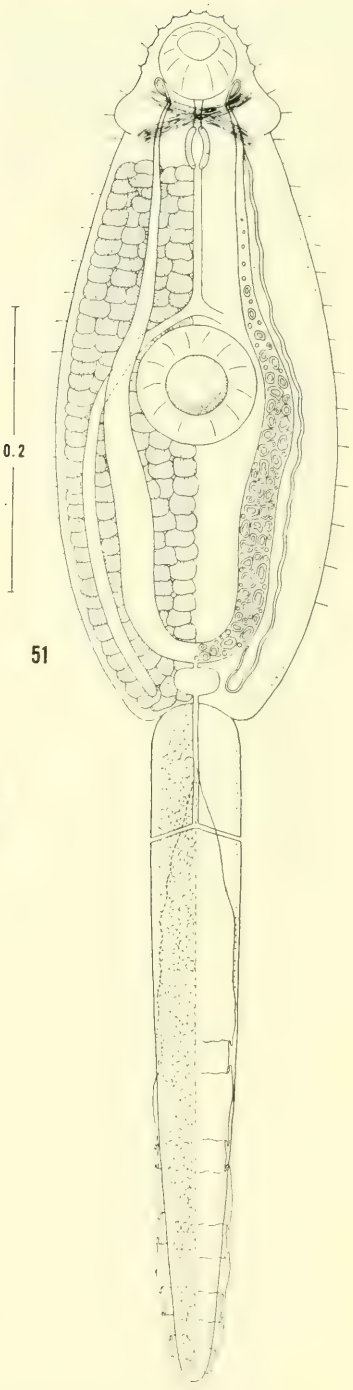
This cercaria is identified as *C. caribbea* III Cable, 1956, from *Cerithidea costata* in Puerto Rico. The minutely granular or scaly rather than spinose cuticle of the Florida species is not considered of specific importance and may be due to development in different hosts. A new host and locality record for this cercaria is here established.

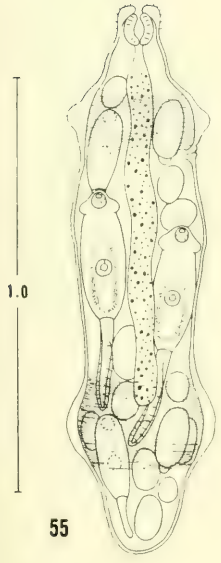
b. *Philophthalmid Cercariae*

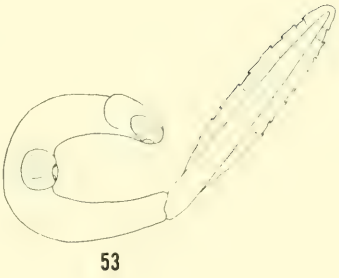
Cercaria of *Parorchis acanthus*
(Nicoll, 1906)
Syn. *Cercaria purpurae* Lebour, 1911
Syn. *Cercaria sensifera* Stunkard and Shaw, 1931
(Figures 56-58)

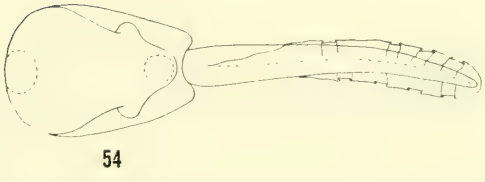
Description: body 0.570-0.921 (0.653) long, 0.163-0.214 (0.191) wide at level of acetabulum. Tail 0.450-0.675 (0.542) long,











Figures 51-55. **51.** *Cercaria caribbea* III Cable, 1956, ventral view, showing details of body and tail. **52.** Same, ventral view of cephalic end, showing collar spines and cephalic glands in oral sucker. **53.** Same, lateral view showing swimming posture. **54.** Same, dorsal view showing swimming posture. **55.** Same, redia.

0.051-0.082 (0.061) wide at base. Oral sucker 0.062-0.075 (0.069) long, 0.070-0.084 (0.078) wide; mouth subterminal; prepharynx 0.018-0.024 (0.022) long; pharynx 0.028-0.033 (0.030) long, 0.020-0.025 (0.022) wide; esophagus long, bifurcating about 3/4 the distance from pharynx to acetabulum; ceca narrow, extending to level of excretory bladder. Acetabulum 0.076-0.086 (0.081) long, 0.070-0.084 (0.078) wide, located just posterior to midbody. Body covered with minute spines, tail smooth; short bristles scattered over body, with those at cephalic end and around mouth set in papillae. Collar 0.102-0.122 (0.107) wide with about 70 spines in one row, interrupted ventrally. Undetermined number of indistinct cephalic glands on each side between level of acetabulum and pharynx. Several gland ducts on each side passing anteriorly dorsal to oral sucker and discharging through indistinct pores on dorsal lip. Excretory bladder small, spherical; descending limbs bending medially anterior to acetabulum and originating from ascending tubules at posterolateral margins of oral sucker; anterior and posterior secondary tubules forming ascending limb at level of acetabulum; smaller tubules obscured by cystogenous glands. Descending limbs with minute, spherical concretions from posterior level of acetabulum to level of pharynx. Embryonic caudal excretory tubule disappearing in parenchyma of tail short distance from body. Eighteen flame cells observed on each side of body. Cephalic ganglia and cross commissure at level of prepharynx. Body with dorsal layer of rod-filled cystogenous cells. Tail with vacuolated parenchyma and terminating with invaginated, glandular tip. Development in yellow, granular rediae in liver and gonad of host. Redia 0.900-1.335 (1.026) long, 0.210-0.390 (0.285) wide. Birth pore lateral and anterior; cuticle thin, with minute bristles around mouth. Young redia with short anterior and long posterior appendages becoming barely visible in old redia. Cecum, yellow, slightly overreaching posterior appendages. Usually ten to 12 embryos per redia, in various stages of development. Flame cells not apparent.

Host: Cerithidea scalariformis Say
Incidence of infection: 189 of 5,508 snails.
Locality: Salt marsh, St. Marks Light and Shell Point, Wakulla County, Florida.

In behavior and staining reaction, this larva is similar to *Cercaria favulosa,* and the two species can be distinguished only by detailed study of structures under oil immersion.

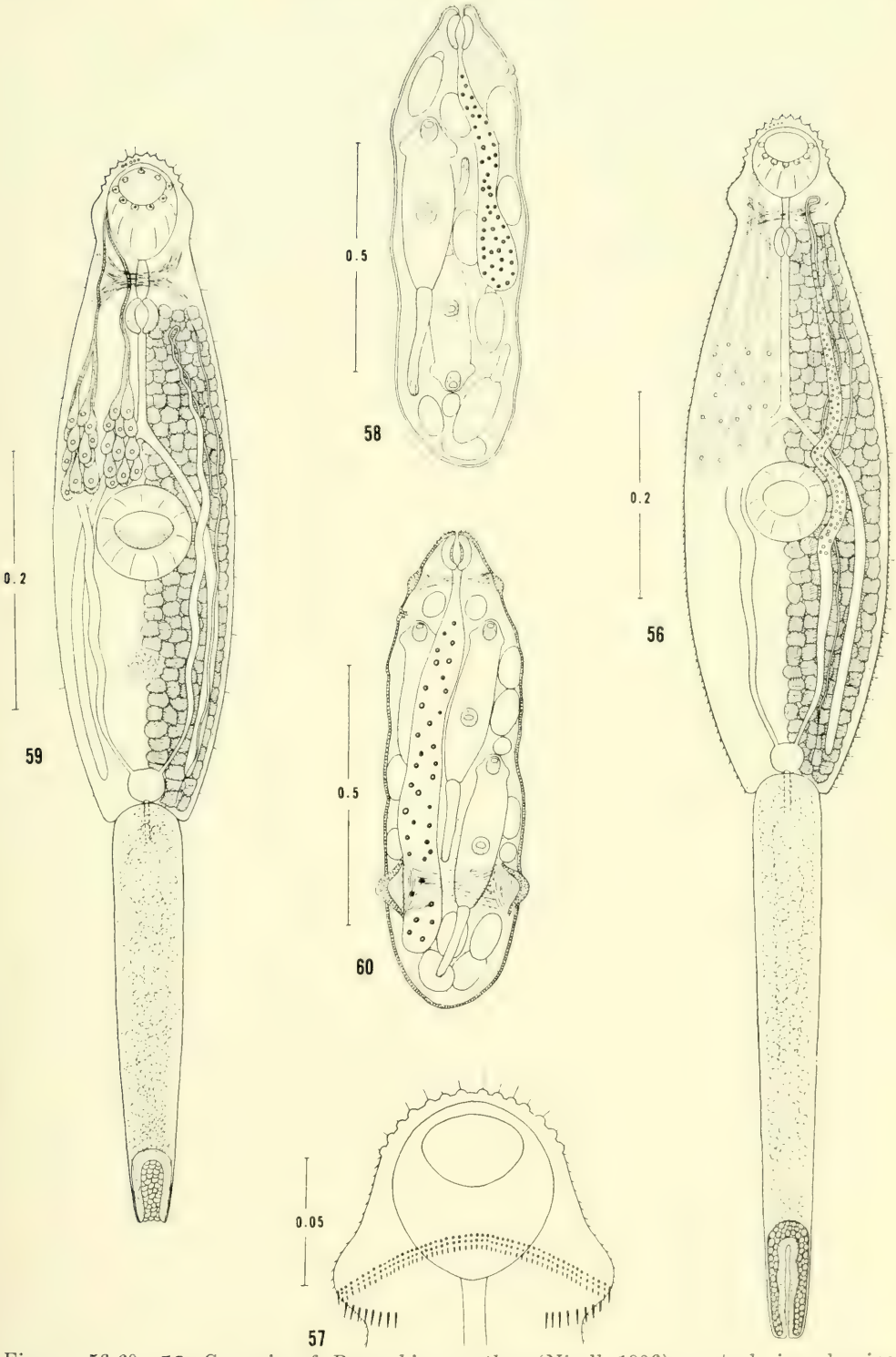
The present one is identified as the cercaria of *Parorchis acanthus* (Nicoll, 1906), adults of which were reared by feeding metacercariae to chicks. A new host and locality record thus is established for the larva. However, the cercaria as observed by the writer differed from the description given by Rees (1937) in respects that are summarized in the following table:

Cercaria purpurae Lebour (from Rees 1937)	*Cercaria purpurae* Lebour (from present study)
Caudal excretory tubule bifurcating and opening through individual pores on lateral margins of tail.	Caudal excretory tubule disappearing in parenchyma of tail a short distance from body. Excretory pore not observed.
64 collar spines	About 70 collar spines
Six cephalic glands with 6 ducts and 6 pores on each side.	Cephalic glands, ducts and pores too indistinct to count.
Concretions filling descending primary tubules.	Concretions in descending primary tubules only between post-acetabular level and post-pharyngeal level.

Confronted with the problem of identifying *Parorchis* from gulls in Australia, Angel (1954) proposed *Parorchis acanthus* var. *australis,* based on minute differences between her cercaria and that described by Rees (1937). This degree of subdivision seems unnecessary, because some degree of variation in cercariae might be expected when produced in different gastropod species.

Cercaria favulosa, sp. nov.
(Figures 59-60)

Description: body 0.495-0.540 (0.515) long, 0.107-0.168 (0.137) wide at level of acetabulum. Tail 0.225-0.465 (0.323) long, 0.041-0.056 (0.052) wide at base. Oral sucker 0.054-0.063 (0.060) long, 0.051-0.058 (0.053) wide; mouth subterminal; prepharynx 0.026-0.044 (0.031) long; pharynx 0.030-0.035 (0.032) long, 0.021-0.024 (0.023) wide; esophagus long, bifurcating at about 2/3 distance from pharynx to acetabulum; ceca narrow, extending to level of excretory bladder. Acetabulum 0.068-0.076 (0.073) long, 0.070-0.076 (0.073) wide, located just posterior to midbody. Body and tail surface aspinose, with scattered short



Figures 56-60. **56.** Cercaria of *Parorchis acanthus* (Nicoll, 1906), ventral view showing details of body and tail. **57.** Same, ventral view of cephalic end showing collar spines. **58.** Same, redia. **59.** *Cercaria favulosa,* sp. nov., ventral view showing details of body and tail. **60.** Same, redia.

bristles, those of cephalic region set in papillae; papillae also around mouth and on inner dorsal surface of oral cavity. Collar 0.071-0.102 (0.078) wide, unarmed. Two groups of granular cephalic glands on each side between level of acetabulum and pharynx; number of glands per group not determined. Their ducts extend anteriorly in two bundles, median one close to esophagus and pharynx and lateral bundle, which converge at side of oral sucker, then separate to pass dorsal to sucker and open at 5 pores on its dorsal lip. Excretory bladder small, spherical; descending limbs originating from ascending tubules at level of pharynx; anterior and posterior secondary tubules forming ascending limb at anterior level of acetabulum; smaller tubules obscured by cystogenous glands. Excretory concretions absent. Embryonic caudal excretory tubule disappearing in parenchyma of tail short distance from body; definitive excretory pore not observed. Eighteen flame cells observed on each side of body. Genital primordium about half way between excretory bladder and acetabulum. Cephalic ganglia and cross commissure at level of prepharynx. Body with dorsal and ventral layers of dense rod-filled cystogenous cells. Tail filled with vacuolated parenchyma, terminating with invaginated, glandular tip. Development in yellow, granular rediae in liver and gonad of host. Redia 0.765-1.080 (0.920) long, 0.180-0.345 (0.257) wide. Birth pore lateral and anterior; cuticle thick; area around mouth with minute bristles. Young redia with short anterior and long posterior appendages, much reduced in old redia; cecum yellow, reaching level of posterior appendages. Average of 12 embryos per redia, in various stages of development. Eight flame cells in each redia, one pair in each quarter of body.

Host: Cerithidea scalariformis Say

Incidence of infection: 149 of 5,508 snails.

Locality: Salt marsh, St. Marks Light (type locality), and Shell Point, Wakulla, County, Florida.

The specific name of this cercaria is taken from the Latin *favulosus,* meaning "full of small cells" and refers to the cercarial body filled with cystogenous cells.

This larva emerges when the host has been dried prior to isolation. Encystment occurs on the wall of the container and the life span of the cercaria is about 36 hours if encystment does not occur. No phototropisms were observed. Encystment can be induced by evaporation of water, chilling, addition of Nile blue sulfate or neutral red, and coverslip pressure. Transfer of this cercaria from one vessel to another is difficult because of the tendency to encyst on the inside of the pipette. The cyst wall is a thin, elastic membrane, surrounded by a thick, brittle adhesive layer which attaches the cyst to the wall of the vessel. Neutral red stains all cercarial features evenly except the suckers. Nile blue sulfate is more toxic than neutral red and stains the same features.

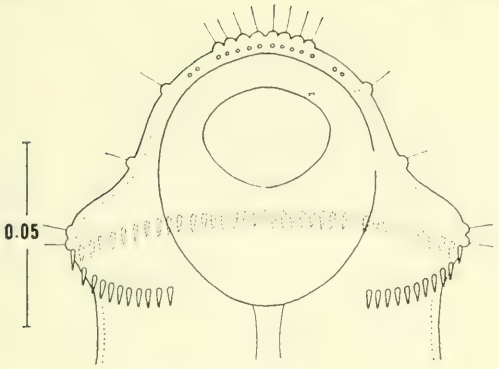
Swimming is by a dorso-ventral sigmoid undulation of the extended tail and body and is not effective in propelling the larva. The tip of the tail is adhesive, attaching the cercaria to the substrate while the body and tail are held erect and lash as when the larva is swimming. It may lie on the bottom, ventral side down, with the tip of the tail attached to the vessel and be very difficult to dislodge with pipette suction. This larva can contract to about 1/4 its extended length.

This species belongs to the "Echinostomoid" group of cercariae proposed by Cable (1956a), the larvae of which have all the characteristics of echinostomatoids except collar spines. Collar spines probably are of little family significance, however, since *Philophthalmus* does not have them as an adult and some species of *Parorchis* have them well developed but others do not. In behavior, this larva resembles the cercaria of *Parorchis acanthus* (Nicoll, 1906). Morphologically, *C. favulosa* resembles *C. caribbea* V Cable, 1956, but differs from it in the length of the descending execretory limbs, number of pores of the cephalic gland ducts, absence of cuticular spination and gross measurements.

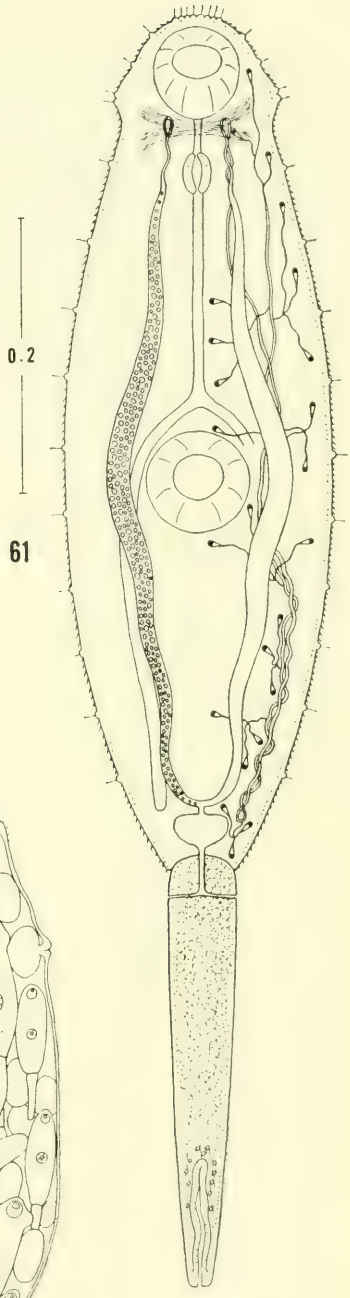
This cercaria is placed in the Philophthalmidae pending the determination of the life history.

Cercaria pustulosa, sp. nov.
(Figures 61-64)

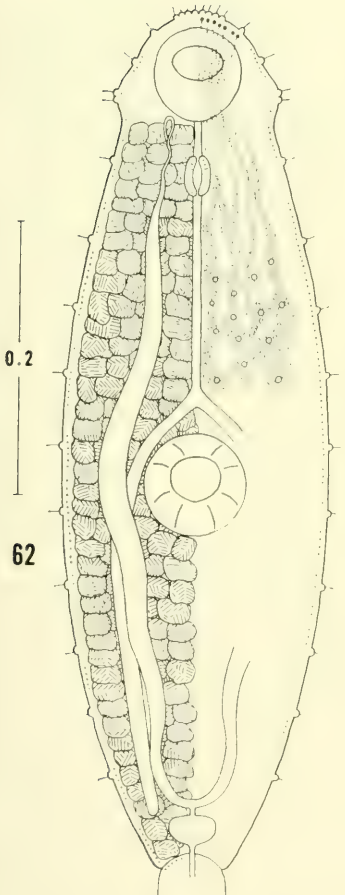
Description: body 0.540-0.720 (0.647) long, 0.153-0.214 (0.196) wide at midbody. Tail 0.270-0.398 (0.324) long, 0.041-0.051 (0.045) wide at base. Oral sucker 0.066-0.077 (0.071) long, 0.051-0.067 (0.061)



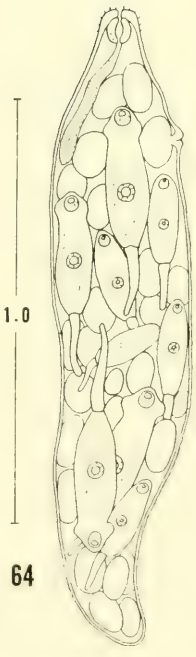
63



61



62



64

Figures 61-64. **61.** *Cercaria pustulosa,* sp. nov., ventral view showing details of excretory system and tail. **62.** Same, ventral view of cercarial body showing cystogenous cells and cephalic glands. **63.** Same, ventral view of cephalic end showing collar spines. **64.** Same, redia.

wide; mouth subterminal; prepharynx 0.017-0.032 (0.025) long; pharynx 0.030-0.038 (0.34) long, 0.018-0.028 (0.023) wide; esophagus long, bifurcating just anterior to acetabulum; ceca narrow, extending to anterior level of excretory bladder. Acetabulum 0.074-0.087 (0.080) in diameter, just posterior to midbody. Body surface spinose with scattered short bristles set in papillae which are more abundant on cephalic end; tail smooth. Collar 0.102-0.117 (0.110) wide with about 58 spines in single row, interrupted ventrally. Indistinct cephalic glands in forebody, with 14 minute ducts passing dorsally over oral sucker to open at individual pores in row on dorsal lip; two lateral pores on each side distinctly separated from others. Excretory bladder small, oval, with short anterior stem receiving descending limbs originating from narrow, ciliated ascending tubules just posterior to oral sucker; secondary tubules, originating in forebody, becoming sinuous in hindbody, forming ascending limbs at level of excretory bladder. Descending limbs filled with small, spherical concretions. Flame cell formula 2 (3 + 3 + 3 + 3 + 3 + 3 + 3 + 3) = 48. Caudal excretory tubule short, bifurcating to open at pores on sides of tail near its base. Cephalic ganglia and cross commissure at level of prepharynx. Body with dorsal layer of rod-filled cystogenous cells. Tail filled with vacuolated parenchyma, terminating with invaginated, glandular tip. Development in cream colored rediae in liver of host. Redia 0.870-2.055 (1.457) long, 0.165-0.450 (0.311) wide, containing about 36 embryos in all stages of development. Birth pore anterior and lateral; area around mouth with minute bristles. Appendages absent; cuticle thin; cecum with granular contents, about 1/4 length of redia. Flame cells not apparent.

Host: Melongena corona Gmelin

Incidence of infection: 6 of 69 conchs

Locality: Live Oak Point, Wakulla County, Florida.

The name of this larva is taken from the Latin *pustulosus,* meaning "full of pimples" and refers to the papillae on the body.

This cercaria emerges at any hour and has a life span of about 36 hours if encystment does not occur. Neutral red, only mildly toxic, stains the penetration glands and ducts. Nile blue sulfate, which is more toxic, stains the cephalic ganglia and commissure and stimulates flame cell activity. All other behavioral characteristics, reactions, and cyst features are similar to those of *Cercaria favulosa.*

This cercaria does not closely resemble any other known marine echinostomatoid. It is distinctive in having the combined features of 58 collar spines, an invaginated tail tip, and a single secondary collecting tubule draining flame cells instead of an anterior and posterior tubule. This pattern of excretory tubules, however, has been reported by this writer for *C. fuscata, C. caribbea* III Cable, 1956, and cercaria of *Himasthla quissetensis* (Miller and Northup, 1926) and by Mathias (1925) for the cercaria of *Hypoderaeum conoideum* Dietz, 1909, from fresh water snails (*Linnaea* spp.).

This larva differs from known philophthalmid cercariae in the arrangement of excretory tubules but resembles members of that group in swimming characteristics, invaginated tail tip, cystogenous glands and encystment. It is tentatively placed in that group pending the determination of the life history.

G. *Plagiorchioid Cercariae*

A single plagiorchioid cercaria of the family Microphallidae was found. Cercariae of this family are characterized by the following general diagnosis:

Small cercariae with acetabulum and pharynx nearly always undeveloped; oral sucker with prominent stylet. Penetration glands usually 4 pairs, consisting of 2 pairs each of 2 types distinguished by position, size, character of granulation and configuration of ducts. Usually 2 anterior pairs of one type and better defined than 2 posterior pairs; exceptions are recorded by Palombi (1940), Schell and Thomas (1955), Lebour (1911), Cable (1956a) and for the species described below. Excretory vesicle U- or V-shaped with tubules entering its arms anterolaterally. Development in sporocysts in prosobranch gastropods. Encystment in arthropods, usually crustaceans; adults generally in intestines of birds, occasionally in other vertebrates, especially fishes.

Cercaria lanceolata, sp. nov.

(Figures 65-68)

Description: body 0.168-0.194 (0.181) long, 0.056-0.071 (0.062) wide at level of acetabular primordium. Tail 0.184-0.209 (0.195) long, 0.017-0.020 (0.018) wide at base. Oral sucker 0.041-0.046 (0.044) long, 0.029-0.035 (0.032) wide; mouth subterminal; other features of digestive system not evident. Stylet 0.029 long, 0.003 wide, laterally compressed, slightly enlarged at base of point; with slight ventral curvature. Genital or acetabular primordium located in posterior third of body. Cuticle of body and tail surfaces aspinose, that of tail thick and minutely wrinkled; a pair of long bristles at cephalic end of body. Three large, overlapping penetration glands on each side, nuclei just posterior to midbody; ventral gland lightly granular, staining darkly with Nile blue sulfate; middle gland with coarse granules staining darkly with neutral red as does the moderately granular dorsal gland. Dorsal and ventral gland ducts sinuous, passing over dorsolateral surface of oral sucker to open at individual pores within oral cavity near tip of stylet. Duct of middle gland bending toward midline at level of cerebral ganglia and then curving laterally around oral sucker and opening through pore within oral sucker anterior to other pores. Excretory bladder small, U-shaped, with short arms; excretory tubules sinuous, originating at level of penetration glands and receiving anterior and posterior collecting tubules. Flame cell formula $2\,[(2+2) + (2+2)] = 16$. Excretory pore at body-tail junction. Cephalic ganglia and cross commissure at about 1/6 distance from oral sucker to genital (or acetabular) primordium. Body filled with granular cystogenous cells. Tail filled with small nuclei and with central, longitudinal strand of muscle fibers. Development in minute, oval, whitish, sporocysts in liver of host. Sporocyst 0.189-0.281 (0.231) long, 0.102-0.179 (0.139) wide, each with 5 to 6 embryos in various stages of development; birth pore not observed.

Host: Cerithidea scalariformis Say

Incidence of infection: 130 of 5,508 snails.

Locality: Salt marsh, St. Marks Light (type locality) and Shell Point, Wakulla County, Florida.

The specific name of this cercaria is taken from the Latin *lanceolatus,* meaning "lance-like," and refers to the stylet.

From previously dried snails, cercariae emerge at all hours in large numbers. They have a life span of about 18 hours and are positively phototropic. Netural red is not toxic whereas Nile blue sulfate is toxic. Swimming movement is typical of xiphidiocercariae with the body slightly flexed ventrally and hanging downward, and with the tail lashing in a figure-eight motion (Figure 67). They swim continuously for the first 12 hours after emergence, then settle to the bottom and, for about 6 hours, creep by extension of the body and attachment of the oral sucker to the substrate.

This is the first report of a marine microphallid cercaria with three pairs of penetration glands and a flame cell formula of $2\,[(2+2) + (2+2)] = 16$. Other such larvae usually have 4 pairs of penetration glands but 2 pairs have been described for *C. minima* Schell and Thomas, 1955, and *C. misenensis* Palombi, 1940; and 6 pairs for *C. ubiquita* Lebour, 1911, and *C. ubiquitensis* Palombi, 1940.

Cercaria lanceolata may encyst in a fiddler crab (*Uca* sp.) abundant in the type locality. The adult probably occurs in a crab-eating bird to judge from known microphallid life cycles.

One distome plagiorchioid xiphidiocercaria was found in the present study. The family relationship of cercariae of this type is unknown; only 4 species have been described adequately: *C. caribbea* XXXII Cable, 1956, *C. caribbea* XXXIII Cable, 1956, *C. roscovita* Stunkard, 1932, and *C. parvicaudata* Stunkard and Shaw, 1931. They have the following general diagnosis:

Marine distome xiphidiocercariae with small, poorly developed stylet. Body cuticle spinose, tail smooth. Dense, granular cystogenous glands filling body, obscuring details of penetration glands and excretory network. Excretory bladder Y-shaped with excretory tubules joining stem at base of arms. Phar-

ynx present. Development in sporocysts in prosobranch snails. Adults probably in birds or mammals.

Cercariae opaca, sp. nov.
(Figures 69-73)

Description: body 0.209-0.240 (0.228) long, 0.097-0.107 (0.103) wide at midlevel. Tail 0.209-0.235 (0.222) long, 0.023-0.025 (0.024) wide at base. Oral sucker 0.036-0.039 (0.037) in diameter; mouth subterminal, with surrounding row of small triangular spines, interrupted ventrally; prepharynx absent; pharynx 0.013 in diameter; esophagus obscured by cystogenous glands. Stylet 0.009 long, 0.005 wide, rod-like with conical point. Acetabulum 0.037-0.038 (0.037) in diameter, just posterior to midbody. Body cuticle thin, covered with minute spines, tail smooth. Numerous granular penetration glands in large group on each side, between levels of pharynx and acetabulum; each group with 4 gland ducts passing through lateral wall of oral sucker to open close together near base of stylet. Arms of excretory bladder embracing posterior margin of acetabulum. Four groups of 3 flame cells observed on each side; their formula probably $2[(3+3)+(3+3)]=24$. Excretory pore at junction of body and tail. Body with scattered refractile spherules in addition to cystogenous cells. Tail filled with small cells and central strand of longitudinal muscle fibers; its cuticle indented at intervals. Development in orange sporocysts with granular cuticle. Sporocysts 0.352-0.556 (0.462) long, 0.163-0.291 (0.222) wide, containing 7 to 20 embryos in various stages of development; birth pore terminal. Fully developed cercariae in sporocyst very active.

Host: Littorina irrorata Linné

Incidence of infection: 2 of 1,538 snails.

Locality: Salt marsh, St. Marks Light, Wakulla County, Florida.

The specific name of this cercaria is taken from the Latin *opacus,* meaning "opaque" or "shaded" and refers to the dense appearance of the body.

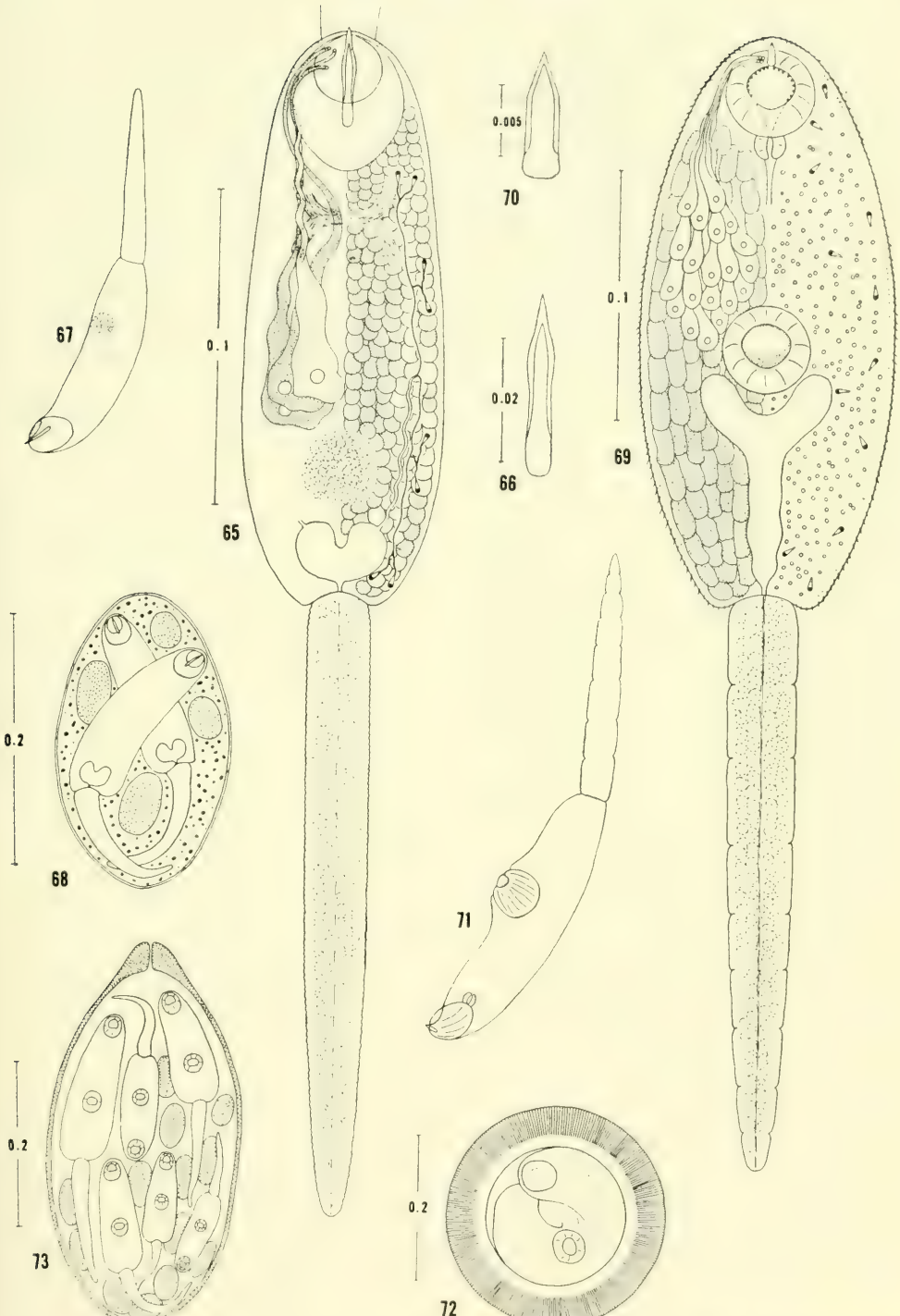
Cercariae emerge from the snail at all hours, but are never seen in large numbers because they immediately return to that host and encyst in its gonad. No phototropisms were noted. The cyst is spherical, 0.281-0.316 (0.296) in diameter, with a thick, brittle outer layer and a thin, elastic inner membrane. The outer layer appears to be radially striated and dissolves in artificial digestive juice (0.5% HCl and 1% pepsin) which does not affect the thin, inner membrane. The metacercaria appears similar to the cercarial body without the stylet. The cyst has the appearance of a tiny translucent pearl, and is very similar to the cysts described by Stunkard (1932) as those of *Spelotrema* spp. provis. from crabs, and by Pelseneer (1906) from *Littorina rudis.*

Neutral red is mildly toxic; it stains the penetration glands lightly and the cystogenous glands darkly. Nile blue sulfate is very toxic and kills the cercaria before staining reactions become evident. Swimming movements are as described for *Cercaria lanceolata* and terminate with the larva sinking to the bottom where it may lie motionless or creep about, using the suckers for attachment to the substrate.

This species resembles *C. caribbea* XXXII Cable, 1956, but differs from it by having spines in the oral sucker, a visible pharynx, a distinctive stylet, and 4 instead of 3 penetration gland ducts. The adult probably is in a snail-eating shore bird.

The systematic position and affinities of the next two species pose a problem. They resemble *C. opaca* in the important features of Y-shaped excretory bladder, dense cystogenous glands, and development in sporocysts in mudflat snails of the order Mesogastropoda. It is known that the stylet may be absent in larvae of certain natural adult groups in which xiphidiocercariae may predominate. It is likewise known that tail form has little taxonomic value; in the psilostomes, echinostomes, and opisthorchioids some cercariae have narrow tails, with or without fins, and others have magnacercous, even zygocercous.

Pending further study on the life cycles, the following two species are tentatively placed in the Plagiorchioidea based on the features mentioned above.



Figures 65-73. 65. *Cercaria lanceolata*, sp. nov., ventral view showing details of body and tail. **66.** Same, ventral view of stylet. **67.** Same, lateral view showing swimming posture. **68.** Same, sporocyst. **69.** *Cercaria opaca*, sp. nov., ventral view showing details of body and tail. **70.** Same, ventral view of stylet. **71.** Same, lateral view showing swimming posture. **72.** Same, living metacercarial cyst. **73.** Same, sporocyst.

To date, no adequate descriptions have been published on marine leptocercous cercariae which lack stylets. Eight poorly described species are known, probably representing larvae of several different families. For this reason, a general diagnosis of the group is omitted.

Cercaria nubeculata, sp. nov.
(Figures 74-76)

Description: body 0.112-0.122 (0.120) long, 0.056-0.071 (0.067) wide at midbody. Tail 0.082-0.102 (0.092) long, 0.020 wide at base. Oral sucker 0.017-0.026 (0.021) long, 0.020-0.023 (0.022) wide; mouth subterminal; prepharynx very short, pharynx 0.006 in diameter; remainder of digestive tract obscured. Acetabulum 0.021-0.023 (0.022) in diameter, just posterior to midbody. Body covered with rows of spines in quincunx pattern except for small bare area on oral sucker just anterior, and another on ventral surface posterior to oral cavity. Tail smooth, with vacuolated parenchyma around central core of longitudinal muscle fibers resembling duct through tail. Bristles and papillae absent. Penetration glands in forebody obscured by dense, granular cystogenous glands and scattered large pigment granules. Six gland ducts on each side extending anteriorly to open at separate pores on dorsal lip. Ducts grouped into a median pair passing close to pharynx and dorsal to oral sucker, and laterally into 1, 2 and 1 ducts converging at side of oral sucker and curving around it to their individual pores. Excretory bladder Y-shaped, anepithelial, with arms embracing posterior margin of acetabulum. Excretory tubules and flame cells obscured by cystogenous glands. Excretory pore at junction of body and tail. Development in large, orange-colored sporocysts in pericardium and surrounding tissues of host. Sporocysts 0.750-1.29 (1.07) long, 0.165-0.270 (0.215) wide, containing 200 to 400 densely packed embryos in all stages of development; cuticle thin, smooth; birth pore terminal.

Host: Cerithidea scalariformis Say

Incidence of infection: 17 of 5,508 snails.

Locality: Salt marsh, St. Marks Light (type locality) and Shell Point, Wakulla County, Florida.

The specific name of this cercaria is taken from the Latin *nubeculatus,* meaning "cloudy" and "with dark spots," and describes the body.

This minute larva emerges from the host in large numbers at all hours, has a life span of about 24 hours and displays no phototropisms. Neutral red and Nile blue sulfate are only slightly toxic and stain the cystogenous glands equally well but show no affinity for other structures.

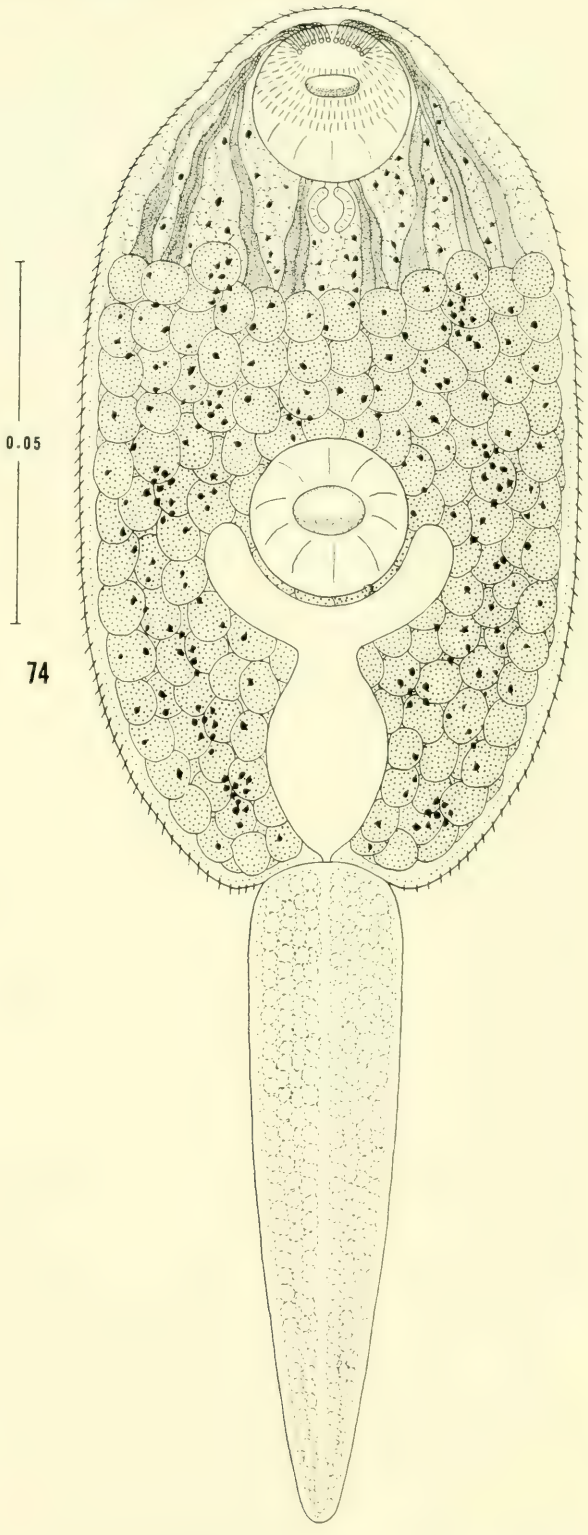
It swims very much like the xiphidiocercariae with body inverted, ventrally flexed and the tail lashing from side to side in a figure 8 manner. Swimming is interrupted by rest periods and after several hours, the larvae settle to the bottom and lie motionless between periods of creeping over the substrate with the aid of the suckers.

One new species of non-ocellate, pharyngeate, magnacercous cercaria was found in the present investigation.

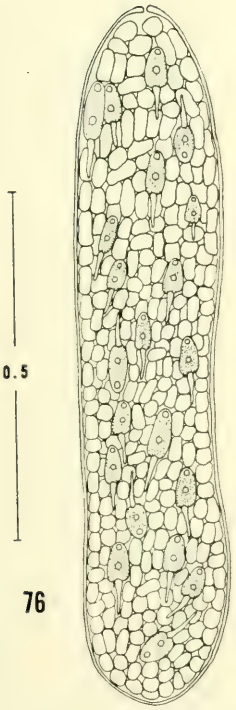
Cercaria ingentis, sp. nov.
(Figures 77-82)

Description: body 0.250-0.281 (0.265) long, 0.071-0.087 (0.081) in maximum width. Tail magnacercous, 0.810-0.960 (0.884) long, gradually enlarging from base for about 2/5 its length to a maximum width of 0.204-0.235 (0.221), then becoming abruptly narrower and tapering gradually to tip. Oral sucker 0.031-0.040 (0.035) long, 0.023-0.029 (0.025) wide; mouth subterminal; prepharynx very short; pharynx spherical, 0.012 in diameter; remainder of digestive system not apparent. Acetabulum 0.026-0.031 (0.029) in diameter, just anterior to midbody. Body covered with widely spaced spines in quincunx arrangement (Figure 80); cuticle of tail smooth; papillae and bristles absent. Two groups of penetration glands on each side between ganglia and acetabulum; three large distinct, overlapping glands in lateral group anterolateral to acetabulum with a bundle of 3 ducts passing anteriorly in lateral region of forebody and discharging through inividual pores on the dorsal lip; second group of 2 small, indistinct glands medial to the first group, just anterior to genital primordium, with poorly defined ducts passing anteriorly close to midline and dorsally to oral sucker to open at minute pores on

75



74



76

Figures 74-76. **74.** *Cercaria nubeculata*, sp. nov., ventral view. **75.** Same, lateral view showing swimming posture. **76.** Same, sporocyst.

dorsal lip, medial to the pores of larger glands. Excretory bladder Y-shaped, its wall with a single layer of flattened cells; arms short, embracing acetabulum posteriorly and laterally. Excretory pore at junction of body and tail. Anterior and posterior collecting tubules forming short main collecting tubule which joins bladder laterally at base of each arm. Genital primordium a small sphere of nuclei at anterior margin of acetabulum. Eyespots absent; cerebral ganglia and commissure just posterior to pharynx. Body filled with dense, granular cystogenous cells posterior to cerebral ganglia. Proximal half of tail filled with small cells and dense, brown, pigment granules, distal half with clear, vacuolated parenchyma. Entire tail with small superficial gland cells apparently opening to surface through minute individual ducts (Figure 81). Muscle fibers distinct in tail near body junction. Development in large, orange-brown sporocysts in the branchial region of host. Sporocysts 0.750-1.575 (1.188) long, 0.255-0.375 (0.324) wide, each containing 30 to 35 embryos, in all stages of development; birth pore terminal.

Host: Cerithidea scalariformis Say

Incidence of infection: 3 of 5,508 snails.

Locality: Salt marsh, St. Marks Light (type locality) and Shell Point, Wakulla County, Florida.

The specific name of this cercaria is taken from the Latin *ingentis,* meaning "remarkable" or "great".

This cercaria emerges in small numbers when the host has been dried prior to isolation. The life span is about 18 hours; no phototropisms were observed. Neutral red is only slightly toxic and readily stains the cystogenous glands. Nile blue sulfate is mildly toxic and stains the cystogenous glands, penetration glands and ducts, and cephalic ganglia.

During swimming, the larva is nearly horizontal with the body slightly lower than the tail and flexed ventrally. The tail is held straight with the distal half lashing slowly in all directions. At rest, the larva is suspended in the water (Figure 79) with the body downward and rhythmically elongating and contracting. Under coverslip pressure, the tail detaches and the body creeps about with the aid of the suckers.

Cercaria ingentis is very closely related to *C. buchanani* Martin and Gregory, 1951, but differs from that species in the number of penetration glands, length of the prepharynx, absence of papillae on acetabulum and non-aggregating behavior.

This new species does not fit the general diagnosis of magnacercous opisthorchioids in lacking eyespots, and having a well-developed pharynx and a Y-shaped excretory bladder.

H. *Monorchiid Cercariae*

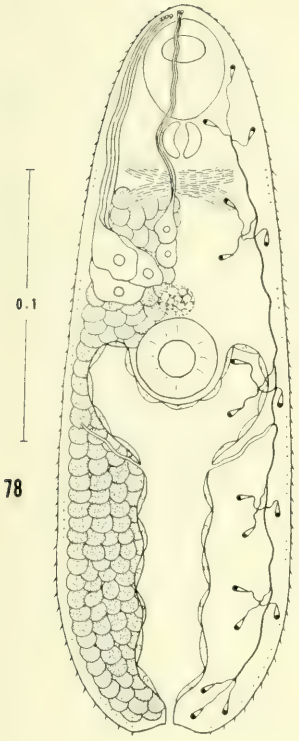
Cercariae of the family Monorchiidae are a relatively obscure group concerning which little work has been done. The investigations of Martin (1940), Young (1953) and Cable (1956a) are the principal contributions. Two species are reported in the present study, *C. caribbea* XXXVI Cable, 1956, and *C. pocillator,* sp. nov.

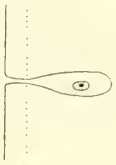
A general diagnosis of monorchiid cercariae, abstracted from Cable (1956a), follows:

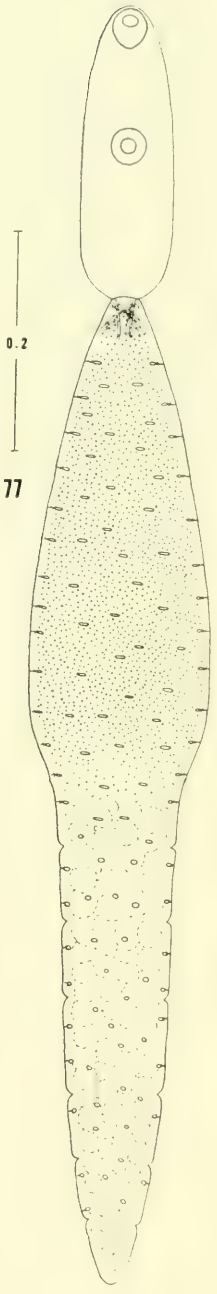
Distomate, pharyngeate cercariae with spinose cuticle, developing in sporocysts in marine lamellibranchs. Tail variable: long and slender with cuticular extensions, reduced or possibly lacking. Eyespots present in larvae with well developed tails, absent in others; stylet absent, penetration glands present. Excretory bladder saccate or tubular, thick walled. Flame cell formula, where known, $2\,[(2+2)+(2+2)]=16$. Encystment, where known, in invertebrates, particularly mollusks. Adults in intestines of marine fishes.

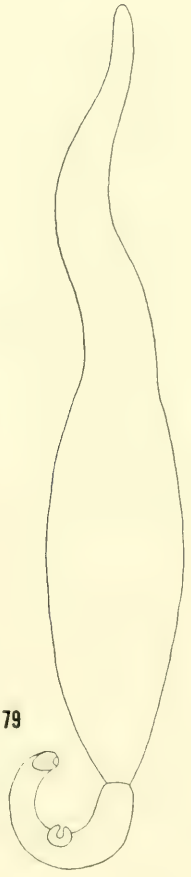
Cercaria caribbea XXXVI Cable, 1956
(Figures 83-85)

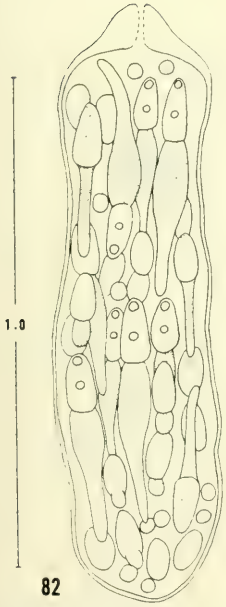
Description: body 0.249-0.301 (0.276) long, 0.066-0.092 (0.078) wide at midbody. Tail a tiny knob, 0.009-0.010 in diameter. Oral sucker 0.041-0.046 (0.044) long, 0.046-0.051 (0.048) wide; mouth subterminal; prepharynx 0.008-0.026 (0.020) long, sinuous, with longitudinal muscles; pharynx 0.023-0.028 (0.025) long, 0.025-0.029 (0.027) wide; esophagus thick walled, short, bifurcating about half way between pharynx and acetabulum; ceca relatively thick walled, sinuous, extending almost to posterior end of body. Acetabulum 0.041-0.049 (0.046) in diameter, located at midbody. Cuticle of body spinose with bristles set in papillae scattered over cephalic end; tail smooth.











Figures 77-82. **77.** *Cercaria ingentis*, sp. nov., ventral view showing pigmentation and glandular nature of tail. **78.** Same, ventral view of cercarial body. **79.** Same, lateral view showing resting posture. **80.** Same, surface of body showing arrangement of spines. **81.** Same, surface of tail showing unicellular gland and duct through cuticle. **82.** Same, sporocyst.

Undetermined number of small, granular penetration glands on each side at level of prepharynx, with indistinct ducts passing laterally and dorsally to oral sucker to open at indistinct pores on dorsal lip. Large irregular cystogenous cells with granular cystoplasm scattered through body parenchyma. Excretory bladder I-shaped with thick wall of small, sperical cells, reaching almost to acetabulum and displaced to one side by genital primordium. Main excretory tubules ciliated, joining bladder laterally, anterior to its midlevel and extending almost to midlevel of acetabulum where each receives anterior and posterior collecting tubule. Flame cell formula $2[(2+2)+(2+2)]=16$. Duct of bladder with small sphincter, and pore at junction of body and tail. Genital primordium large, immediately posterior to acetabulum. Development in cream colored sporocysts in gonad of host. Sporocysts 0.255-0.638 (0.418) long, 0.087-0.097 (0.094) wide, containing 4 to 5 loosely packed embryos in various stages of development; cuticle rough; birth pore not observed.

Host: Chione cancellata Linné

Incidence of infection: 16 of 120 clams.

Locality: Bay mouth sand bar, Alligator Harbor, Franklin County, Florida.

These cercariae emerge from the gonad of the host, and from cysts which are ejected from the clam through the excurrent siphon. They measure 0.087-0.097 (0.094) in diameter, and appear as minute whitish spheres stuck together in bunches by the gelatinous outer covering which is thick and granular; inner cyst layer thin, membranous (Figure 84). Ciliated ducts and flame cells of larvae visible in cysts.

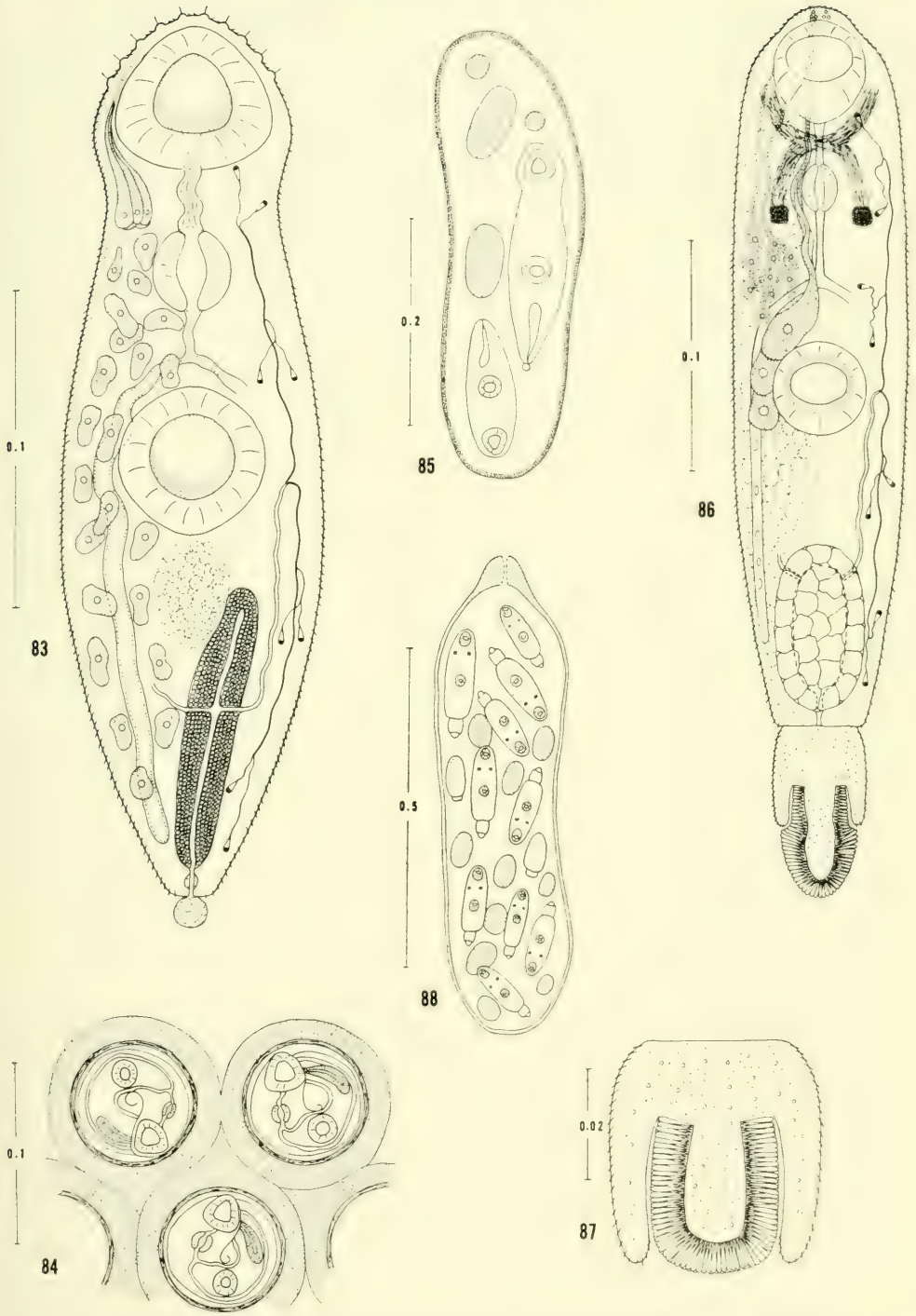
The description of this cercaria is based on larvae teased from sporocysts and only the largest and presumably fully developed ones were used. Such carcariae are active and creep about on the bottom of the dish.

Neutral red, only slightly toxic, stains the cystogenous glands. Nile blue sulfate stains the penetration glands and stimulates encystment, but apparently is not toxic.

The present study records a new host and locality record for *Cercaria caribbea* XXXVI which Cable (1956a) described from *Gemma purpurea* in Puerto Rico. He observed that the species did not emerge but he failed to note its encystment in the mollusk, or the genital primordium.

Cercaria pocillator, sp. nov.
(Figures 86-88)

Description: body 0.286-0.316 (0.308) long, 0.061-0.077 (0.068) wide at level of acetabulum. Tail composed of cup-like basal segment containing glandular, protrusible portion, and measuring 0.034-0.046 (0.040) long by 0.034-0.046 (0.038) wide when contained portion is retracted (Figure 87); with glandular portion extended, tail measures 0.071-0.079 (0.074) long (Figure 86). Oral sucker 0.041-0.048 (0.045) long, 0.037-0.043 (0.040) wide; mouth subterminal; prepharynx 0.013-0.017 (0.016) long; pharynx 0.020-0.021 (0.020) long, 0.015-0.016 (0.015) wide; esophagus 0.035-0.044 (0.040) long, bifurcating about midway between pharynx and acetabulum; ceca narrow, containing few small oval concretions and extending to midlevel of excretory vesicle. Acetabulum at midbody, 0.038-0.044 (0.041) long, 0.037-0.043 (0.039) wide, with several rows of minute spines bordering cavity. Body with parallel rows of spines; those of tail restricted to cup-like portion; bristles and papillae absent. Penetration glands of 2 types: one group of 3 large, granular, overlapping glands on each side along lateral and anterolateral margins of acetabulum, with ducts extending anteriorly close to esophagus and pharynx, passing dorsal to oral sucker and opening at 3 submedian pores forming triangle on the dorsal lip; glands of second type poorly defined, finely granular, grouped on each side between levels of eyespots and cecal bifurcation with 2 groups of poorly defined ducts passing laterally and dorsally over oral sucker to indistinct pores on dorsal lip. Excretory bladder elongate, oval, thick walled, extending about half way to acetabulum with wall of large, irregularly shaped cells; excretory pore at junction of body and tail. Main excretory ducts ciliated, joining bladder anterolaterally and extending to midlevel of acetabulum where each receives anterior and posterior collecting tubule. Flame cell formula $2[(2+2)+(2+2)]=16$. Cephalic ganglia and cross commissure at level of prepharynx. Eyespots on each side of pharynx, rectangular, 0.009 long and 0.010 wide, composed of spherical brown



Figures 83-88. **83.** *Cercaria caribbea* XXXVI Cable, 1956, ventral view showing details of body. **84.** Same, living metacercarial cysts. **85.** Same, sporocyst. **86.** *Cercaria pocillator*, sp. nov., ventral view showing details of body and tail. **87.** Same, ventral view showing tail stem with glandular core retracted. **88.** Same, sporocyst.

granules. Body filled with indistinct cystogenous cells. Distal segment of tail stem with many small, fusiform glandular cells perpendicular to its surface. Development in cream colored, elongate sporocysts in gonad and liver of host. Sporocyst 0.525-0.960 (0.749) long, 0.150-0.270 (0.216) wide; cuticle smooth, birth pore terminal; containing 14 to 22 embryos, in all stages of development.

Host: Donax variabilis Say

Incidence of infection: 5 of 1,763 clams.

Locality: Gulf beach, Alligator Point, Franklin County, Florida.

The specific name of this cercaria is taken from the Latin *pocillator,* meaning "bearer of a cup" and refers to the shape of the tail.

Because this cercaria was not observed to emerge spontaneously, it is described from specimens dissected from the clam and selected for their apparent complete development. No swimming movements were observed but the larva lies on the bottom writhing, twisting and creeping with momentary rest periods during which the body is flexed ventrally. The life span of larvae removed from the sporocyst is about 24 hours.

Neutral red is toxic; it stains the large penetration glands, their ducts, the contents of the ceca, and cells of the excretory bladder. Neutral red also stimulates the glands of the tail stem to secrete an adhesive substance whereby the larva adheres to the vessel and is difficult to dislodge. Nile blue sulfate is not toxic; it stains the cephalic ganglia, large penetration glands, their ducts, cells of the excretory bladder; and it stimulates flame cell activity.

Cercaria pocillator resembles most *C. choanura* Hopkins, 1958, in *Donax variabilis* from Mustang Island, Texas. It differs from that species in having diffuse as well as distinct penetration glands, long ceca, and by lacking a genital primordium. Hopkins did not describe features of the excretory system other than the bladder. *C. pocillator* may encyst in the first intermediate host, as reported by Hopkins for *C. choanura,* but this writer observed no cysts in the infected clams. The adult of *C. pocillator* probably occurs in mollusk-eating fishes.

I. *Allocreadioid Cercariae*

Life history studies have shown that trematodes assigned to the family Allocreadiidae by some workers have at least three types of cercariae (leptocercous, cotylocercous, xiphidiocercariae). For that reason, others have recognized separate families for the adults of each type of cercaria and combined them in the superfamily Allocreadioidea. One such family is the Opecoelidae in which the cercariae are of the type characterized in the following general diagnosis which applies to two species found in the present study:

Non-ocellate distome cercariae with aspinose cuticle and a stylet set vertically in the anterior wall of the oral sucker. Cuticle thick, with bristles set in papillae. Tail an adhesive organ; usually short and either cup-like with glandular walls or with a glandular core that may be protrusible; less often, tail longer, rarely exceeding body in length and then with a non-protrusible core of glands at distal end only. Number of penetration glands variable; their ducts in one or two bundles on each side, opening near tip of stylet. Excretory bladder with thick wall composed of large, granular cells. Excretory pores lateral at junction of body and tail. Flame cell formula of marine species, where known $2\,[(2+2)+(2+2)]=16$. Development in sporocysts in prosobranch gastropods and encystment commonly in crustaceans. Adults in the Opecoelidae, a family of trematodes occurring in both marine and fresh water fishes.

Cercaria contorta, sp. nov.
(Figures 89-91)

Description: body 0.179-0209 (0.191) long, 0.036-0.046 (0.040) wide at midlevel. Tail 0.066-0.076 (0.069) long, 0.018-0.021 (0.019) wide at base. Oral sucker 0.029-0.033 (0.031) long, 0.024-0.029 (0.026) wide; mouth subterminal, surrounded by band of minute scales or spines; prepharynx indistinct; pharynx difficult to see at posterior level of ganglionic commissure about half way between oral sucker and acetabulum; remainder of digestive tract not evident. Stylet in anterior wall of oral sucker, 0.006 long and 0.003 wide; not curved dorsoventrally; with two short points. Acetabulum 0.024-0.029 (0.026) long, 0.023-0.024 (0.023) wide, posterior to midbody;

a band of minute scales or spines around acetabular cavity. Body and tail aspinose; bristles set in papillae scattered over anterior 2/3 of body, denser on cephalic end. Three overlapping, granular penetration glands on each side between levels of pharynx and acetabulum; their ducts extending anteriorly and dorsal to oral sucker to open at pores near tip of stylet; ducts and pores of middle and ventral glands medial to those of dorsal gland. Excretory bladder voluminous, extending about 3/4 distance from posterior end to acetabulum; with thick wall of large, irregular, granular cells; with short duct to lateral pores in body-tail furrow. Main excretory tubules joining anterolateral margins of bladder, extending to level of acetabulum where each receives anterior and posterior collecting tubule. Proximal end of anterior collecting tubule ciliated. Flame cell formula $2\,[(2+2) + (2+2)] = 16$. Cephalic ganglia and large commissure very distinct, overlapping anterior margin of pharynx. Two genital primordia present, the larger along anterior margin of acetabulum and smaller one posterior to pharynx. Body filled with indistinct cystogenous cells. Tail filled with vacuolated parenchyma; expanded cup-like tip enclosing protrusible core of longitudinal fusiform gland cells. Development in orange, granular sporocysts in liver of host. Sporocysts 0.306-0.490 (0.389) long, 0.102-0.173 (0.135) wide, containing 15 to 20 embryos in all stages of development; cuticle thin, smooth; 4 flame cells observed in equatorial region; birth pore not apparent.

Host: Anachis obesa C. B. Adams (type host), and *Mitrella lunata* Say

Incidence of infection: 21 of 268 *Anachis obesa;* one of one *Mitrella lunata.*

Locality: Mud Cove, Alligator Point, Franklin County, Florida.

The specific name of this cercaria is taken from the Latin *contortus,* meaning "twisted", and refers to the characteristic movements of this species.

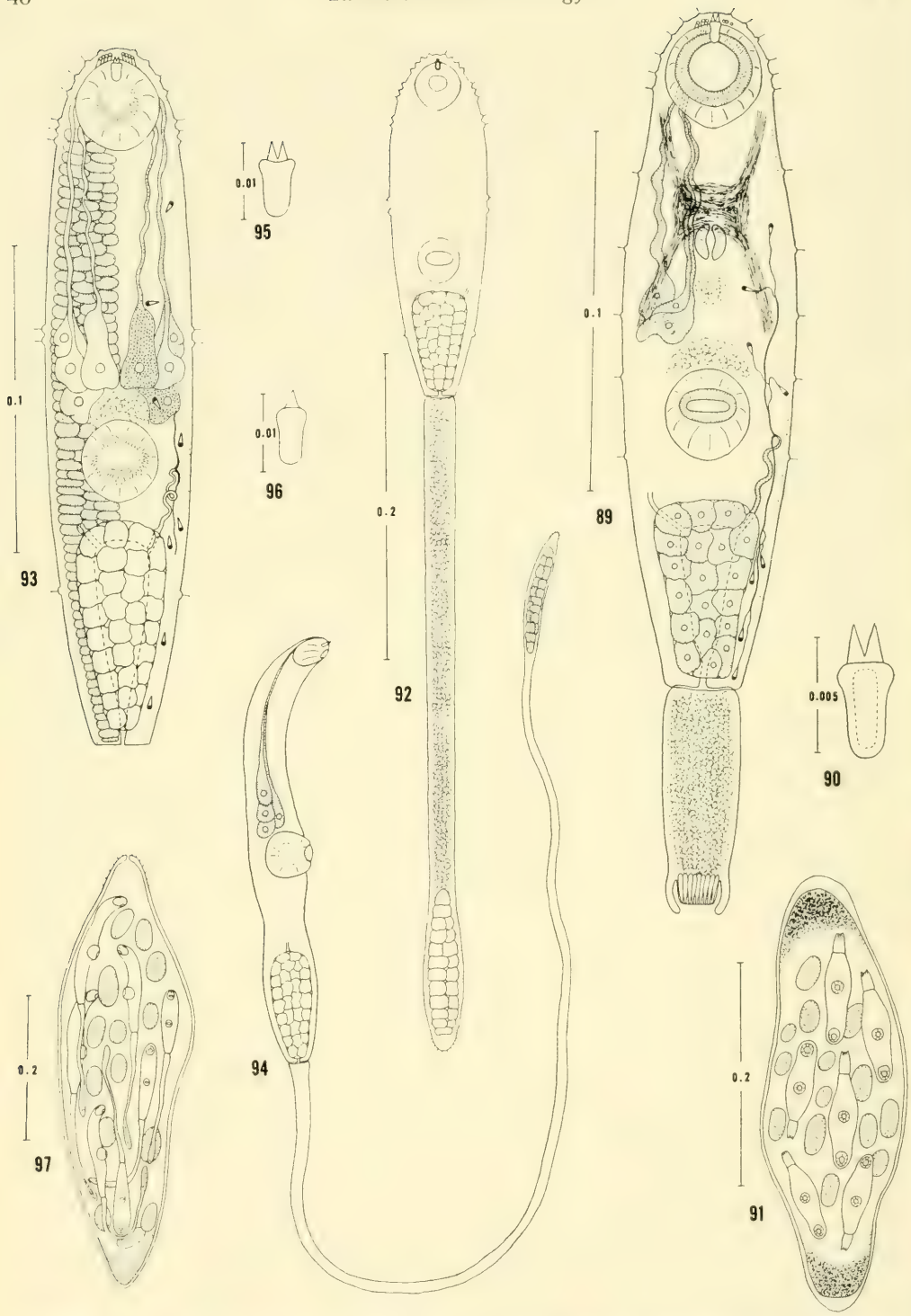
The larva emerges at all hours in large numbers, has a life span of about 36 hours, and shows no phototropisms. Neutral red is non-toxic and readily stains the penetration glands and the adhesive glands in the tail. Nile blue sulfate is relatively non-toxic and stains cephalic ganglia, and the same features as neutral red.

It does not swim, but attaches to the substrate by means of the adhesive glands in the tail tip and either stands erect or lies on its side and contracts ventrally, rolling into a spring-like coil. It has also been observed to contract and contort violently as if trying to tie itself in a knot. The tail can contract to about 1/2 its extended length, the body to about 1/3. When creeping by means of the suckers, the tail length does not change appreciably.

This species resembles most the larval form of *Opecoeloides manteri* described by Hunninen and Cable (1941), but is smaller and has body papillae, and a ciliated anterior collecting tubule. Hunninen and Cable (1943a) observed such cilia in the larva of *Podocotyle atomon,* another closely related form.

Cercaria paradoxa, sp. nov.
(Figures 92-97)

Description: body 0.214-0.240 (0.227) long, 0.038-0.047 (0.042) wide at midlevel. Tail 0.347-0.530 (0.424) long, 0.014-0.016 (0.015) wide at base. Oral sucker 0.029-0.031 (0.030) long, 0.022-0.025 (0.024) wide; mouth subterminal, surrounded by several rows of minute scales or spines; remainder of digestive tract not apparent. Stylet in anterior wall of oral sucker, 0.010 long, 0.006 wide, with two short points; not curved dorso-ventrally; its body circular in cross-section. Acetabulum 0.025-0.029 (0.027) long, 0.023-0.025 (0.023) wide, slightly posterior to midbody; about 6 rows of minute scales or spines around cavity of acetabulum. Body and tail surfaces aspinose; short bristles set in papillae just anterior to midlevel of excretory bladder, at anterior level of penetration glands, and on cephalic end. Tip of tail with few minute bristles. Four overlapping penetration glands on each side, in posterior 1/3 of forebody, with ducts extending anteriorly to open at individual pores on dorsal lip near tip of stylet. Dorsal and ventral glands coarsely granular, staining darkly with neutral red, their ducts and pores medial to those of the middle two glands which are finely granular and stain darkly with Nile blue sulfate. Excretory bladder voluminous, with thick wall composed of large irregularly-shaped cells occupying most of body posterior to acetabulum; with short duct to lateral pores in



Figures 89-97. **89.** *Cercaria contorta*, sp. nov., ventral view showing details of body and tail. **90.** Same, ventral view of stylet. **91.** Same, sporocyst. **92.** *Cercaria paradoxa*, sp. nov., ventral view showing details of tail. **93.** Same, ventral view of cercarial body. **94.** Same, lateral view showing extended resting posture. **95.** Same, ventral view of stylet. **96.** Same, lateral view of stylet. **97.** Same, sporocyst.

body-tail furrow. Main excretory tubules ciliated, joining anterolateral margins of bladder, extending to midlevel of acetabulum where each receives anterior and posterior collecting tubule; their distal portions obscured. Four pairs of flame cells on each side; formula probably $2[(2+2)+(2+2)]=16$. Genital primordium at anterior margin of acetabulum, stained by neutral red. Body filled with oval, granular cystogenous cells. Tail filled with vacuolated parencyhma, distal portion slightly swollen, containing group of granular gland cells, secreting adhesive substance at tip of tail. Development in motile, whitish sporocysts in gonad and liver of host. Sporocysts 0.510-0.705 (0.588) long, 0.150-0.225 (0.180) wide, cuticle smooth; birth pore terminal, surrounded by minute bristles. About 20 embryos, in all stages of development, per sporocyst.

Host: Anachis translirata Ravenel

Incidence of infection: 1 of 5 snails.

Locality: Apalachee Bay, off St. Marks Light, Wakulla County, Florida.

The specific name of this cercaria is taken from the Latin *paradoxus,* meaning "strange" or "contrary to expectation", and refers to the unusual tail structure for a larva of this type.

This species emerges at any hour, has a life span of about 24 hours and displays no phototropisms. Neutral red is non-toxic and stains the genital primordium and dorsal and ventral penetration glands. Nile blue sulfate is non-toxic and stains middle sets of penetration glands.

Being unable to swim, the larva nevertheless displays unusual behavior. At rest, it lies on its side on the bottom with the tail greatly extended (Figure 94). If the vessel is tapped, the larva contracts quickly and coils ventrally. It responds to stirring of the water also by immediate contraction but then slowly relaxes and becomes elongated as it is carried around by the water current. Rapid contraction and relaxation with coiling and uncoiling also occur spontaneously as does creeping with the aid of the suckers. The tip of the tail attaches to the substrate with a weak adhesive secreted by the caudal glands.

Cercaria paradoxa does not closely resemble any other known marine opecoelid larva in having the combined features of 4 pairs of penetration glands, a two-pointed stylet, and the unusually long tail.

J. *Opisthorchioid Cercariae*

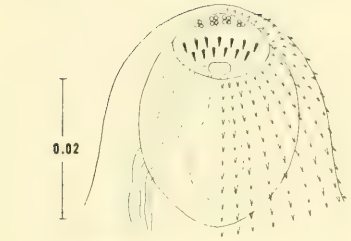
Three new species of pleurolophocercous cercariae were found in the present investigation. All resemble closely larvae in the families Opisthorchiidae and Heterophyidae. The term "pleurolophocercous" was introduced by Sewell (1922) for biocellate, monostome cercariae having well developed caudal finfolds.

Pleurolophocercous cercariae have been studied extensively and many life histories have been elucidated, including several in which man may harbor the adult stage. The following general diagnosis of the cercarial type is abstracted from Cable (1956a):

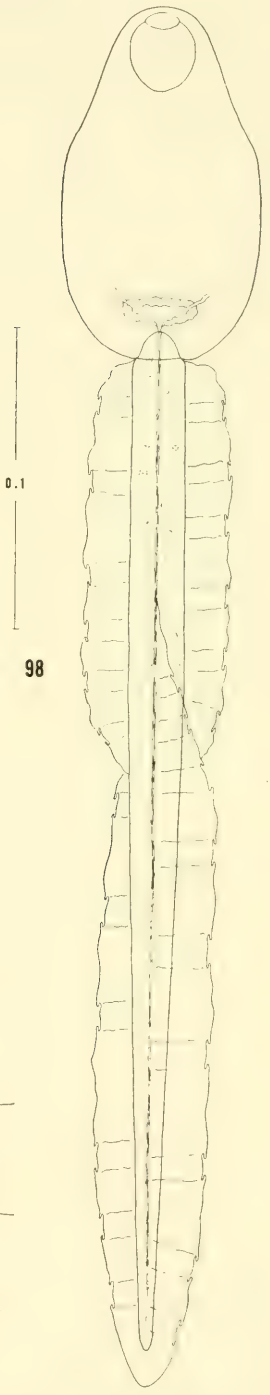
Biocellate cercariae, with acetabulum embryonic or absent. Oral sucker a protrusible penetration organ generally having spines on the dorsal lip. Tail long, with dorsal, ventral, and sometimes lateral finfolds. Penetration glands usually 7 pairs, with ducts usually opening at 4 groups of pores in crypt dorsal to mouth. Pharynx present or rudimentary, remainder of digestive system undeveloped. Excretory bladder thick walled and granular; empirical flame cell formula, where known, usually $2[(n+n)+(n+n)]$ or $2[(n+n+n)+(n+n+n)]$. Development in simple rediae in prosobranch gastropods; encystment generally in fishes; adults in piscivorous vertebrates.

Cercaria cursitans, sp. nov.
(Figures 98-102)

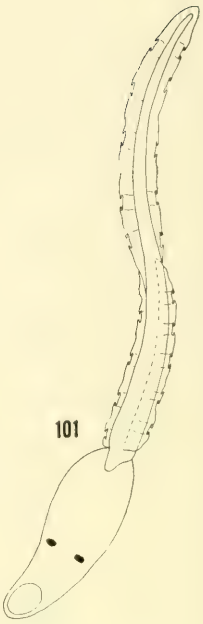
Description: body 0.107-0.138 (0.123) long, 0.056-0.077 (0.065) wide at midlevel. Tail attached subterminally; excluding finfolds, measuring 0.326-0.372 (0.351) long, 0.015-0.020 (0.016) wide at base; proximal end of tail with plicated lateral finfolds 0.138-0.153 (0.144) long, 0.015 wide. Distal portion of tail with plicated dorsal finfold, 0.250-0.286 (0.270) long, 0.021 wide, continuous around tip of tail with similar ventral finfold, 0.230-0.245 (0.235) long, 0.018 wide. Oral sucker 0.025-0.030 (0.028) long, 0.020-0.023 (0.021) wide, its dorsal lip with anterior row of 7 spines and posterior row of 6. Mouth transversely oval, small, subterminal; oral cavity flask-shaped; prepharynx not observed; pharynx small, well developed, somewhat over 1/3 body



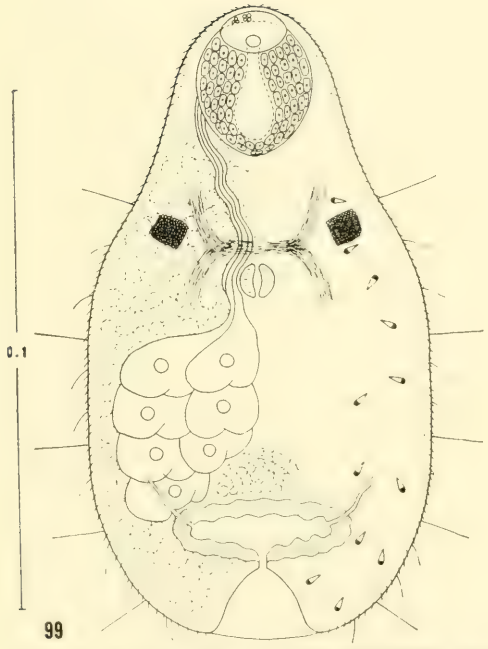
100



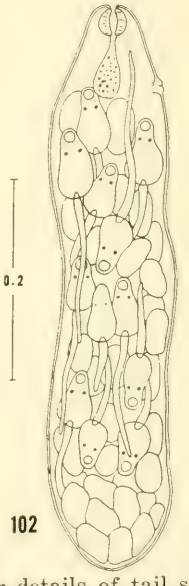
98



101



99



102

Figures 98-102. **98.** *Cercaria cursitans*, sp. nov., dorsal view showing details of tail stem and finolds. **99.** Same, ventral view of cercarial body. **100.** Same, ventral view of cephalic end showing arrangement of spines in oral crypt. **101.** *Cercaria cursitans*, sp. nov., *Cercaria vivata*, sp. nov., and *Cercaria coruscantis*, typical resting postures. **102.** *Cercaria cursitans*, sp. nov., redia.

length from anterior end; remainder of digestive system not observed. Acetabulum undeveloped. Entire body with minute spines forming parallel transverse rows; tail stem smooth. Posterior 3/4 body with scattered, long, stiff bristles and short, curved ones; papillae absent. Seven large penetration glands on each side, 4 lateral, 3 medial, between pharyngeal level and excretory bladder. Gland ducts in single bundle on each side, passing close to pharynx, then in sinuous path to side of oral sucker and dorsally over it to open in crypt above mouth through pores in groups of 3, 4, 4, 3. Excretory bladder transversely oval, with thick granular wall; main excretory tubules joining bladder at its anterolateral margins, extending anteriorly a short distance beyond which they and collecting tubules are obscured by cystogenous glands; 12 flame cells on each side, their formula probably being $2[(2+2+2)+(2+2+2)]=24$. Excretory pore at body-tail junction. Genital primordium a crescent of cells just anterior to excretory bladder. Eyespots well separated, about midway between oral sucker and penetration glands, cuboid, 0.007 × 0.007, composed of spherical brown granules. Cerebral ganglia and commissure between eyespots. Body filled with cystogenous glands, less distinct in anterior half. Development in smooth, whitish rediae in liver of host and measuring 0.418-0.724 (0.560) long, 0.092-0.133 (0.111) wide; pharynx small; cecum short, extending to level of birth pore; cuticle thin, birth pore near anterior end. Twelve to 25 embryos per redia, in all stages of development.

Host: Cerithidea scalariformis Say

Incidence of infection: 1,017 of 5,508 snails.

Locality: Salt marsh, St. Marks Light (type locality), and Shell Point, Wakulla County, Florida.

The specific name of this cercaria is taken from the Latin *cursitans,* meaning "running about", and refers to the swimming movements of the larva.

This species emerges in large numbers at any hour, lives about 24 hours, and is positively phototropic. Neutral red, which is non-toxic, stains the cystogenous glands and genital primordium. Nile blue sulfate is toxic, and both dyes stain the penetration glands equally well.

This cercaria is a strong but intermittent swimmer, moving in an erratic, zig-zag pathway as the tail lashes rapidly. Swimming periods of 2-3 seconds alternate with rest periods of 2-10 seconds, with the body downward and slightly flexed ventrally, and the sigmoid tail above (Figure 101). At rest, the body-tail length ratio is about 1:3; with the body extended, about 1:2. Resting cercariae swim when disturbed.

This species resembles most the cercaria of *Parastictodora hancocki* Martin, 1950, but differs from it in respects given in the following summary:

Cercaria of *Parastictodora hancocki* Martin, 1950	*Cercaria cursitans,* sp. nov.
Oral crypt with 3 rows of spines; 5 in first row, 5-6 in second row, 6-8 in third row.	Oral crypt with 2 rows of spines; 6 in first row, 7 in second row.
Eyespot shape not described; figures show eyespots irregular.	Eyespots cuboidal.

Other larvae less similar to *C. cursitans* but much like it are cercaria of *Euhaplorchis californiensis* Martin, 1950, and *Cercaria caribbea* X Cable, 1956.

Cercaria vivata, sp. nov.
(Figures 103-105)

Description: body 0.148-0.158 (0.151) long, 0.077-0.081 (0.079) wide at midlevel. Tail attached subterminally; excluding finfolds, measuring 0.367-0.413 (0.398) long, 0.021-0.022 (0.022) wide at base; proximal end of tail with plicated lateral finfolds, 0.117-0.128 (0.122) long, 0.014-0.016 (0.015) wide. Distal portion of tail with plicated dorsal finfold, 0.291-0.316 (0.303) long, 0.015-0.016 (0.016) wide, continuous around tip of tail with similar ventral finfold, 0.179-0.199 (0.187) long, 0.013-0.014 (0.013) wide. Oral sucker 0.026-0.029 (0.028) long, 0.023-0.024 (0.024) wide; its structure as in preceding species except spines on dorsal lip apparently lacking and mouth circular. Prepharynx not observed; pharynx small, well developed, about 2/5 body length from anterior end, 0.008 in diameter; remainder of digestive system not observed. Acetabulum undeveloped. Body covered with minute spines and encircled by about 5 irregular rows of long bristles, 2 rows on anterior half of body and 3 on posterior half; papillae absent; cuticle of tail smooth. Seven large, overlapping

penetration glands on each side, 5 lateral and 2 medial, between level of pharynx and midlevel of excretory bladder; their ducts in single bundle on each side, close to midline, passing dorsally over oral sucker to open through pores grouped 3, 4, 4, 3 in crypt above mouth. Excretory bladder transversely oval to V-shaped, with thick, granular wall; excretory pore at body-tail junction. Main excretory tubules joining anterolateral tips of bladder, but after extending anteriorly a short distance, becoming obscured by cystogenous glands as are other excretory tubules. Twelve flame cells on each side, their formula probably $2\ [(2+2+2) + (2+2+2)] = 24$. Genital primordium a globular mass of nuclei just anterior to excretory bladder. Eyespots midway between oral sucker and pharynx, cuboid, measuring 0.007 × 0.007, composed of brown granules. Similar pigment granules throughout body posterior to eyespots, giving larva brown appearance under low magnification (10X). Cerebral ganglia and commissure just posterior to level of eyespots. Body filled with finely granular cystogenous cells. Development in yellow-brown rediae in liver of host. Rediae 0.357-0.561 (0.476) long, 0.077-0.122 (0.095) wide; containing 10 to 20 embryos in all stages of development; cuticle thin, with minute bristles at cephalic end; pharynx small; cecum indistinct, short, extending to level of birth pore. Body wall with scattered fat-like globules and lateral birth pore near anterior end. Excretory network confined to anterior half of body; flame cell formula $2\ [(3) + (3)] = 12$.

Host: Cerithidea scalariformis Say

Incidence of infection: 24 of 5,508 snails.

Locality: Salt Marsh, St. Marks Light (type locality) and Shell Point, Wakulla County, Florida.

The specific name of this cercaria is taken from the Latin *vivatus,* meaning "vigorous" or "animated" and refers to the swimming activity of this species.

Emergence, life span and behavior of this larva are very similar to those of the preceding species. The penetration glands stain darkly with neutral red which is non-toxic. Nile blue sulfate is very toxic; it stains the penetration glands and the cephalic ganglia quickly.

This species resembles *Cercaria caribbea* X Cable, 1956, but differs from it in respects summarized as follows:

Cercaria caribbea X Cable, 1956	*Cercaria vivata,* sp. nov.
Six spines in oral crypt.	Oral crypt unarmed.
Dorsal and ventral caudal fins equal, about 0.114 long.	Dorsal caudal fin 0.291-0.316 long; ventral fin 0.179-0.199 long.
Body pigment absent.	Body pigment present.
Eyespots cuboid, 0.009 X 0.009	Eyespots cuboid, 0.007 X 0.007

Other similar species include the cercariae of *Parastictodora hancocki* Martin, 1950, and *Euhaplorchis californiensis* Martin. 1950.

Cercaria coruscantis, sp. nov.

(Figures 106-108)

Description: body 0.106-0.129 (0.117) long, 0.049-0.056 (0.053) wide at midlevel. Tail attached subterminally; excluding finfolds, measuring 0.270-0.316 (0.297) long, 0.017-0.018 (0.018) wide at base; proximal end of tail with plicated lateral finfolds, 0.112-0.132 (0.121) long, 0.009-0.010 (0.009) wide. Distal portion of tail with plicated dorsal finfold, 0.158-0.173 (0.165) long, 0.007 wide, continuous around tip of tail with similar ventral finfold, 0.138-0.158 (0.149) long, 0.007 wide. Oral sucker 0.023-0.025 (0.024) long, 0.017-0.018 (0.018) wide; its dorsal lip without evident spines; mouth circular, subterminal; oral cavity flask-shaped; prepharynx not observed; pharynx embryonic, about midway between oral sucker and excretory bladder; remainder of digestive system not observed. Acetabulum undeveloped. Minute cuticular spines on anterior third of body; entire surface posterior to oral sucker with scattered long, stiff bristles and short ones; papillae absent; cuticle of tail smooth. Seven large, granular penetration glands on each side between level of pharyngeal primordium and posterior end of body, arranged as shown in Figure 107; their ducts wide, in single bundle on each side close to midline and passing dorsolaterally over oral sucker to open dorsally in oral crypt at pores in groups of 3, 4, 4, 3. Excretory bladder inverted U-shaped, with thick wall; its pore at body-tail junction. Main excretory tubules joining anterolateral margins of bladder, extending from bladder to level of genital primordium where each receives long anterior and short posterior collecting tubule.

Flame cell formula 2 [(2+2) + (2+2)] = 16. Genital primordium an oval mass of nuclei just anterior to excretory bladder. Irregularly oval eyespots of brown granules at level of pharyngeal primordium, measuring about 0.007 × 0.007. Similar pigment granules in body posterior to eyespots, concentrated in lateral regions. Cerebral ganglia and commissure at level just anterior to eyespots. Body filled with indistinct cystogenous cells, those posterior to eyespots staining most intensely with neutral red or Nile blue sulfate. Development in whitish, granular rediae in liver and gonad of host. Rediae 0.408 - 0.673 (0.559) long, 0.061-0.107 (0.088) wide, containing 10 to 15 embryos in various stages of development; cuticle thin, with minute bristles near mouth. Pharynx small; cecum short, extending only slightly beyond level of birth pore.

Host: Cerithidea scalariformis Say

Incidence of infection: 389 of 5,508 snails.

Locality: Salt marsh, St. Marks Light (type locality) and Shell Point, Wakulla County, Florida.

The specific name of this cercaria is taken from the Latin *coruscantis,* meaning "vibrating" and refers to the swimming movements.

Emergence, life span, and behavior of this larva are very similar to those of *C. cursitans* and *C. vivata.* Neutral red is not toxic and stains the genital primordium. Nile blue sulfate is very toxic and stains the cephalic ganglia. The penetration glands are stained equally well with both dyes. The resting cercaria has a body-tail ratio of about 1:2.5 and the body can be extended until the ratio is about 1:1.5.

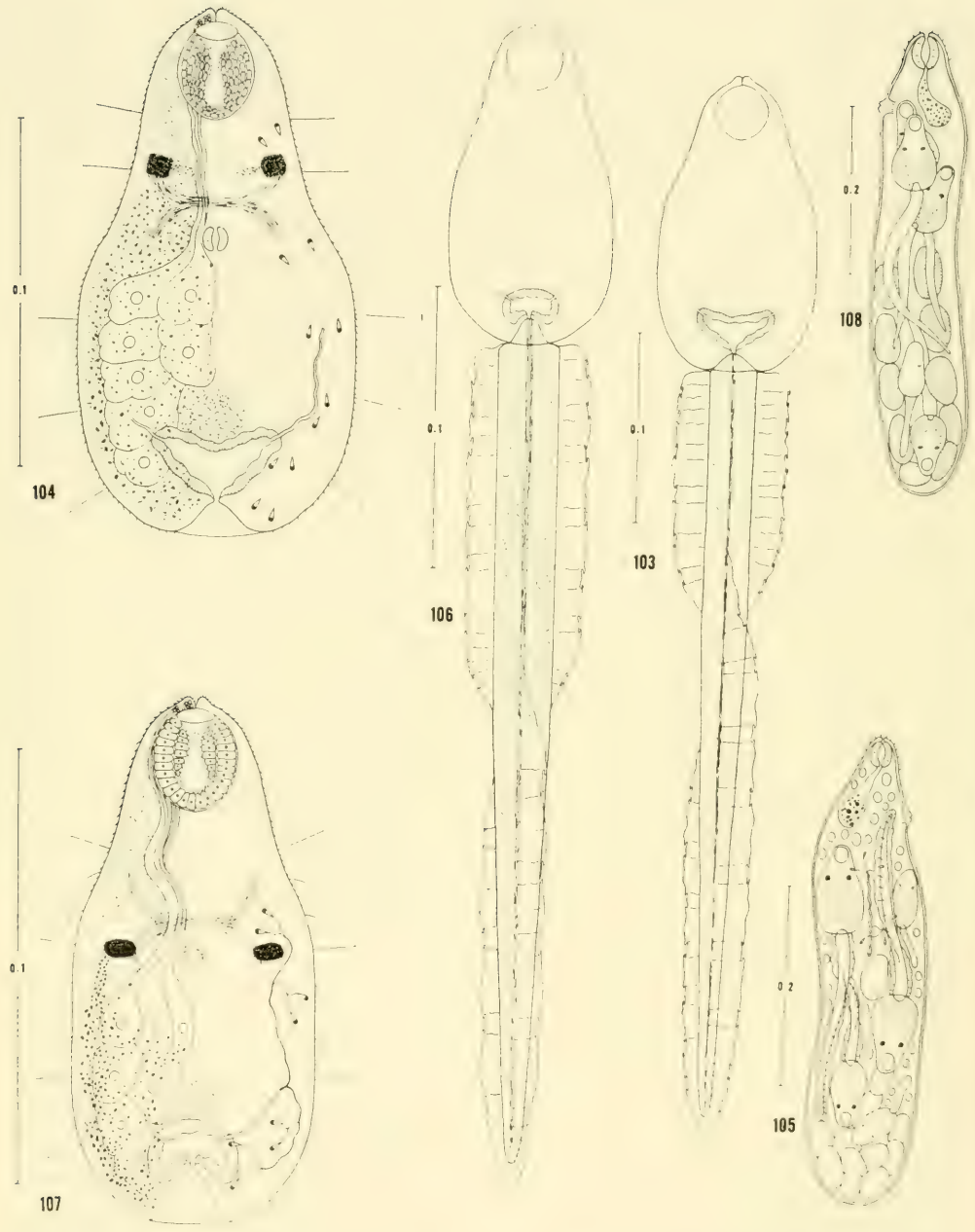
This larva is most closely related to *Cercaria caribbea* X Cable, 1956, and the cercaria of *Euhaplorchis californiensis* Martin, 1950, but differs from them in respects summarized as follows:

Cercaria caribbea X Cable, 1956	Cercaria of *Euhaplorchis californiensis* Martin, 1950	*Cercaria coruscantis* sp. nov.
Six spines in oral crypt.	Five spines in oral crypt.	Oral crypt unarmed.
Entire body spinose.	Entire body spinose.	Anterior 1/3 of body spinose.
Excretory bladder slightly U-shaped.	Excretory bladder transversely oval.	Excretory bladder inverted U-shaped.
Pharynx developed.	Pharynx developed.	Pharynx embryonic.

K. *"Hemiuroid" Cercaria*

One remarkable new cercaria of uncertain family position was found in the present study. It is of the type of *Cercaria caribbea* XXXIV which Cable (1956a) described from Puerto Rico and assigned to the superfamily Hemiuroidea because the larva resembled cystophorous cercariae of that group in certain respects and seemed to illustrate how such cercariae may have been derived from a more generalized type. In a recent personal communication, Cable has stated that his analysis of adults collected in Puerto Rico and further studies in the Caribbean region, including the discovery of an additional species, have raised doubts that such cercariae become adults of the superfamily Hemiuroidea. In his opinion, determination of their status must await solution of the life history. Because such information could justify the recognition of a distinct family for trematodes having such cercariae, a general diagnosis of their type is given:

Biocellate, distome cercariae with a distinctive tail consisting of an enlarged vesicular basal portion with a long, narrow appendage which is an effective swimming organ and, in its embryonic development, bears the primary excretory pores. Forebody narrow, with cuticular spines and conspicuous cephalic glands with ducts opening at anterior end. Hindbody expanded, with numerous peculiar masses, perhaps cystogenous glands. Prepharynx long, pharynx small, esophagus short, intestinal bifurcation near anterior margin of acetabulum; form and extent of ceca uncertain but possibly filling most of the hindbody not occupied by dorsal and ventral parenchymal (muscle?) strands and excretory structures. Excretory bladder not reaching posterior margin of acetabulum, tubular to saccate, with thick wall of columnar cells. Main excretory tubules join anterolateral margins of bladder and extend well into forebody where each receives anterior and posterior collecting tubules; excretory tubules and flame cells coursing in, and supported by dorsal parenchymal strands; flame cells restricted to body. Development in simple rediae in marine prosobranch gastropods. Further hosts unknown.



Figures 103-108. **103.** *Cercaria vivata*, sp. nov., dorsal view showing details of tail stem and finfolds. **99.** Same, ventral view of cercarcarial body. **105.** Same, redia. **106.** *Cercaria coruscantis*, sp. nov., dorsal view showing details of tail stem and finfolds. **107.** Same, ventral view of cercarial body. **108.** Same, redia.

Cercaria portosacculus, sp. nov.
(Figures 109-113)

Description: body pyriform, 0.209-0.306 (0.255) long, 0.112-0.148 (0.131) in maximum width. Tail stem 0.362-0.388 (0.376) long, 0.046-0.051 (0.047) wide at base to which is attached dorsally a large, sac-like structure, 0.138-0.158 (0.147) long, 0.204-0.224 (0.218) wide, and with a wall thickness of 0.150. Oral sucker 0.038-0.047 (0.044) long, 0.037-0.045 (0.041) wide; mouth subterminal; prepharynx not apparent; pharynx spherical, 0.007-0.012 (0.010) in diameter, about 3/4 distance from oral sucker to acetabulum; esophagus very short, bifurcating just anterior to acetabulum; ceca not apparent. Acetabulum at midbody, 0.043-0.045 (0.044) long, 0.046-0.053 (0.050) wide, with single row of minute spines around opening. Anterior 2/3 of body surface spinose; tail surfaces smooth. Papillae and setae absent. Body with dorsal and ventral tracts of longitudinal parenchymal (muscle?) fibers from which many others diverge to internal structures and to body wall (Figure 109). Two groups of cephalic glands on each side; lateral group of 4 large, conspicuous granular glands extending from level of eyespots to midlevel of acetabulum; an undetermined number of small, indistinct glands in a medial group just overlapping pharynx. From each lateral group, a bundle of 4 ducts extends anteriorly near side of body to open at group of pores on dorsal lip; medial glands with minute ducts passing dorsal to oral sucker and opening through indistinct pores near those of large glands. Excretory bladder I-shaped, with wall a single layer of columnar cells, its posterior duct disappearing into parenchyma of tail, probably opening through lateral pores on stem, as in other "hemiuroids". Main collecting tubules extending in sinuous path to level of medial penetration glands where each receives short anterior and long posterior collecting tubule; other tubules obscured; 18 flame cells on each side. Eyespots spherical, 0.012 in diameter. Bilobed, hyaline structure (cephalic ganglia?) at level of eyespots between oral sucker and pharynx. Posterior half of body, near excretory bladder, with small, oval cystogenous cells, densely packed in linear order. Tail stem filled with vacuolated parenchyma and rod-like, granular bodies. Caudal vesicle apparently filled with vacuolated parenchyma and internal network of muscles forming a fibrous mat. Development in whitish, smooth rediae in liver of host. Rediae 0.332-0.490 (0.395) long, 0.143-0.189 (0.165) wide, containing about 35 embryos in various stages of development; birth pore not apparent; pharynx small; cecum short. Caudal vesicle and tail stem develop simultaneously on each embryo. Cercarial body never retracted into vesicle or tail stem.

Host: Anachis obesa C. B. Adams
Incidence of infection: 2 of 268 snails.
Locality: Mud Cove, Alligator Point, Franklin County, Florida.

The specific name of this cercaria is derived from the Latin *porto* + *sacculus* meaning "to carry a small sac", and refers to the vesicular structure attached to the base of the tail stem.

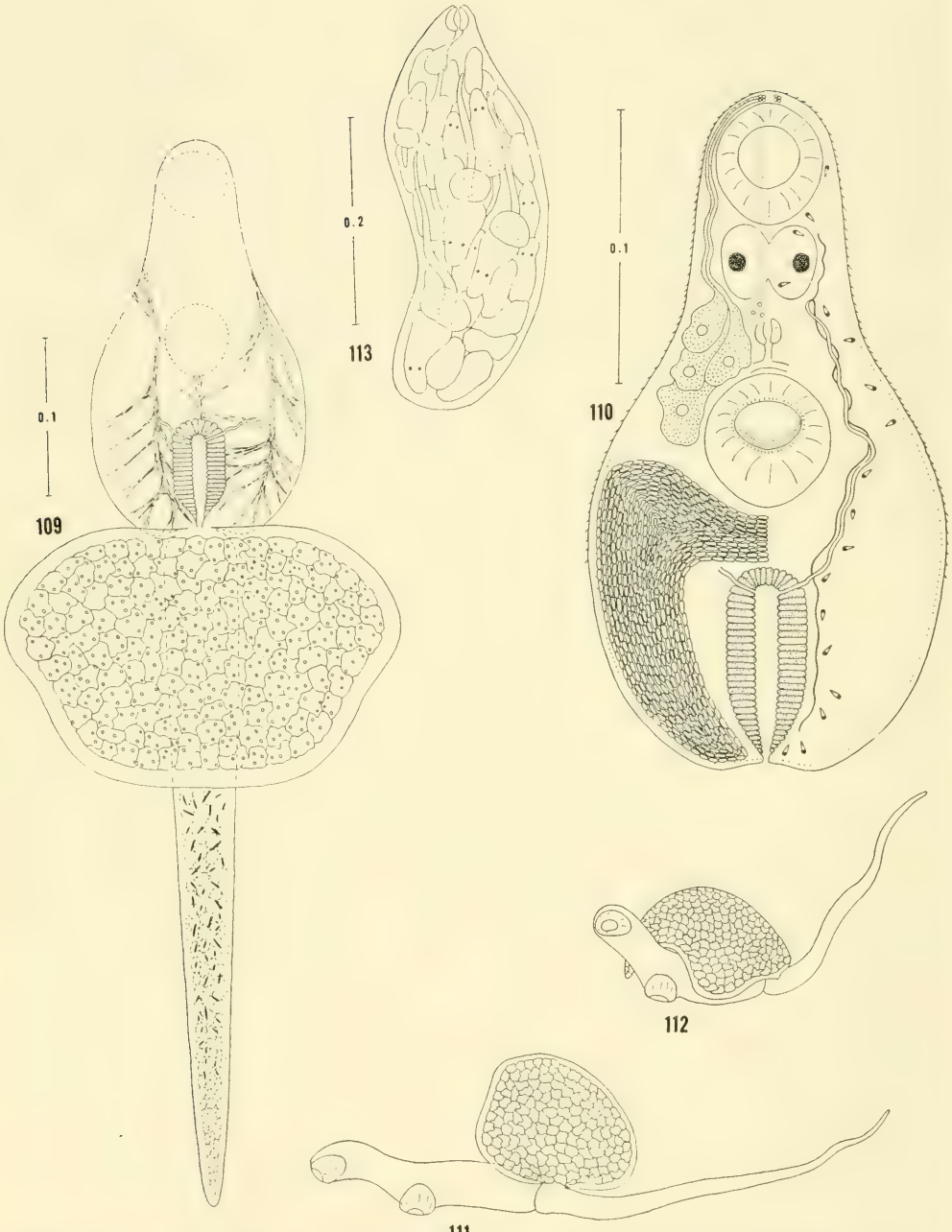
This larva emerges at night in small numbers, has a life span of about 36 hours and is photopositive. Neutral red is slightly toxic; it stains the large penetration glands lightly, the small glands darkly, and it stimulates flame cell activity. Nile blue sulfate is very toxic and stains the cystogenous glands and cephalic ganglia.

This species swims vigorously, lashing the tail from side to side with the forebody slightly arched (Figure 111). When resting, the larva sinks to the bottom, ventral side down, with the body contracted into a depression in the anteroventral side of the caudal vesicle and the tail stem pointing upward at an angle of about 45° (Figure 112). At times, the larva will lie on its side with its parts in the same relative positions.

Cercaria portosacculus resembles *C. caribbea* XXXIV Cable, 1956, but differs from it in the number of cephalic glands, shape of the caudal vesicle, shape and size of the body, and other less apparent features.

V. Introduction to Key and Bibliography

A survey of marine cercariae necessarily entails a comprehensive study of the literature. Since no keys to marine cercariae exist, except Cable's (1956a) which deals with 51 species from Puerto Rico, a study of the world's literature has been undertaken with the purpose of abstracting pertinent data concerning each described cer-



Figures 109-113. **109.** *Cercaria portosacculus*, sp. nov., dorsal view showing dorsal parenchymal (muscle?) fibers on left side and ventral fibers on right side of body, and details of vesicle and tail. **110.** Same, ventral view of cercarial body. **111.** Same, lateral view showing swimming posture. **112.** Same, laterofrontal view showing resting posture. **113.** Same, redia.

caria. These cercariae have been categorized as far as possible according to LaRue's (1957) scheme of classification in a Key to Superfamilies with the species listed according to families, where possible.

The names of all described marine cercariae encountered, regardless of the accuracy and quality of their descriptions, have been included in the key. Almost all of the cercarial descriptions published prior to 1900 are inadequate by modern standards and one would have difficulty recognizing and comparing these larval stages with living material.

In using the key, the readers must realize that external morphology is no longer the sole basis for classifying cercariae. For example, trichocercous forms are found in the Allocreadioidea and Fellodistomatoidea; tailless forms are found in the Plagiorchioidea, Allocreadioidea and Fellodistomatoidea; and xiphidiocercariae are found in the Plagiorchioidea and Allocreadioidea. An effort has been made to categorize forms of uncertain affinities properly by comparing them with cercariae whose life cycles are known. There is little or no question concerning the taxonomic position of many cercariae. Where no suggestion of affinity was made by another author, or a suggestion seemed incorrect, the writer used his own judgment in placing the cercaria. These examples are marked by an asterisk.

At the conclusion of the key, a category of cercariae of unknown status has been included. These larvae were either inadequately described or their descriptions do not fit any category in the key.

The assemblage of "type" and "group" names introduced by Sewell (1922), Lühe (1909), Cort (1915), and others are used only to a limited extent. These terms, which were originally devised to show morphological relationships between cercariae, are now obsolete. We now know through life history studies, as indicated above, that morphologically dissimilar cercariae can be members of the same family.

The key contains 334 different species of marine cercariae. Thirty-six additional names have been reduced to synonymy. Eighteen per cent, or 60 species, have had their life cycles partially or completely elucidated.

The bibliography includes not only cited references but all references to authors of specific names that appear in the key and elsewhere.

Key To Superfamilies Of Cercariae With a Checklist of Known Marine Species

I. Primitive excretory bladder retained, i.e. not replaced by cells from mesoderm, hence definitive excretory bladder not epithelial. Cercariae with forked or single tails, sometimes absent in Fellodistomatidae, caudal excretory vessels present in developing cercariae (except perhaps in certain species of Renicolidae); stylet always absent ..... Superorder Anepitheliocystidia LaRue, 1957

A. Cercariae usually fork-tailed.....Order Strigeatoidea LaRue, 1926

1. Cercariae fork-tailed; usually distomate; excretory bladder V-shaped; protonephridia mesostomate or stenostomate; penetration glands present; active penetration into next host ..... Suborder Strigeata LaRue, 1926

a. Cercariae usually longifurcate, tail-stem usually slender; oral sucker well developed; acetabulum usually present; two to four pairs of large penetration glands located in acetabular zone (Strigeidae, Diplostomidae), or many glands near cecal bifurcation (Cyathocotylidae); protonephridia mesostomate; development in filiform sporocysts; three-host life cycle .....Superfamily Strigeoidea Railliet, 1919

Family Strigeidae Railliet, 1919

**Cercaria* sp. (abnormal) Mathias, 1930

Cercaria nassa Martin, 1945

**Cercaria* "K" Hutton, 1952

Family Cyathocotylidae Poche, 1926

Cercaria utriculata Lutz, 1933

Cercaria "R" McCoy, 1928

Cercaria sp. Maxon and Pequegnat, 1949

Cercaria caribbea L Cable, 1956

Cercaria caribbea LI Cable, 1956

Cercaria ogatai Ito, 1956

No marine cercariae described for the following families:

Family Diplostomidae Poirier, 1886

Family Brauninidae Bosma, 1931

Family Bolbocephalodidae Strand, 1935

Family Proterodiplostomidae Dubois, 1937

b. Cercariae brevifurcate; apharyngeate; oral sucker replaced by extensible penetration organ as in Schistosomatidae; acetabulum rudimentary; penetration glands as in Strigeidae and Diplostomidae; eyespots pigmented; develop in rediae; three-host life cycle ..... Superfamily Clinostomoidea Dollfus, 1931

Family Clinostomidae Luhe, 1901. No marine cercariae described for this family.

c. Cercaria brevifurcate; apharyngeate; oral sucker replaced by extensible penetration organ; six or seven pairs of penetration glands; with or without pigmented eyespots; development in simple sporocysts; cercariae penetrating into final host..Superfamily Schistosomatoidea Stiles and Hassal, 1926

Family Schistosomatidae Looss, 1899

Cercaria of *Austrobilharzia variglandis,* Penner, 1953; *syns*: *Cercaria variglandis,* Miller and Northup, 1926; *Microbilharzia variglandis,* Stunkard and Hinchliffe, 1952

Cercaria littorinalinae Penner, 1950

Cercaria "H" Hutton, 1952

Cercaria of *Gigantobilharzia huttoni* (Leigh, 1953) Leigh, 1955; *syns*: *Cercaria* huttoni Leigh, 1953; *Cercaria* "J" Hutton, 1952

Cercaria of *Ornithobilharzia canaliculata* (Odhner, 1912) Penner, 1953

Cercaria Caribbea XLIX Cable, 1956

Cercaria tympanotoni Ito, 1956

Cercaria of *Austrobilharzia terrigalensis* (Johnston, 1917) Bearup, 1956

Family Aporocotylidae Odhner, 1912

Cercaria loossi Linton, 1915

Cercaria sp. Linton, 1915

Cercaria solemyae Martin, 1944

Cercaria hartmanae Martin, 1952

Cercaria sp. Holliman, 1958; *syn*: *C. asymmetrica,* sp. nov.

Family Spirorchiidae Stunkard, 1921. No marine cercariae described for this family.

2. Cercariae fork-tailed or variously modified from that condition; distomate or gasterostomate. Cercariae usually furcocystocercous; distomate or monostomate; protonephridia stenostomate, with flame cell groups in the tail; development in rediae .....Suborder Azygiata LaRue, 1957

a. Cercariae furcocystocercous ... Superfamily Azygioidea Skrjabin and Guschanskaja, 1956

Family Azygiidae Odhner, 1911. No marine cercariae described for this family.

Family Bivesiculidae Yamaguti, 1939

Cercaria sp. Katsuta, 1932

Cercaria caribbea XLVIII LeZotte, 1954; syn: *Cercaria* "A" Hutton, 1952

Cercaria caribbea XLVI LeZotte, 1954; syn: *Cercaria* "B" Hutton, 1952

Cercaria caribbea XLIV LeZotte, 1954; syn: *Cercaria* "C" Hutton, 1952

Cercaria caribbea, XLIII LeZotte, 1954

Cercaria caribbea XLV LeZotte, 1954

Cercaria caribbea XLVII LeZotte, 1954

b. Cercariae brevifurcate; tail stem bearing a pair of anteriorly placed appendages; body leaflike: distomate; apharyngeate; eyespots pigmented; branches of gut fused posteriorly ...Superfamily Transversotrematoidea LaRue, 1957

Family Transversotrematidae Yamaguti, 1953. No marine cercariae described for this family.

3. Cercariae distomate; tail very short and bilobed (*Pseudhyptiasmus*) or lacking; excretory bladder V-shaped; developing in rediae; encysting in or near rediae ...Suborder Cyclocoelata LaRue, 1957

Characterisitcs the same as for Suborder ..... Superfamily Cyclocoelidea Nicoll, 1934

No marine cercariae described for the following families:

Family Cyclocoelidae Kossack, 1911

Family Typhlocoelidae Bittner and Sprehn, 1928

Family Bothrigastridae Dollfus, 1948

4. Cercariae distomate; tail forked, of moderate size, greatly reduced, or lacking; protonephridia stenostomate; development in sporocysts.. Suborder Brachylaimata LaRue, 1957

a. Tail functional, rudimentary, or lacking; excretory vesicle V-shaped with short arms; development in branching sporocysts in aquatic or terrestrial snails; life cycle with 2 or 3 hosts; those with 3 hosts provided with penetration glands near acetabulum and in oral sucker .....Superfamily Brachylaimoidea Allison, 1943 (emend. LaRue, 1957)

Family Brachylaimidae Joyeux and Foley, 1930. No marine cercariae described for this family.

b. Cercariae with tail forked, modified to single tail, or lacking; tail stem with or without paired multiple setae; excretory vesicle U- or lyre-shaped, with short stem and long broad arms; protonephridia stenostomate; penetration glands numerous and far anterior; development in simple sporocysts in marine lamellibranchs; 3 host life cycle ..... Superfamily Fellodistomatoidea LaRue, 1957

Family Fellodistomatidae Nicoll, 1913 Fork-tailed cercariae:

Cercaria dichotoma Muller, 1850

**Cercaria fissicauda* LaValette, 1855

**Cercaria* sp. Huet, 1888

Cercaria sp. Haswell, 1903; *syn*: *Cercaria tergestia haswelli,* Dollfus, 1927

Cercaria syndosmyae Pelseneer, 1906

Cercaria of *Fellodistomum fellis* Nicoll, 1909

Cercaria margaritae Lebour, 1911

**Cercaria* sp. Odhner, 1911

**Cercaria discursata* Sinitzin, 1911

Cercaria sp. Stafford, 1912

Cercaria kenti Dollfus, 1927

Cercaria baltica Markowski, 1936

Cercaria of *Haplocladus* sp. Rees, 1947

Cercaria mathiasi Dubois, Baer and Euzet, 1952

Cercaria myae Uzmann, 1952; syn: *Cercaria* sp. I Stunkard and Uzmann, 1958
Cercaria caribbea XLI Cable, 1953; *syn*: Cercaria of *Parvatrema borinquenae* Cable, 1953
Cercaria reesi Hutton, 1953; syn: *Cercaria* sp. II Stunkard and Uzmann, 1958
Cercaria sp. Loesch, 1957
Cercaria of *Parvatrema donacis* Hopkins, 1958
Cercaria sp. III Stunkard and Uzmann, 1958

Trichocercous cercariae:
Cercaria of *Bacciger bacciger* (Rud., 1819) Palombi, 1932; syns:
Cercaria lata Lespes, 1857; Huet, 1891; *Cercaria lutea* Giard, 1897; *Cercaria* sp. Fujita, 1906; *Cercaria* sp. Pelseneer, 1906.
Cercaria pectinata Chilton, 1905
Cercaria pennata Sinitzin, 1911
Cercaria plumosa Sinitzin, 1911
Cercaria chiltoni Dollfus, 1925
Cercaria laevicardium Martin, 1945; syn: *Cercaria laevicardii*, Cable, 1954
Cercaria caribbea XXXIX Cable, 1956

Tailless cercariae:
Cercaria of *Gymnophallus somateriae* Jameson, 1902; *syns*: *Cercaria glandosa* Lebour, 1911; *Cercaria strigata* Lebour, 1911; Cercaria of *Gymnophallus oedemiae* Jameson and Nicoll, 1913
**Cercaria crispata* Pelseneer, 1906
Cercaria sp. Dubois, 1907
Cercaria cambrensis Cole, 1938
Cercaria of *Rhodotrema quadrilobata* Bazikalova, 1932
Cercaria fulbrighti Hutton, 1952
Cercaria branchidontis Hopkins, 1954

Microcercous cercariae:
Cercaria milfordensis Uzmann, 1953; syn: Cercaria of *Proctoeces maculatus* (Looss, 1901), Stunkard and Uzmann, 1959
Cercaria adranocerca Stunkard and Uzmann 1959

Furcotrichocercous cercaria:
Cercaria caribbea XL Cable, 1956

C. Cercariae gasterostomate: tail stem short and bulbous; furcae very long and active; excretory vesicle cylindrical; protonephridia mesostomate; development in branched sporocysts in lamellibranchs of fresh and brackish waters; life cycle with 3 hosts ..... Superfamily Bucephaloidea LaRue, 1926
Family Bucephalidae Poche, 1907
Cercaria of *Bucephalus* (*Bucephalopsis*) *haimeanus* Lacaze-Duthiers, 1854
Cercaria of *Bucephalus cuculus* McCrady, 1874
Cercaria of *Bucephalus crux* Levinsen, 1881
Cercaria sp Haswell, 1903
Cercaria of *Bucephalus syndosmyae* Lebour, 1911
Cercaria hydriformis Sinitzin, 1911; syn: Cercaria of *Bucephalus haimeanus tapes rugatus* Sinitzin, 1909
Cercaria "N" Miller, 1925
Cercaria of *Bucephalus margaritae* Ozaki and Ishibashi, 1934
Cercaria of *Bucephalus mytili* Cole, 1935
Cercaria of *Prosorhynchus squamatus* (Odhner, 1905) Chubrik, 1952
Cercaria caribbea XLII Cable, 1956
Cercaria of *Bucephalus loeschi* Hopkins, 1958

B. Cercariae with large bodies and strong tails; cystogenous glands numerous; protonephridia stenostomate; miracidia with one pair of flame cells; development in rediae ..... Order Echinostomida LaRue, 1957

1. Cercariae echinostomate or exhibiting modifications therefrom in time of appearance of collar and collar-spines and in degree of development of these structures; development in collared rediae with stumpy appendages; life cycle usually involving 3 hosts ..... Suborder Echinostomata Szidat, 1939
Characteristics the same as for Suborder ..... Superfamily Echinostomoidea Faust, 1929
Family Echinostomidae Looss, 1902
Cercaria with collar spines:
Cercaria proxima Lespes, 1857
Cercaria of *Echinostomum leptosomum* Lebour, 1911
Cercaria of *Echinostomum secundum* Lebour, 1911
Cercaria littorinae obtusatae Lebour, 1911
Cercaria of *Himasthla quissetensis* (Miller and Northup, 1926); *syn*: *Cercaria quissetensis* Miller and Northup, 1926
Cercaria of *Acanthoparyphium* sp. Yamaguti, 1934
Cercaria granifera Ogata, 1943
Cercaria I Maxon and Pequegnat, 1949
Cercaria III Maxon and Pequegnat, 1949
Cercaria "G" Hutton, 1952
Cercaria "L" Hutton, 1952
Cercaria caribbea II Cable, 1956
Cercaria caribbea III Cable, 1956
Cercaria ophthalmoechinata Ito, 1957
Cercaria yamaguti Ito, 1957

Cercariae without collar spines:
Cercaria "F" Hutton, 1952
Cercaria caribbea IV Cable, 1956
Cercaria caribbea VI Cable, 1956
Family Philophthalmidae Travassos, 1918
**Cercaria* sp. Lebour, 1907
Cercaria of *Parorchis acanthus* (Nicoll, 1906); *syns*: *Cercaria purpurae* Lebour 1911; Cercaria of *Parorchis avitus* Linton, 1914; *Cercaria sensifera* Stunkard and Shaw, 1934; *Cercaria* II Maxon and Pequegnat, 1949; *Cercaria purpurae* var. *australis* Angel, 1954

**Cercaria patellae* Lebour, 1911
**Cercaria* "O" Miller, 1925
Cercaria of *Cloacitrema michiganensis* McIntosh, 1938, Robinson, 1952
**Cercaria caribbea* V Cable, 1956
**Cercaria pseudogranifera* Ito, 1957
Family Haplosplanchnidae Poche, 1926
Cercaria of *Haplosplanchnus acutus*, Cable, 1954; *syn*: *Cercaria caribbea* XXXVIII Cable, 1954
**Cercaria digitalis* Schell and Thomas, 1955
No marine cercariae described for the following families:
Family Fasciolidae Railliet, 1895
Family Rhopaliidae Looss, 1898
Family Psilostomidae Odhner, 1911
Family Campulidae Odhner, 1926
Family Rhytidodidae Odhner, 1926
Family Cathaemasiidae Fuhrmann, 1928

3 Cercariae amphistomate or monostomate; penetration apparatus lacking; bodies heavily pigmented; two or three pigmented eyespots; development in rediae lacking collar and usually lacking stumpy appendages; cercariae emerging from rediae before completing growth; 2 host life cycle; encystment on substrate ..... Suborder Paramphistomata Szidat, 1936

a Cercariae typically amphistomate; pharynx present and often replacing oral sucker ..... Superfamily Paramphistomatoidea Stiles and Goldberger, 1910
Family Mesometridae Poche, 1926
Cercaria of *Mesometra orbicularis* (Rud., 1819), Palombi, 1937
No marine cercariae described for the following families:
Family Paramphistomatidae Fischoeder, 1901
Family Gastrodiscidae Stiles and Goldberger, 1910
Family Gastrothylacidae Stiles and Goldberger, 1910
Family Heronimidae Ward, 1918
Family Microscaphidiidae Travassos, 1922
Family Cladorchiidae Southwell and Kirschner, 1937
Family Brumptidae Skrjabin, 1949
Family Diplodiscidae Skrjabin, 1949
Family Stephanopharyngidae Skrjabin, 1949

b. Cercaria monostomate; pharynx lacking; main collecting vessels fused anteriorly; protrusible cup-shaped attaching structures situated posterolaterally .... Superfamily Notocotyloidea LaRue, 1957
Family Notocotylidae Luhe, 1909
Cercaria ephemera Lebour, 1907
Cercaria inkermanni Sinitzin, 1911
Cercaria zostera Sinitzin, 1911
Cercaria "Q" Miller, 1926
Cercaria lebouri Stunkard, 1932
Cercaria sp. Maxon and Pequegnat, 1949
Cercaria caribbea I Cable, 1956
Cercaria of *Catatropis johnstoni* Martin, 1956
No marine cercariae described for the following families:
Family Pronocephalidae Looss, 1902
Family Rhabdopoeidae Poche, 1926

C. Cercariae of rhodometopa type (distomate; pharyngeate; body large, two or four groups of small penetration glands anterior to ventral sucker; tail large, frequently provided with dorsal, ventral, and lateral fins; excretory bladder large, Y-shaped, with lateral diverticula arising from stem and arms, post-acetabular commissure present or lacking; protonephridia mesostomate; caudal vessels usually present in developing cercariae; development in simple sporocysts in marine gastropods; 3-host life cycle) Order Renicolida LaRue, 1957
Characteristics the same as for Order ..... Suborder Renicolata LaRue, 1957
Characteristics the same as for Order ..... Superfamily Renicoloidea LaRue, 1957
Family Renicolidae Dollfus, 1939
Cercaria rhodometopa Perez, 1924, 1926
Cercaria "D" Miller, 1925
Cercaria "E" Miller, 1925
Cercaria "H" Miller, 1925
Cercaria ampelis Rothschild, 1935
Cercaria doricha Rothschild, 1935; *syn*: *Cercaria dorichapigmentata* Wright, 1956
Cercaria herpsyllis Rothschild, 1935
Cercaria nicarete Rothschild, 1935
Cercaria pythionike Rothschild, 1935
Cercaria ranzii Rothschild, 1935
**Cercaria prehensa* Schell and Thomas, 1955
Cercaria caribbea VII Cable, 1956
Cercaria caribbea VIII Cable, 1956
Cercaria caribbea IX Cable, 1956
Cercaria cooki Wright, 1956

II. Primitive excretory bladder surrounded by, and then replaced by, layer or cells derived from mesoderm, hence definitive bladder thick-walled and epithelial, cercarial tail single, reduced in size, or lacking; caudal excretory vessels present or lacking ..... Superorder Epitheliocystidia LaRue, 1957

A. Cercariae completely lacking caudal excretory vessels at any stage of development; stylet present or lacking .... Order Plagiorchiida LaRue, 1957

1. Cercaria typically distomate and pharyngeate; of various xiphidiocercarial types (armatae, ornatae, virgulae, microcotylae, or tailless); stylet horizontal; protonephridia mesostomate; encystment in invertebrates (chiefly arthropods, rarely in vertebrates ..... Suborder Plagiorchiata LaRue, 1957

a. Characteristics the same as for Suborder ..... Superfamily Plagiorchioidea Dollfus, 1930
Family Microphallidae Travassos, 1921
Tailless cercariae:
**Cercaria dentalii* Pelseneer, 1906
**Cercaria giardi* Pelseneer, 1906
Cercaria oocysta Lebour, 1907
Cercaria littorinae-rudis Lebour, 1911

Cercaria sinuosa Sinitzin, 1911 ; *syn* : *Cercaria plicata var. rissoa* Sinitzin, 1910
**Cercaria suctoria* Sinitzen, 1911
**Cercaria* sp. Linton, 1915
Cercaria tenuans Cole, 1935
**Cercariacum hydrobiae ventrosae* Markowski, 1936
Cercaria franci Arvy, 1952

Distome xiphidiocercaria :
Cercaria of *Microphallus pirum* (Afanassjew, 1941) Schiller, 1959

Monostome xiphidiocercariae :
Cercaria of *Microphallus similis* (Jagersk, 1900), Stunkard, 1957 ; *syns* : *Cercaria ubiquita* Lebour, 1911 ; Cercaria of *Spelotrema simile* Lebour, 1911 ; *Cercaria ubiquitoides* Stunkard, 1932 ; *Cercaria* sp. Rees, W. J., 1936
Cercaria grisea Markowski, 1936
Cercaria of *Levinseniella cruzi* (Travassos, 1920) Young, 1938
Cercaria of *Gynaecotyla adunca* (Linton, 1905) Hunter and Vernberg, 1953 ; *syns* : *Cercaria nassicola* Cable and Hunninen, 1940 ; *Cornucopula nassicola* (Cable and Hunninen, 1938) ; *Gynaecotyla nassicola* (Cable and Hunninen, 1938) Rankin, 1940
Cercaria of *Spelotrema nicolli* Cable and Hunninen, 1940
Cercaria misenensis Palombi, 1940
Cercaria ubiquitensis Palombi, 1940
Cercaria sp. Maxon and Pequegnat, 1949
Cercaria minima Schell and Thomas, 1955
Cercaria caribbea XXV Cable, 1956
Cercaria caribbea XXVI Cable, 1956
Cercaria caribbea XXVII Cable, 1956
Cercaria caribbea XXVIII Cable, 1956
Cercaria caribbea XXIX Cable, 1956
Cercaria caribbea XXX Cable, 1956
Cercaria caribbea XXXI Cable, 1956

Plagiorchioid cercariae of unknown affinity :
Distome xiphidiocercariae :
**Cercaria brevicauda* Pelseneer, 1906
**Cercaria emasculans* Pelseneer, 1906
**Cercaria cribrata* Sinitzin, 1911
**Cercaria plicata* var. *cerithiolus* Sinitzin, 1910 ; syn : *Cercaria dimorpha* Sinitzin, 1911
**Cercaria* "G" Miller, 1925
**Cercaria parvicaudata* Stunkard and Shaw, 1931
**Cercaria roscovita* Stunkard, 1932
Cercaria caribbea XXXII Cable, 1956
Cercaria caribbea XXXIII Cable, 1956

*Family Brachycoeliidae Johnston, 1912
**Cercaria cerithidia* Porter, 1938

No marine cercariae described for the following families :
Family Plagiorchiidae Luhe, 1901
Family Dicrocoeliidae Odhner, 1910
Family Lecithodendriidae Odhner, 1910
Family Cephalogonimidae Nicoll, 1915
Family Collyriclidae Ward, 1918
Family Eucotylidae Skrjabin, 1924
Family Lissorchiidae Poche, 1926
Family Mesotretidae Poche, 1926
Family Stomylotrematidae Poche, 1926
Family Urotrematidae Poche, 1926
Family Haplometridae McMullen, 1937
Family Macroderoididae McMullen, 1937
Family Ochetosomatidae Leao, 1944

b. Cercariae of various types (ophthalmoxiphidiocercariae, microcercous, cotylomicrocercous, macrocercous, rhopalocercous, ophthalmotrichocercous, tailless, or of megaperid type with muscular tail having lateral and ventral fins) ; stylet usually not horizontal, if present ; protonephridia usually mesostomate ; excretory bladder saccate or Y-shaped ; development in rediae or sporocysts, in snails or lamellibranchs ; encystment in invertebrates (chiefly arthropods), rarely in vertebrates ; usually 3 host life cycle ..... Superfamily Allocreadioidea Nicoll, 1934
Family Acanthocolpidae Luhe, 1909
Ophthalmoxiphidiocercariae :
**Cercaria microsoma* Sinitzin, 1911
Cercaria of *Stephanostomum tenue* (Linton, 1898) Martin, 1939
Cercaria of *Stephanostomum baccatum* (Nicoll, 1907) Wolfgang, 1955
Family Allocreadiidae Stossich, 1903
Leptocercous cercariae :
**Cercaria parvirenalis* Pelseneer, 1906
Cercaria of *Acanthopsolus laeniformis* Lebour, 1911
Cercaria of Lepodora rachion (Cobbold, 1858) Lebour, 1913
**Cercaria mesentera* Sinitzin, 1911
**Cercaria metentera* Sinitzin, 1911
**Cercaria trivesicata* Sinitzin, 1911
**Cercaria zernowi* Sinitzin, 1911
**Cercaria* sp. Rothschild, 1939
**Cercaria diecarchiae* Palombi, 1940
Family Lepocreadiidae Nicoll, 1934
Oculate trichocercous cercariae :
**Histrionella echinocerca* Diesing, 1855 ; *syn* : *Cercaria echinocerca* Diesing, 1858
**Cercaria echinocerca* Filippi, 1855
**Cercaria elegans* LaValette, 1855 ; *syn* : *Distomum cavinariae* Carus, 1885
**Cercaria coni mediterranei* Filippi, 1857
*Cercaria of *Macrurochacta aculeatharum* Costa, 1864

**Cercaria fascicularis* Villot, 1875
**Cercaria* sp. Fewkes, 1882
**Histrionella setosicauda* Daday, 1888
Cercaria of *Opechona bacillaris* (Molin, 1859) Lebour, 1916
**Cercaria quintareti* Dollfus, 1925
**Cercaria* sp. Dollfus, 1925
Cercaria of *Lepocreadium setiferoides* (Miller and Northup, 1926); *syn*: *Cercaria setiferoides* Miller and Northup, 1926
Cercaria of *Lepocreadium* sp. Dollfus, 1927
Cercaria of *Lepocreadium album* (Stossich, 1890) Palombi, 1937
Cercaria of *Deropristis inflata* (Molin, 1859) Cable and Hunninen, 1942; *syn*: *Cercaria inflata* Cable and Hunninen, 1942

Non-oculate trichocercous cercariae:
Cercaria setifera Muller, 1850
**Distomum hippopodii* Vogt, 1853
**Cercaria thaumantiatis* Graeffe, 1858
**Cercaria villoti* Monticelli, 1888
**Cercaria pelseneeri* Monticelli, 1914
**Cercaria claparedei* Dollfus, 1925

Trichocercous cercariae (presence or absence of eyespots unknown):
**Distoma carinariae* Chiaie, 1841
**Distomum physophorae* Philippi, 1843
Family Megaperidae Manter, 1934
Cercaria of *Megapera gyrina* (Linton, 1907), Cable, 1954; *syns*: *Cercaria "K"* Miller, 1925; *Cercaria caribbea* XXXVII, Cable 1954
Family Monorchiidae Odhner, 1911
**Cercaria myocerca* Villot, 1878
**Cercaria myocercoides* Pelseneer, 1906
**Cercaria nigrotincta* Pelseneer, 1906
**Cercaria neptuneae* Lebour, 1911
**Cercaria ophiocerca* Palombi, 1934
Cercaria of *Monorcheides cumingiae* Martin, 1940; *syn*: *Cercaria cumingiae* Martin, 1938
Cercaria of *Postmonorchis donacis* Young, 1953; *syns*: *Cercaria donacis* Young, 1953; (?) *Cercaria myocerca* Villot, 1878
Cercaria caribbea XXXV Cable, 1956
Cercaria caribbea XXXVI Cable, 1956
Cercaria choanura Hopkins, 1958
Family Opecoelidae Ozaki, 1925
Cotylocercous cercariae:
**Cercaria pachycerca* Lespes, 1857; *syns*: *Cercaria pachycerca* Diesing, 1858; *Cercaria brachyura* Lebour, 1911
**Cercaria collumbellae* Pagenstecher, 1863
**Cercaria cotylura* Pagenstecher, 1863
**Cercaria buccini* Lebour, 1911
**Cercaria linearis* Lespes, 1857; syn: *Cercaria linearis* Lebour, 1911
Cercaria of *Hamacreadium mutabile* Linton, 1901, McCoy, 1929; *syn*: *Cercaria "A"* Miller, 1925
Cercaria of *Hamacreadium gulella* Linton, 1910, McCoy, 1930; *syn*: *Cercaria "B"* Miller, 1925
Cercaria of *Helicometrina nimia* Linton, 1910, Manter, 1933; syn: *Cercaria "J"* Miller, 1925
**Cercaria inconstans* Sinitzin, 1911
**Cercaria "I"* Miller, 1925
**Cercaria "M"* Miller, 1925
**Cercaria searlesiae* Miller, 1925
**Cercaria "V"* McCoy, 1929
**Cercaria pisaniae* Palombi, 1938
**Cercaria ruvida* Palombi, 1938
**Cercaria stunkardi* Palombi, 1938
**Cercaria tridentata* Palombi, 1938
Cercaria of *Opecoeloides manteri* Hunninen and Cable, 1941
Cercaria of *Podocotyle atomon* (Rud., 1802) Huninen and Cable, 1943
Cercaria caribbea XX Cable, 1956
Cercaria caribbea XXI Cable, 1956
Cercaria caribbea XXII Cable, 1956
Cercaria caribbea XXIII Cable, 1956
Cercaria caribbea XXIV Cable, 1956
Cercaria cotylicerca A Dollfus, 1959
Cercaria cotylicerca B Dollfus, 1959
Cercaria cotylicerca C Dollfus, 1959
Cercaria cotylicerca D Dollfus, 1959
Cercaria cotylicerca E Dollfus, 1959
Cercaria cotylicerca F Dollfus, 1959
Cercaria cotylicerca G Dollfus, 1959
Cercaria cotylicerca H Dollfus, 1959
Cercaria cotylicerca I Dollfus, 1959
Cercaria sp. Gaillard, 1959
Family Zoogonidae Odhner, 1911
Cercaria of *Zoogonus viviparus* (Olsson, 1868) Lebour, 1916
Cercaria of *Zoogonus rubellus* (Olsson, 1868), Stunkard, 1938; *syns*: (?) *Distomum lasium* Leidy, 1891; *Cercariaeum lintoni* Miller and Northup, 1926
Cercaria of *Diphterostomum brusinae* (Stossich, 1899) Palombi, 1930; *syns*: (?) *Distoma buccini mutabilis* Filippi, 1857; *Cercaria crispata* Pelseneer, 1906; *Cercaria inconstans* Sinitzin, 1911
Cercaria reticulatum Stunkard, 1932
Cercaria of *Zoogonoides laevis* (Linton, 1940) Stunkard, 1943
Cercaria of *Diphtherostomum luteum* Yamaguti, 1958; *syns*: *Cercaria lutea* Giard,

1897; Cercaria of *Brachycoelium luteum* Giard, 1897
No marine cercariae described for the following families:
Family Gorgoderidae Looss, 1901
Family Gyliauchenidae (Goto and Matsudaira) in Ozaki, 1933
Family Opistholebetidae Fukui, 1929
Family Troglotrematidae Odhner, 1914

B. Cercariae with caudal excretory vessels during development; stylet always lacking .....Order Opisthorchiida LaRue, 1957

1. Primary excretory pores on margins of tail near body-tail furrow; bodies of opisthorchioid type; oral sucker protrusible, with large spines and openings of penetration glands in crypt anterior to subterminal mouth; ventral sucker usually rudimentary; tails pleuro- or parapleurolophocercous, magna- or even zygocercous; protonephridia mesostomate or stenostomate; bladder V-shaped or globular; development in sporocysts or rediae; encystment in lower vertebrates ..... Suborder Opisthorchiata LaRue, 1957
Characteristics the same as for Suborder .....Superfamily Opisthorchioidea Faust, 1929
Family Heterophyidae Odhner, 1914
Magnacercous cercariae:
**Cercaria sp Fujita,* 1906
**Cercaria equitator* Sinitzin, 1911
**Cercaria "F"* Miller, 1925
**Cercaria purpuracauda* Miller, 1925
**Cercaria "T"* Miller, 1929
**Cercaria "U"* Miller, 1929
**Cercaria "W"* Miller, 1929
Cercaria caribbea XVI Cable, 1956
Cercaria caribbea XVII Cable, 1956
Cercaria caribbea XVIII Cable, 1956
Cercaria caribbea XIX Cable, 1956
Cercaria komiya Ito, 1956
Cercaria nigrocaudata Ito, 1956

Pleurolophocercous cercariae:
Cercaria quadripterygia Sinitzin, 1911
Cercaria floridensis McCoy, 1929; *syn*: *Cercaria "P"* Miller, 1926
Cercaria of *Cryptocotyle lingua* (Crepl., 1825), Stunkard, 1930; *syns*: *Cercaria lophocerca* Filippi, 1859; *Cercaria lophocerca,* Lebour, 1911
Cercaria of *Cryptocotyle jejuna* (Nicoll, 1907) Rothschild, 1938
Cercaria of *Pygidiopsis summa* (Onji and Nishio, 1916) Ochi, 1931
Cercaria coronanda Rothschild, 1938
**Cercaria* sp. Rothschild, 1938
Cercaria sp. Rothschild, 1941
Cercaria of *Euhaplorchis californiensis* Martin, 1950
Cercaria of *Parastictodora hancocki* Martin, 1950; *syn*: *Cercaria pleurolophocercous* I Maxon and Pequegnat, 1949
Cercaria of *Heterophyes* sp. Martin and Kuntz, 1955
Cercaria of *Stictodora tridactyla* Martin and Kuntz, 1955
**Cercaria bermudensis* Schell and Thomas, 1955
Cercaria caribbea X Cable, 1956
Cercaria caribbea XI Cable, 1956
Cercaria caribbea XII Cable, 1956
Cercaria of *Heterophyes aequalis* Looss, 1902, Kuntz and Chandler, 1956

Magnacercous opisthorchioid cercariae of unknown affinity:
Cercaria clausii Monticelli, 1888
Cercaria buchanani Martin and Gregory, 1951
Cercaria dipterocerca Miller and Northup, 1926
Family Opisthorchiidae Braun, 1901
Cercaria of *Phocitremoides ovale* Martin, 1950; *syn*: *Cercaria pleurolophocercous* II Maxon and Pequegnat, 1949
Family Cryptogonimidae Ciurea, 1933
Cercaria of *Siphodera vinaledwardsii* (Linton, 1901) Cable and Hunninen, 1942; *syn*: *Cercaria vinaledwardsii.* Cable and Hunninen, 1942
Cercaria caribbea XIII Cable, 1956
Cercaria caribbea XIV Cable, 1956
Cercaria caribbea XV Cable, 1956
Gymnocephalous cercariae whose family relationship is unknown:
Cercaria neptuneae Lebour, 1911
Cercaria foliatae Miller, 1925
No marine cercariae described for the following families:
Family Acanthostomidae Poche 1926
Family Pachytrematidae Baer, 1944
Family Ratziidae Baer, 1944

2. Primary excretory pores on tail distant from body-tail furrow; cercariae of cystophorous type or modified therefrom; bladder saccate or cylindrical; protonephridia stenostomate; main collecting vessels fused anteriorly, development in rediae; second intermediate host a copepod .....Suborder Hemiurata Skrjabin and Guschanskaja, 1954
Characteristics the same as for Suborder ..... Superfamily Hemiuroidea Faust, 1929
Family Hemiuridae Luhe, 1901
Cercaria sp. Vaullegeard, 1896
Cercaria appendiculata Pelseneer, 1906
Cercaria vaullegeardi Pelseneer, 1906
Cercaria laqueator Sinitzin, 1911
Cercaria sagittarius Sinitzin, 1911
Cercaria calliostomae Dollfus, 1923
Cercaria "L" Miller, 1925
Cercaria "A" Miller, 1925
Cercaria "B" Miller, 1925
Cercaria "K" Rothschild, 1936
Cercaria sinitzini Rothschild, 1938
Cercaria rothschildi Palombi, 1940
Cercaria prenanti Arvy, 1949
Cercaria dollfusi Arvy, 1951

Cercaria tregouboffi Arvy, 1952
Cercaria appendiculata Chubrik, 1952
Cercaria naticae Chubrik, 1952
Cercaria "X" Hutton, 1952
Cercaria sp. Chabaud and Biguet, 1955
Cercaria melanocystea Arvy and Gaillard, 1956

"Hemiuroid" cercaria:
Cercaria caribbea XXXIV Cable, 1956
Family Ptychogonimidae Dollfus, 1937
Cercaria of *Ptychogonimus megastoma* (Rud., 1819), Palombi, 1942; *syn*: *Cercaria dentali* Pelseneer, 1906
Family Lecithasteridae Skrjabin and Guschanskaja, 1954
Cercaria of *Lecithaster confusus* (Odhner, 1905), Hunninen and Cable, 1943
No marine cercariae described for the following families:
Family Didymozoidae Poche, 1907
Family Halipegidae Poche, 1926
Family Isoparorchiidae Poche, 1926
Family Bathycotylidae Dollfus, 1932
Family Dinuridae Skrjabin and Guschanskaja, 1954
Family Lecithochiridae Skrjabin and Guschanskaja, 1954

Cercariae of unknown taxonomic position:
Cercaria sagittata Lespes, 1857
Cercariaeum tellinae baltica Diesing, 1858
Cercaria hymenocerca Villot, 1875
Cercaria sp. (fork-tail) Morgan, 1891
Cercaria obtusicaudata Pelseneer, 1906
Cercaria navicularia Sinitzin, 1911
Cercaria sp. Jones and Rothschild, 1932
*Cercaria caullery*i Markowski, 1936
Cercaria "D" (fork-tail) Hutton 1952
Cercaria "E" (leptocercous) Hutton, 1952
Cercaria "I" (leptocercous) Hutton, 1952
Cercaria "M" (leptocercous) Hutton, 1952
Cercaria turritellae (magnacercous monostome) Hutton, 1955

VI. Summary

This work constitutes the first major effort to study the cercarial fauna of the Gulf of Mexico and each species establishes a new host and locality record. The present work supports the contention that detailed specific diagnoses are necessary to separate closely related forms, and that the study of the redial or sporocyst stage, the behavior, and cercarial reaction to vital dyes are helpful in diagnosis.

Twenty-eight marine cercariae are reported herein; 24 are new species; 4 previously reported larvae are redescribed: cercaria of *Parorchis acanthus* (Nicoll, 1906), *Cercaria caribbea* III Cable, 1956, cercaria of *Himasthla quissetensis* (Miller and Northup, 1926), and *Cercaria caribbea* XXXVI Cable, 1956.

The following numbers and types of cercariae are described: 1 cyathocotylid, 1 schistosome, 2 aporocotylids, 4 furcocercous fellodistomatids, 1 tailless fellodistomatid, 1 bucephalid, 6 echinostomoids, 4 plagiorchioids, 2 monorchiids, 2 opecoelids, 3 opisthorchioids, and 1 "hemiuroid".

Sixty-nine collections of mollusks were made from Apalachee Bay between September, 1956, and September, 1959. Nineteen species of gastropods were examined involving 13,961 individuals. Of this total 17.7%, or 2,477 individuals, were infected with larval trematodes. Twenty-one trematode cercariae were obtained from gastropods. Ten species of pelecypods were examined involving 2,616 individuals. Of this total 145 individuals, or 5.5%, were infected. Ten species of cercariae were obtained from pelecypods.

A review of the literature on marine cercariae of the world has been made up to January, 1960, and a bibliography has been compiled. All of the known marine cercariae encountered, 334 species, have been taxonomically separated, where possible, according to the classification of LaRue (1957) and have been placed in checklists within the key based on his system.

VII. Bibliography

Abbott, R. Tucker 1954. *American Seashells*. D. Van Nostrand Co., Inc., New York. 541 p.

Africa, Candido M. 1930. The excretory system of *Cercariaeum lintoni* Miller 1926. *Jour. Parasitol.* 17 (1): 14-17.

Andreu, Buenaventura 1949. Sobre la presencia de dos cercarias en el ovario de almeja (*Tapes aureus* Gmelin) en la bahia de Santander. *Bol. Inst. Españ. Oceanog.* 22: 1-7.

Angel, L. M. 1954. *Parorchis acanthus* var. *australis*, n. var., with an account of the life cycle in South Australia. *Trans. Roy. Soc. So. Austral.* 77: 164-174.

Arvy, Lucie 1949a. Sur la castration parasitaire chez *Dentalium entale* Deshazes. *Compt. Rend. Acad. des Sci., Paris* 229: 780-782.

1949b. Présentation de documents relatifs à l'ovogenèse chez le dentale et à deux parasites de ce Scaphopode: *Cercaria prenanti*, n. sp. et *Haplosporidium dentali*, n. sp. *Bull. Soc. Zool. de France* 74: 292-294.

1951a. Contribution à l'étude de *Cercaria dollfus* cercaire cystophore parasite de *Philine aperta* L. (opisthobranche cephalaspide). *Bull. Soc. Zool. de France* 76 (5-6): 339-348.

1951b. Sur la castration parasitaire chez *Philine aperta* Linné. *Compt. Rend. Acad. des Sci., Paris* 233 (18): 1065-1067.

1952a. Contribution a l'étude des trématodes parasites de *Columbella rustica* L. (Gastéropode prosobranche). *Ann. Parasitol. Humaine et Compar.* 27 (5): 485-498.

1952b. Présentation de documents relatifs a trois cercaires parasites de *Columbella rustica* L. (Gastéropode prosobranche). *Bull. Soc. Zool. de France* 77 (2/2): 217-220.

1953. Présence de Cercaria setifera (Monticello, 1888 et 1914, nec. John Muller, 1850), chez *Phyllirhoe bucephala* Per. et Les., a Villefranche-sur-mer. *Ann. Parasitol. Humaine et Compar.* 28 (4): 289-299.

1954. Contribution à l'étude de *Cercaria sagittarius* (Sinitzin, 1911). *Ann. Paraistol. Humaine et Compar.* 29 (4): 347-357.

and Jean M. Gaillard 1956. Castration parasitaire de *Pandora albida* (Roding), (*P. inaequivalvis* L.), mollusque pélécypode eulamellibranche, par *Cercaria melanocystea* n. sp., cercaire à grande queue vesiculeuse. *Compt. Rend. Acad. des Sci., Paris* 243 (15): 1074-1077.

Bearup, A. J. 1955. A schistosome larva from the marine snail *Pyrazus australis* as a cause of cercarial dermatitis in man. *Med. Jour. Austral.* 1: 955.

1956. Life cycle of *Austrobilharzia terrigalensis* Johnston, 1917. *Parasitology* 46: 470-479.

Belopolskaya, M. M. and Uspenskaya, A. V. 1953. Some data about the life-cycle of *Spelotrema arenaria* n. sp. *Dok. Akad. Nauk, S. S. S. R.* 89: 581-583.

Bojanus, L. H. 1818. Kurze Nachricht über die Cercarien und ihren Fundort. *Oken. Isis.* 1 (4): 729-730 (corrected numbers 688-689).

Cable, R. M. 1934. Studies on the germ-cell cycle of *Cryptocotyle lingua*. II. Germinal development in the larval stages. *Quart. Jour. Microscop. Sci.* n.s. 76: 573-614.

1938. Studies on the larval trematodes from Kentucky, with a summary of known related species. *Amer. Midland Nat.* 19 (2): 440-464.

1953. The life cycle of *Parvatrema boringueñae* gen. et sp. nov. (Trematoda: Digenea) and the systematic position of the subfamily Gymnophallinae. *Jour. Parasitol.* 39 (4): 408-421.

1954a. A new marine cercaria from the Woods Hole region and its bearing on the interpretation of larval types in the Féllodistomatidae (Trematoda: Digenea). *Biol. Bull.* 106 (1): 15-20.

1954b. Studies on marine digenetic trematodes of Puerto Rico. The life cycle in the family Haplosplanchnidae. *Jour Parasitol.* 40 (1): 71-76.

1954c. Studies on marine digenetic trematodes of Puerto Rico. The life cycle in the family Megaperidae. *Jour. Parasitol.* 40 (2): 202-208.

1956a. Scientific Survey of Puerto Rico and the Virgin Islands. Marine Cercariae of Puerto Rico. *N. Y. Acad. Sci.*, Part 4, 16: 490-577.

1956b. *Opistholebes diodontis*, n. sp., its development in the final host, the affinities of some amphistomatous trematodes from marine fishes and the allocreadioid problem. *Parasitology* 46 (1): 1-13.

and A. V. Hunninen 1940. Studies on the life history of *Spelotrema nicolli* (Trematoda: Microphallidae) with the description of a new microphallid cercaria. *Biol. Bull.* 78 (1): 136-157.

and 1942a. Studies on *Deropristis inflata* (Molin), its life history and affinities to trematodes of the family Acanthocolpidae. *Biol. Bull.* 82 (2): 292-312.

and 1942b. Studies on the life history of *Siphodera vinaledwardsii* (Linton) (Trematoda: Cryptogonimidae). *Jour. Parasitol.* 28 (5): 407-420.

and W. E. Martin 1935. *Parorchis avitus* (Linton, 1914), a synonym of *P. acanthus* (Nicoll, 1906). *Jour. Parasitol.* 21 (6): 436-437.

and R. A. McLean 1943. The occurrence of *Cercaria clausii* Monticelli, a marine Rattenkonig larval trematode, on the west coast of Florida. *Notulae Naturae* (129), October 29. 7 pp.

Carrère, Pierre 1938. Recherches sur le cycle évolutif de trématodes de poissons. *Compt. Rend. Acad. des Sci., Paris* 206 (26): 1994-1996.

Carus, J. V. 1885. *Prodromus Faunae Mediterraneae*. Vol. I. Stuttgart. p. 112-282.

Caullery, M. and A. Chappellier 1906. *Anurosporidium pelseneeri*, n. g., n. sp., haplosporidie infectant les sporocystes d'un trématode parasite de *Donax trunculus* L. *Compt. Rend. Soc. de Biol., Paris* 60 (7): 325-328.

Cepédè, C. 1911. Le cycle évolutif et les affinites systématiques de L'Haplosporidie des *Donax*. *Compt. Rend. Acad. des Sci., Paris* 1953 (9) : 507-509.

Chabaud, A. G. and J. Biguet 1955. Etude d'un trématode hémiuroide à métacercaire progénétique. I. Développement chez le mollusque. II. Infestation du copépode. III. Développement chez le copépode. *Ann. Parasitol. Humaine et Compar.* 29 (5-6) : 527-545.

Chiaie, Delle S. 1841. *Descrizione e notomia degli animali invertebrati della Sicilia citeriore*. T. 3. Napoli.

Chilton, Charles 1905. On the occurrence of a species of cercaria in the cockle. *Trans. and Proc. New Zeal. Inst.* 37: 322-325.

Chu, George W. T. C. 1952. First report of presence of a dermatitis-producing marine larval schistosome in Hawaii. *Science* 115: 151-153.

——— and C. E. Cutress 1954. *Austrobilharzia variglandis* (Miller and Northup, 1926) Penner, 1953, (Trematoda: Schistosomatidae) in Hawaii with notes on its biology. *Jour. Parasitol.* 40: 515-524.

Chubrik, G. K. 1952a. The life cycle of *Prosorhynchus squamatus* Odhner, 1905. *Doklady Akad. Nauk S. S. S. R.* 83 (2) : 327-329.

——— 1952b. The life cycle of *Rhodotrema quadrilobata* Baskilova 1932, parasite of the intestines of flat-fish. *Doklady Akad. Nauk. S. S. S. R.*, n. s. 83 (6) : 981-983.

——— 1952c. The immature stages of the trematode *Fellodistomum fellis* Nicoll, 1909, from invertebrates of the Barents Sea. *Zool. Zhur.* 31: 653-658.

——— 1952d. Cystophorous cercaria from *Natica clausa* Brod. et Sow. *Doklady Akad. Nauk. S. S. S. R.* 86 (6) : 1233-1236.

——— 1954a. The life cycle of *Parapronocephallum symmetricum* Belopolskaja, 1952. *Doklady Akad. Nauk. S. S. S. R.*, n. s. 97 (3) : 565-567.

——— 1954b. Parasitological investigations of Mollusca of the littoral zone of eastern Murmansk and the White Sea. *Trudy Problem. i Temat. Soveshchanii, Akad. Nauk. S. S. S. R.*, Zool. Inst. 4: 128-134.

Claparède, Edouard 1863. *Beobachtungen über Anatomie und Entwickelung wirbelloser Thiere an der Kuste der Normandie angestellt*. Leipzig. 120 p.

Claus, C. 1880. *Grundzuge der Zoologie*. I. 4th ed., vol. I. Margurg. 821 p.

Cole, H. A. 1935. On some larval trematode parasites of the mussel (*Mytilus edulis*) and the cockle (*Cardium edule*). *Parasitology* 27: 276-280.

——— 1938. On some larval trematode parasites of the mussel (*Mytilus edulis*) and the cockle (*Cardium edule*). Part II. A new larval Gymnophallus (*Cercaria cambrensis* sp. nov.) from the cockle. *Parasitology* 30: 40-43.

Cooley, Nelson R. 1957. Laboratory and field studies of an oyster drill parasite. *Proc. Natl. Shellfish. Assoc.* 48: 174-188.

Cort, W. W. 1915. Some North American Larval Trematodes. *Ill. Biol. Monog.* 1 (no. 4) : 1-87.

——— 1917. Homologies of the excretory system of the forked-tailed cercariae. *Jour. Parasitol.* 4: 48-57.

Cuenot, L. 1927. Contributions à la faune du bassin d'Arachon. IX. Revue générale de la faune et bibliographie. *Bull. Stat. Biol. d'Arachon* 24 (2) : 229-308.

Daday, E. 1888. Eine neue Cercaria-Form aus dem Golf von Neapel. *Termeszettud.* Kozlony 11 (2) : 107-109.

Dawes, Ben 1946. *The Trematoda*. Cambridge Univ. Press, London. 644 p.

Diesing, K. M. 1850. *Systema Helminthum*. Vol. I. Vindobonae, apud W. Bramuller. 679 p.

——— 1855. Revision der Cercarien. *Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber.* Abt. 1. 15: 377-400.

——— 1858. Berichtigungen und Zusatze zur Revision der Cercarien. *Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber.* Abt. 1. 31: 239-290.

Dollfus, R. P. 1911. L'appareil néphridien de deux cercaires parasites de *Donax vittatus* Da Costa. *Comvt. Rend. Soc. de Biol., Paris* 71 (31) : 422-425.

——— 1912. Une méta-cercaire margaritigéne parasite de *Donax vittatus* Da Costa. Contribution à l'étude des Trématodes marins des côtes du Boulonnais. *Mem. Soc. Zool. de France* 25 (3-4) : 85-144.

——— 1914. *Cercaria pachycerca* Diesing et les cercaires à queue dite en moignon. *Compt. Rend. Congr. Intern. de Zool.*, Monaco, 1913-14, pp. 683-685. Résumés des Communications, pp. 38-42.

——— 1923a. Le trématode des perles de nacre des moules de Provence. *Compt. Rend. Acad. des Sci., Paris* 176: 1427-1429.

——— 1923b. Remarques sur le cycle évolutif des Hémiurides. *Ann. Parasitol. Humaine et Compar.* 1: 345-351.

——— 1925. Liste critique des cercaires marines à queue setigére signalées jusqu'à présent. *Trav. Stat. Zool.* Wimereux 9: 43-65.

——— 1927a. Notules sur des Cercaires atlantiques (I-II). *Bull. Soc. Zool. de France* 52: 111-118.

——— 1927b. Sur une métacercaire *progénétique d'hémiuridae* (Trématoda: Digenea). *Bull. Biol. de la France et Belg.* 61: 49-58.

——— 1930. Le point d'aboutissement des canaux collecteurs a la vessil chez les distomes; son importance au point de vue systématique. *Ann. Parasitol. Humaine et Compar.* 8: 143-146.

——— 1949. Sur une cercaire ophthalmoxiphidiocerque, *Cercaria isopori*, A. Looss, 1894, et sur la délimitation des Allocreadioidea. *Ann. Parasitol. Humaine et Compar.* 24: 424-435.

——— 1950. Hôtes et distribution géographique des cercaires cystophores. *Ann. Parasitol. Humaine el Compar.* 25 (4): 276-296.

——— 1959. Duxième Supplément (*décembre 1952 - janvier 1959*) *aux Titres et Travaux scientifiques de Robert Ph. Dollfus. Paris.* 40 p.

——— 1960. Recherches expérimentales sur *Nicolla gallica* (R. Ph. Dollfus 1941) R. Ph. Dollfus 1958, sa cercaire cotylicerque et sa métacercaire progénétique. Observations sur la famille des Coitocaecidae Y. Ozaki 1928, s.f. Coitocaecinae F. Poche 1926 Trematoda Podocotyloidea et sur cercaires cotylicerques d'eau douche et marines. *Ann Parasitol. Humaine et Compar.*, 34: 595-622.

——— 1960. *Ibid.*, 35: 65-117.

Dubois, Georges 1929. Les Cercaires de la région de Neuchâtel. *Bull. Soc. Neuchâteloise des Sci. Nat.* 53 (2): 2-177.

——, Jean G. Baer and L. Euzet 1952. Une nouvelle cercaire du plancton marin de Sète, *Cercaria mathiasi* n. sp. *Rev. Suisse de Zool.* 59 (4): 503-510.

Dubois, R. 1901a. Sur le mécanisme de la formation des perles fines dans le *Mytilus edulis. Compt. Rend. Acad. des Sci.*, Paris 133: 603-605.

——— 1901b. Sur le mode de formation des perles dans *Mytilus edulis* L. *Compt. Rend., Assoc. Franc. pour l'Avanc. des Sci.* Part 1: 149-150.

——— 1903. L'origine des perles chez le *Mytilus gallo-provincialis. Compt. Rend. Acad. des Sci., Paris* 136: 178-179.

——— 1907. Sur les métamorphoses du distome parasite des *Mytilus perliers. Compt. Rend. Soc. de Biol., Paris* 63: 334-336.

——— 1909. Contribution à l'étude des perles fines, de la nacre, et des animaux qui les produisent. *Ann. Univ. Lyon* (n.s.) *Fasc.* 29: 1-126.

Dujardin, Felix 1845. *Histoire naturelle des helminthes ou vers intestinaux.* Paris. 654 p.

Eckmann, F. 1932. Beitraege zur Kenntnis der Trematodenfamilie Bucephalidae. *Ztschr. f. Parasitenk.* 5: 94-111.

Faust, E. C. 1932. The excretory system as a method of classification of digenetic trematodes. *Quart. Rev. Biol.* 7: 458-468.

Fewkes, J. W. 1882. A cercaria with caudal setae. *Amer. Jour. Sci.* 23: 134-135.

de Filippi, Filippo 1837. Descrizione di nuovi entozoi trovati in alcuni molluschi d'aqua dolce. *Bibliotheca Ital.* 87: 333-340.

——— 1854. Mémoire pour servir a l'histoire génétique des trématodes. *Ann. des Sci. Nat., Zool.* 2 (4): 255-284.

——— 1855. Nouvelles observations sur le développement des trématodes. *Ann. des Sci. Nat., Zool.* 3 (4): 111-113.

——— 1856. Quelques nouvelles observations sur les larves des trématodes. *Ann. des Sci. Nat., Zool.* 6 (4): 83-86.

——— 1857. Deuxiéme mémoire pour servir à l'histoire génétique des trématodes. *Mem. Accad. Sci., Torino* 16 (2): 419-442.

——— 1859. Troisième mémoire pour servir à l'histoire génétique des trématodes. *Mem. Accad. Sci., Torino* 18 (2): 201-232.

Fujita, T. 1906. Two species of cercariae from *Paphia* (= *Amygdala*) *philippinarum. Dobutsugaku Zasshi* 18: 197-202.

——— 1907. The specific name of the cercaria found in *Paphia* (*Amygdala*) *philipminarum. Dobutsugaku Zasshi* 19: 281-282.

——— 1925. Etudes sur les parasites de l'huitre comestible du Japan *Ostrea gigas* Thunberg. *Ann. Parasitol. Humaine el Compar.* 3: 36-59.

Gaillard, J. M. 1953. Sur quelques points d'anatomie et de biologie de *Gibbula umbilicalis* Da Costa (Mollusque Prosobranche). *Bull. Lab. Mar. Dinard,* 39: 1-21.

Gambino, Jerome J. 1959. The seasonal incidence of infection of the snail *Nassarius obsoletus* (Say) with larval trematodes. *Jour. Parasitol.* 45 (4): 440-456.

Giard, A. 1897a. Sur un cercarie setigere (*Cercaria lutea*) parasite des pelecypodes. *Compt. Rend. Soc. de Biol., Paris* 49: 954-956.

——— 1897b Sur un distome (*Brachycoelium* sp.) parasite des pelecypodes. *Compt. Rend. Soc. de Biol., Paris* 49: 956-957.

——— 1907. Sur les trematodes margaritigenes du Pas-de-Calaise. *Compt. Rend. Soc. de Biol., Paris* 63: 416-420.

Glading, B. 1935. The life cycle of *Cercariaeum lintoni* Miller and Northup. *Jour. Parasitol.* 21: 434.

Goldsmith, Richard 1902. Ueber Bau und Embryonalentwickelung von *Zoogonus mirus* Lss. *Zentr. Bakteriol., Parasitenk.* Abt. I. 32: 870-876.

Graeffe, E. 1858. Beobachtungen über Radiaten und Wurmer in Nizza. *Denkschr. Schweiz. Naturgesch.* Zurich 17: 59.

Grodhaus, G. and B. Keh 1958. The marine, dermatitis-producing cercaria of *Austrobilharzia variglandis* in California

(Trematoda: Schistosomatidae). *Jour. Parasitol.* 44 (6): 633-638.

HASWELL, W. A. 1903. On two remarkable sporocysts occurring in *Mytilus latus*. *Proc. Linn. Soc. N. So. Wales* 27 (4): 497-515.

HOLLIMAN, R. B. 1958. A new marine aporocotylid cercaria from *Donax variabilis* Say. *Assoc. So. East Biol. Bull.* 5 (1): 9.

——— and R. B. SHORT 1961. Studies on the life cycle of a new avian schistosome in the genus *Austrobilharzia*. *Assoc. So. East. Biol. Bull.* 8 (2): 30.

HOPKINS, SEWELL H. 1954a. *Cercaria brachidontis* n. sp. from the hooked mussel in Louisiana. *Jour. Parasitol.* 40 (1): 29-31.

——— 1954b. The American species of trematode confused with *Bucephalus* (*Bucephalopsis*) *haimeanus*. *Parasitology* 44 (3): 353-370.

——— 1958. Trematode parasites of *Donax variabilis* at Mustang Island, Texas. *Univ. Texas Publ. Inst. Marine Sci.* 5: 301-311.

HUET, M. 1888a. Note sur le *Bucephalus haimeanus*. *Bull. Soc. Linn. de Normandie* 2 (4): 145-149.

——— 1888b. Note sur un parasite nouveau du *Cardium edule*. *Bull. Soc. Linn. de Normandie* 2 (4): 149-152.

——— 1891. Une nouvelle cercarie (*C. pectinata*) chez *Donax anatinum*. *Jour. Anat. Physiol., Paris* 27: 162-165.

——— 1893. Nouvelle note sur le *Bucephalus haimeanus*. *Bull. Soc. Linn. de Normandie* 4 (7): 40-41.

HUNNINEN, A. V. and R. M. CABLE 1941. Studies on the life history of *Anisoporus manteri* Hunninen and Cable, 1940 (Trematoda: Allocreadiidae). *Biol. Bull.* 80 (3): 415-428.

——— and ——— 1943a. The life history of *Podocotyle atomon* (Rudolphi) (Trematoda: Opecoelidae). *Trans. Amer. Microscop. Soc.* 62 (1): 57-58.

——— and ——— 1943b. The life history of *Lecithaster confusus* Odhner (Trematoda: Hemiuridae). *Jour. Parasitol.* 29 (1): 71-79.

HUNTER, WANDA 1941. Studies on cercariae of the common mud-flat snail, *Cerithidea californica*. 1. The Pleurolophocercous groups. *Jour. Parasitol.* Suppl. 27: 11.

——— 1952. Contributions to the morphlogy and life history of *Gynaecotyla adunca* (Linton, 1905) (Trematoda: Microphallidae). *Jour. Parasitol.* 38: 308-314.

——— and D. C. CHAIT 1952. Notes on encystment and culture *in vitro* of the microphallid trematode, *Gynaecotyla adunca* (Linton, 1905). *Jour. Parasitol.* 38: 87.

——— and WINONA B. VERNBERG 1953. Early stages in the life cycle of the trematode, *Gynaecotyla adunca* (Linton, 1905). *Trans. Amer. Microscop. Soc.* 72 (2): 163-170.

——— and ——— 1957. Further observations on the life cycle of *Gynaecotyla adunca* (Linton, 1905). *Jour. Parasitol.* 43: 493-494.

HUSSEY, KATHLEEN L. 1941. Comparative embryological development of the excretory system in digenetic trematodes. *Trans. Amer. Microscop. Soc.* 60 (2): 171-210.

——— 1943. Further studies on the comparative embryological development of the excretory system in digenetic trematodes. *Trans. Amer. Microscop. Soc.* 62 (3): 271-279.

HUTTON, R. F. 1952a. Studies on the parasites of *Cardium edule* L.: *Cercaria fulbrighti* n. sp., a Gymnophallus larva with a forked tail. *Jour. Marine Biol. Assoc. United Kingdom* 31 (2): 317-326.

——— 1952b. Schistosome cercariae as the possible cause of sea bathers' eruption. *Bull. Marine Sci. Gulf and Caribbean* 2: 346-359.

——— 1953. *Cercaria reesi* n. sp., a new furcocercous larva from Plymouth. *Jour. Marine Biol. Assoc. United Kingdom* 31 (3): 581-585.

——— 1954. *Metacercaria owreae* n. sp., an unusual trematode larva from Florida current chaetognaths. *Bull. Marine Sci. Gulf and Caribbean* 4 (2): 104-109.

——— 1955. *Cercaria turritella* n. sp., a "huge-tailed" monostome larva from *Turritella communis* Risso. *Jour. Marine Biol. Assoc. United Kingdom* 34 (2): 249-255.

ITO, JIRO 1956a. Studies on the brackish water cercariae in Japan. I. Two new furcocercous cercariae, *Cercaria ogatai* n. sp., and *Cercaria tympanotoni* n. sp., in Tokyo Bay (Trematoda). *Japan. Jour. Med. Sci. & Biol.* 9: 233-234.

——— 1956b. Studies on the brackish water cercariae in Japan. II. Two new long-tailed cercariae, *Cercaria komiyai* n. sp., and *Cercaria nigrocaudata* n. sp., in Tokyo Bay (Trematoda). *Japan. Jour. Med. Sci. & Biol.* 9: 235-242.

——— 1957. Studies on the brackish water cercariae in Japan. II. Three new echinostome cercariae in Tokyo Bay, with a list of Japanese echinostome cercariae (Trematoda). *Japan. Jour. Med. Sci. & Biol.* 10 (6): 439-453.

JAMESON, H. L. 1902. On the origin of pearls. *Proc. Zool. Soc., London* 1 (2): 140-166.

——— and W. NICOLL 1913. On some parasites of the Scoter duck (*Oedemia nigra*) and their relation to the pearl-inducing trematode in the edible mussel (*Mytilus edulis*). *Proc. Zool. Soc. London* 12: 53-63.

JOHNSTONE, JAMES 1904. Internal parasites and diseased conditions of fishes. *Rept. Sci. Invest. Lancashire Sea-Fisheries Lab.* 1903, 12: 98-120, 151-191.

——— 1905. Internal parasites and diseased conditions of fishes. *Proc. Trans. Liverpool Biol. Soc.* 19: 278-300.

——— 1922. Diseases and parasites of fishes. *Rept. Sci. Invest. Lancashire Sea-Fisheries Lab.* (1921) 30: 222-237.

JONES, E. IDRIS and MIRIAM ROTHSCHILD 1932. On the sporocyst and cercaria of a marine distomid trematode from *Nucula. Parasitology* 24 (2): 260-264.

KATSUTA, I. 1932. Uber Cercarien als Parasiten von Schnecken in halbsalzigen Wasser, insbesondere über eine Art von cystophoren Cercarien (Vorbericht.). *Jour. Med. Assoc. Formosa* 31 (12): 113-114.

KENT, W. S. 1871. Notes on appendicularia and the larval condition of an acanthocephaloid scolecid from the coast of Portugal. *Quart. Jour. Microscop. Sci.* n.s. (43) 11: 267-270.

KUNTZ, ROBERT E. 1950. Embryonic development of the excretory system in forktailed cercariae of the schistosomes and in a blunt-tailed brachylaemid cercaria. *Trans. Amer. Microscop. Soc.* 69 (1): 1-20.

——— 1951. Embryonic development of the excretory system in a psilostome cercaria, a gymnocephalous (fasciolid) cercaria and in three monostome cercariae. *Trans. Amer. Microscop. Soc.* 70: 95-118.

——— 1952. Embryonic development of the excretory system in a pleurolophocercous (acanthostomatid) cercaria, three stylet cercariae (a microcercous cercaria, a brevicaudate, and a longicaudate dicrocoelid cercaria) and in a microcaudate eucotylid cercaria. *Trans. Amer. Microscop. Soc.* 71 (1): 45-81.

——— and ASA C. CHANDLER 1956. Studies on Egyptian trematodes with special reference to the heterophyids of mammals. II. Embryonic development of *Heterophyes aequalis* Looss. *Jour. Parasitol.* 42 (6): 613-625.

LACAZE-DUTHIERS, H. DE 1854. Memoire sur le bucephale Haime (*Bucephalus haimeanus*) helminthe parasite des huitres et des bucardes. *Ann. Sci. Nat.* ser. 4, 1: 294-302.

LANKESTER, E. R. 1873. Summary of zoological observations made at Naples in the winter of 1871-72. *Ann. Mag. Nat. Hist.* ser. 4, 11: 81-97.

LARUE, GEORGE R. 1926. Studies on the trematode family Strigeidae (Holostomidae). III. Relationship. *Trans Amer. Microscop. Soc.* 45: 265-278.

——— 1938. Life history studies and their relation to problems in taxonomy of digenetic trematodes. *Jour. Parasitol.* 24 (1): 1-11.

——— 1957. The classification of digenetic Trematoda: a review and a new system. *Exp. Parasitol.* 6 (3): 306-344.

LEBOUR, MARIE V. 1904. A preliminary note on a trematode parasite in *Cardium edule. Rept. Sci. Invest. Northumberland Sea Fisheries Comm.* December 31, pp. 82-84.

——— 1905. Notes on Northumbrian trematodes. *Rept. Sci. Invest. Northumberland Sea Fisheries Comm.* December 31, pp. 100-105.

——— 1907a. Larval trematodes of the Northumberland coast. *Trans. Nat. Hist. Soc. Northumberland,* n.s., 1: 437-454, 500-501.

——— 1907b. On three mollusk-infesting trematodes. *Ann. Mag. Nat. Hist.* (7) 19: 102-106.

——— 1907c. Some trematodes in *Mytilus. Proc. Univ. Durham Phil. Soc.* 2 (6): 231-238.

——— 1908. Trematodes of the Northumberland coast. *Trans. Nat. Hist. Soc. Northumberland* 3 (1): 28-45.

——— 1911. A review of the British marine cercariae. *Parasitology* 4: 416-456.

——— 1914. Some larval trematodes from Millport. *Parasitology* 7: 1-11.

——— 1916a. Medusae as hosts for larval trematodes. *Jour. Marine Biol. Assoc. United Kingdom* 11: 57-59.

——— 1916b. A trematode larva from *Buccinum undatum* and notes on trematodes from post-larval fish. *Jour. Marine Biol. Assoc. United Kingdom,* n.s., 11: 514-518.

——— 1923. Note on the life history of *Hemiurus communis* Odhner. *Parasitology* 15: 233-235.

LEIDY, JOSEPH 1878. On *Donax fossor. Proc. Acad. Nat. Sci., Philadelphia* 30: 382-383.

——— 1891. Notices of Entozoa. *Proc. Acad. Nat. Sci., Philadelphia* 42: 410-418.

LEIGH, W. H. 1953. *Cercaria huttoni,* sp. nov., a dermatitis-producing schistosome larva from the marine snail *Haminoea antillarum guadalupensis* Sowerby. *Jour. Parasitol.* 39 (6): 625-629.

——— 1955. The morphology of *Gigantobilharzia huttoni* (Leigh, 1953), an avian schistosome with marine dermatitis-producing larvae. *Jour Parasitol.* 41 (3): 1-8.

LESPÉS, CHARLES 1857. Observations sur quelques parasites de mollusques marins. *Ann. Sci. Nat.,* ser. 4, 7: 113-118.

LEUCKART, R. 1882. Zur Entwicklungsgeschichte des Leberegels (*Distomum hepaticum*). *Arch. f. Naturgesch.* 48: 80-119.

LEVINSEN, G. M. R. 1881. Bidrag til Kundskab on Gronlands Trematodfauna.

Overs. K. Danske. Vidensk. Selsk, Fork. 1: 52-84.

LeZotte, L. A., Jr. 1954. Studies on marine digenetic trematodes of Puerto Rico: The family Bivesiculidae, its biology and affinities. *Jour. Parasitol.* 40 (2): 148-162.

Linton, Edwin 1915a. Sporocysts in an annelid. *Biol. Bull.* 28 (2): 115-118.

———— 1915b. Note on trematode sporocysts and cercariae in marine mollusks of the Woods Hole region. *Biol. Bull.* 28 (4): 198-209.

Loesch, H. C. 1957. Studies of the ecology of two species of *Donax* on Mustang Island, Texas. *Inst. Marine Sci., Univ. Texas* 4 (2): 201-227.

Lühe, Max 1909. *Parasitische Plattwurmer.* I. Trematodes Susswasserfauna Deutschland (Brauer), Heft 17, iv + 217 pp.

Lutz, A. 1933. Notas sobre dicranocercarias brazileiras (Beobachtungen ueber Brasilianische Dicranocercarien) *Mem. Inst. Oswaldo Cruz.* 27(4)349-376.

Lysaght, A. 1941. The biology and trematode parasites of the gastropod *Littorina neritoides* (L.) on the Plymouth breakwater. *Jour. Marine Biol. Assoc.* 25: 41-67.

Manter, H. W. 1933. The genus *Helicometra* and related trematodes from Tortugas, Florida. Papers from Tortguas Lab., *Carnegie Inst. Year Book* 28: 167-182.

Markowski S. 1936. Uber die trematodenfauna der baltischen mollusken aus der umgebung der Halbinsel. *Bull. Intern. Acad. Polon. Sci.,* Ser. B, 11: 285-317.

Martin, W. E. 1938. Studies on trematodes of Woods Hole: The life cycle of *Lepocreadium setiferoides* (Miller and Northup), Allocreadiidae, and the description of *Cercaria cumingiae* n. sp. *Biol. Bull.* 75 (3): 463-474.

———— 1939. Studies on the trematodes of Woods Hole. II. The life cycle of *Stephanostomum tenue* (Linton). *Biol. Bull.* 77 (1): 65-73.

———— 1940. Studies on the trematodes of Woods Hole. III. The life cycle of *Monorcheides cumingiae* (Martin) with special reference to its effect on the invertebrate host. *Biol. Bull.* 79 (1): 131-144.

———— 1944a. *Cercaria solemyae* n. sp., probably a blood fluke, from the marine pelecypod, *Solemya velum. Jour. Parasitol.* 30 (3): 191-195.

———— 1944b. Studies on trematodes of Woods Hole. IV. Additional observations upon *Cercaria loossi* Stunkard developing in an annelid. *Trans. Amer. Microscop. Soc.* 63 (3): 237-243.

———— 1945. Two new species of marine cercariae. *Trans. Amer. Microscop. Soc.* 64 (3): 203-212.

———— 1950a. *Euhaplorchis californiensis* n. g., n. sp., Heterophyidae, Trematoda, with notes on its life-cycle. *Trans. Amer. Microscop. Soc.* 69 (2): 194-209.

———— 1950b. *Parastictodora hancocki* n. gen., n. sp. (Trematoda: Heterophyidae), with observations on its life cycle. *Jour. Parasitol.* 36 (4): 360-370.

———— 1950c. *Phocitremoides ovale* n. gen., n. sp. (Trematoda: Opisthorchiidae), with observations on its life cycle. *Jour. Parasitol.* 36 (6): 552-558.

———— 1952. Another annelid first intermediate host of a digenetic trematode. *Jour. Parasitol.* 38 (4): 1-4.

———— 1955. Seasonal infections of the snail, *Cerithidea californica* Holdeman, with larval trematodes. *Essays in the Nat. Sci. in Honor of Capt. Allan Hancock,* 203-210.

———— 1956. The life cycle of *Catatropis johnstoni* n. sp. (Trematoda: Notocotylidae). *Trans. Amer. Microscop. Soc.* 75 (1): 117-128.

———— and V. L. Gregory 1951. *Cercaria buchanani* n. sp., an aggregating marine trematode. *Trans. Amer. Microscop. Soc.* 70 (4): 359-362.

———— and R. E. Kuntz 1955. Some Egyptian Heterophyid trematodes. *Jour Parasitol.* 41 (4): 374-382.

Mathias, Paul 1925. Recherches expérimentales sur le cycle évolutif de quelques trématodes. *Bull. Biol.* 49: 1-123.

———— 1930. Sur une cercaire monstre double du type Lambdoide. *Ann. Parasitol. Humaine et Compar.* 8 (2): 147-150.

Maxon, M. G. and W. E. Pequegnat 1949. Cercariae from upper Newport Bay. *Jour. Entomol. and Zool.* 41 (1): 30-55.

McCoy, O. R. 1928. Studies on marine trematode life histories. Papers from Tortguas Lab., *Carnegie Inst. Year Book* 27: 280-284.

———— 1929a. Further life history studies on marine trematodes. Papers from Tortugas Lab., *Carnegie Inst. Year Book* 28: 290-292.

———— 1929b. Notes on cercariae from Missouri. *Jour. Parasitol.* 15 (3): 199-208.

———— 1929c. The life history of a marine trematode, *Hamacreadium mutabile* Linton, 1910. *Parasitology* 21 (1/2): 220-225.

———— 1929d. Observations on the life history of a marine lophocercous cercaria. *Jour. Parasitol.* 16 (1): 29-34.

———— 1930. Experimental studies on two fish trematodes of the genus *Hamacreadium* (family Allocreadiidae). *Jour. Parasitol.* 17 (1): 1-13.

McCrady, J. 1874. Observations on the food and reproductive organs of *Ostrea virginica,* with some account of *Bucephalus cuculus. Proc. Boston Soc. Nat. Hist.* 16: 170-192.

MENZEL, R. W. and S. H. HOPKINS 1955. The growth of oysters parasitized by the fungus *Dermocystidium marinum* and by the trematode *Bucephalus cuculus*. *Jour. Parasitol.* 41 (4): 333-342.

MILLER, H. M., JR. 1925a. A preliminary report on the larval trematodes infesting certain mollusks from Dry Tortugas. Papers from Tortugas Lab., *Carnegie Inst. Year Book* 24: 232-238.

———— 1925b. Larval trematodes of certain marine gastropods from Puget Sound, Washington. *Publs. Puget Sound Biol. Sta., Univ. Wash.* 5: 75-89.

———— 1926a. Further studies on the behavior of larval trematodes from Dry Tortugas. Papers from Tortugas Lab., *Carnegie Inst. Year Book* 25: 224-226.

———— 1926b. Behavior studies on Tortugas larval trematodes, with notes on the morphology of two additional species. Papers from Tortugas Lab., *Carnegie Inst. Year Book* 25: 243-247.

———— 1926c. Comparative studies on furcocercous cercariae. *Ill. Biol. Monogr.* 10 (3): 1-112.

———— 1929. Continuation of study on behavior and reactions of marine cercariae from Tortugas. Papers from Tortugas Lab., *Carnegie Inst. Year Book* 28: 292-294.

———— 1930. Formation and behavior of aggregations of cercariae. *Jour. Parasitol.* 17: 111-112.

———— and O. R. MCCOY 1930. An experimental study of the behavior of *Cercaria floridensis* in relation to its fish intermediate host. *Jour Parasitol.* 16 (4): 185-197.

———— and FLORA E. NORTHUP 1926. The seasonal infestation of *Nassa obsoelta* (Say) with larval trematodes. *Biol. Bull.* 50 (6): 490-508.

MONTICELLI, F. S. 1888. *Saggio di una morfologia dei trematodi.* Tesi per ottenere la privata docenza in zoologia nella R. Universita di Napoli. 130 p.

———— 1914. Ricerche sulla *Cercaria setifera* di Joh. Muller. *Atti Accad. delle Sci. Fis. e Mat., Napoli* 15 (11): 48 p.

MORGAN, T. H. 1891. A new larval form from Jamaica. *Amer. Nat.* 25: 1137-1139.

MOULINIE, J. J. 1856. De la reproduction chez les Trématodes endoparasites. *Mem. Inst. Natl. Genevois* 3: 7-278.

MÜLLER, JOHANNES 1850. Ueber eine eigenthumliche Wurmlarve aus der Classe der Turbellarien und aus der Familie der Planarien. *Arch. Anat. Physiol. u. Wissensch. Med.* 1850: 485-500.

MÜLLER, O. F. 1786. *Animalcula Infusoria fluviatilia et marina, quae detexit, systematice descripsit et ad vivum delineari curavit . . .* sistit opus hoc posthumum quod cum tabulis sencis L. in lucem tradit vidua ejus nobilissima, cura Othoris Fabricii. Hauniae. 367 p.

NICOLL, W. 1906. Notes on trematode parasites of the cockle (*Cardium edule*) and mussel (*Mytilus edulis*). *Ann. Mag. Nat. Hist.* 17: 148-155.

———— and W. SMALL 1909. Notes on larval trematodes. *Ann. Mag. Nat. Hist. London* (8) 3: 237-246.

NITZSCH, C. L. 1817. Beitrag zu Infusorienkunde oder Naturbeschreibung der Zerkarien und Bazillarien. *N. Schrift. Naturf. Gesellsch.*, Halle 3 (1): 128 p.

OCHI, S. 1931. Studies on brackish water fish trematoda. On the life history of *Pygidiopsis summus*. *Tokyo Iji Shinshi* 2712: 346-353.

ODHNER, T. 1902. Mitteilungen zur Kenntnis der Distomen. I. Ueber die Gattung *Zoogonus* Lss. *Zentr. Bakteriol., Parasitenk*, Abt. I, 31: 58-69.

———— 1914. *Cercaria setifera* von Monticelli—die Larvenform von *Lepocreadium album* Stoss. *Zool. Bidr. Uppsala* 3: 247-255.

OGATA, T. 1943. Studies on Japanese cercariae. I. A new echinostome cercaria from brackish water snail *Cercaria granifera* n. sp. *Dobutsugaku Zasshi* 55: 265-284.

OZAKI, Y. and C. ISHIBASHI 1934. Notes on the cercariae of the pearl oyster. *Proc. Imp. Acad., Tokyo* 10: 439-441.

PAGENSTECHER, H. A. 1857. Trematodenlarven und Trematoden. *Helminthologischer Beitrag.*, Heidelberg. 56 p.

———— 1863. Untersuchungen über niedere Seethiere aus Cette. *Z. wiss. Zool.* 12: 265-311.

PALOMBI, ARTURO 1924. Le cercarie del genere *Gymnophallus* (Odhner) dei mitili. *Pubbl. Staz. Zool. Napoli* 5 (2): 137-152.

———— 1925. Di un nuovo ospitatore della cercaria dell *Echinostomum secundum* Nicoll, 1906: *Mytilus galloprovincialis* Lamk. *Boll. soc. nat. Napoli* 16: 49-54.

———— 1926. Nuova cercaria di *Mytilus galloprovincialis* Lamk. *Cercaria megalophallos* n. sp. *Ann. Mus. Zool. Univ. Napoli* 5 (17): 1-3.

———— 1928. La *cercaria pectinata* Huet 1891 nella sua fase d'incistidamento. *Ann. Mus. Zool. Univ. Napoli* 5 (20): 1-3.

———— 1929. Ricerche sul ciclo evolutivo di *Helicometra fasciata* (Rud.). Revisione delle specie del genere *Helicometra* Odhner. *Pubbl. Staz. Zool. Napoli* 9 (2): 237-292.

———— 1930. Life cycle of *Diphterostomum brusinae*. (Trematode digenetico: fam. Zoogonidae Odhner). *Pubbl. Staz. Zool. Napoli* 10 (1): 111-149.

———— 1931. Rapporti genetici tra *Lepocreadium album* Stossich e *Cercaria setifera* (non Joh. Muller) Monticelli. *Boll. Zool. Unione Zool. Italiana* 2 (4): 165-171.

———— 1932. *Bacciger bacciger* (Rud.) Nicoll 1914, forma adult di *Cercaria pectinata* Huet 1891. *Boll. soc. nat. Napoli* 44: 217.

———— 1933a. *Cercaria pectinata* Huet e *Bacciger bacciger* (Rud.). Rapporti genetici e biologia. *Boll. Zool., Naples* 4 (1): 1-11.

———— 1933b. Una parola di risposta a C. Ruth Shaw su *Cercariaeum lintoni* Miller and Northup. *Boll. Zool., Naples* 4 (3): 117-119.

———— 1934a. *Bacciger bacciger* (Rud.) Trematode digenetico: fam. Sterinzophoridae Odhner. Anatomia, sistematica e biologia. *Pubbl. Staz. Zool. Napoli* 13 (3): 438-478.

———— 1934b. Gli stadi larvali dei Trematodi del Gulfo di Napoli. I. Contributo ollo studio della morfologia, biologia e sistematica delle cercarie marine. *Pubbl. Staz. Zool. Napoli* 14 (1): 51-94.

———— 1937a. Il ciclo biologico di *Lepocreadium album* Stossich sperimentalmente realizzato. Osservazioni etologiche e considerazioni sistematiche sulla *Cercaria setifera* (non Joh. Muller) Monticelli. *Riv. Parassitol.* 1 (1): 1-12.

———— 1937b. La cercaria di *Mesometra orbicularis* (Rud.). e la sua transformazione in metacercaria. Appunti sul ciclo evoluto. *Riv. Parassitol.* 1 (1): 13-17.

———— 1938a. Metodi impiegati per lo studio dei cicli evolutivi dei Trematodi digenetici. Materiale per la conoscenza della biologia di *Podocotyle atomon* (Rud.). *Livro Jub. Prof. Lauro Travassos* 1938: 371-379.

———— 1938b. Gli stadi larvali dei trematodi del Golfo di Napoli. 2° contributo allo studio della morphologia, biologia, e sistematica delle cercariae marine: (il grouppe delle cercarie cotilocerche). *Riv. Parassitol.* 2 (3): 189-206.

———— 1940. Gli stadi larvali dei trematodi del Golfo de Napoli. *Riv. Parassitol.* 4 (1): 7-30.

———— 1941. *Cercaria dentali* Pelseneer, forma larvale di *Ptychogonimus megastoma* (Rud.). Nota preventiva. *Riv. Parassitol.* 5 (2): 127-128.

———— 1942a. Ricerche sperimentali sull 'azione del secreto delle glandole cefaliche della cercaria di *Ptychogonimus megastoma* (Rud.). *Boll. Zool. Unione Zool. Italiana* 13: 2-15.

———— 1942b. Il ciclo biologico di *Ptychogonimus megastoma* (Rud.). Osservazioni sulla morfologia e fisiologia della forma larvali e considerazioni filogenetiche. *Riv. Parassitol.* 6 (3): 117-172.

PELSENEER, PAUL 1896. Un trématode produisant la castration parasitaire chez *Donax trunculus*. *Bull. Sci. de la France et Belg.* 6: 357-363.

———— 1906. Trématodes parasites de mollusques marins. *Bull. Sci. de la France et Belg.*, ser. 5, 9: 161-186.

PENNER, L. R. 1950. *Cercaria littorinalinae* sp. nov., a dermatitis-producing schistosome larva from the marine snail, *Littorina planaxis* Philippi. *Jour. Parasitol.* 36 (5): 466-472.

———— 1953a. The biology of a marine dermatitis-producing schistosome cercaria from *Batillaria minima* (Gmelin). *Jour. Parasitol.* 39 (no. 4, sect. 2): 19-20.

———— 1953b. The red-breasted merganser as a natural avian host of the causative agent of clam digger's itch. *Jour. Parasitol.* 39 (No. 4, sect. 2): 20.

———— 1956. Studies on the biology of marine acquired avian schistosomiasis. *Jour Parasitol.* 42 (4): 38.

———— and A. WAGNER 1956. Concerning the early developmental stages of *Ornithobilharzia canaliculata* (Rudolphi, 1819). *Jour. Parasitol.* 42 (4): 37.

PEREZ, CHARLES 1924. La complexe ethnologique de la Turritelle et des Phascolion Strombi. *Bull. Soc. Zool. de France* 49: 341-343.

———— 1936. Atrophie des glandes genitales de la Turritelle sous l'influence du parasitisme par les sporcysts d'une trematode. *Mem. Mus. d'Hist. Nat. Belg.*, ser. 2, 3: 539-547.

PHILIPPI, C. 1843. Ueber den Bau der Physophoren eine neue Art derselben (*Physophora tetrasticha*). *Arch. Anat. u. Physiol. u Wissensch. Med. Jahrg.* 1843: 58-67.

PINTNER, T. 1891. Ueber *Cercaria clausii* Monticelli. *Arb. Zool. Inst. Univ. Wien.* 11: 285-294.

PORTER, ANNIE 1938. The larval trematoda found in certain South African Mollusca, with special reference to schistosomiasis (bilharziasis). *Publ. So. African Inst. Med. Res.* No. XLII, vol. 8. 492 p.

PRICE, E. W. 1940. A review of the trematode superfamily Opisthorchoidea. *Proc. Helm. Soc. Wash.* 7: 1-13.

QUINTARET, GUSTAVE 1905. Note sur une cercaire parasite du *Barleeia rubra* (Adams). *Compt. Rend. Soc. de Biol., Paris* 58 (15): 724-725.

RANKIN, J. S. 1939a. Studies on the trematode family Microphallidae Travassos, 1921. I. The genus *Levinsenilla* Stiles and Hassall, 1901 and description of a new genus *Cornucopula*. *Trans. Amer. Microscop. Soc.* 58: 431-447.

———— 1939b. The life cycle of *Cornucopula nassicola* (Cable and Hunninen, 1938) Rankin, 1939 (Trematoda: Microphallidae). *Jour. Parasitol.* Suppl. 25 (6): 12.

———— 1940a. Studies on the trematode family Microphallidae Travassos, 1921. II. The genus *Spelotrema* Jagerskiold, 1901, and description of a

new species, *Spelotrema papillorobusta. Trans. Amer. Microscop. Soc.* 59 (1): 38-47.

———— 1940b. Studies on the trematode family Microphallidae Travassos, 1921. IV. The life cycle and ecology of *Gynaecotyla nassicola* (Cable and Hunninen, 1938) Yamaguti, 1939. *Biol. Bull.* 79 (3): 439-451.

———— 1946. Examination of tube-dwelling polychaete annelids for larval trematode infections. *Jour. Parasitol.* 32: 92.

REES, F. GWENDOLEN 1934. *Cercaria patellae* Lebour, 1911, and its effect on the digestive gland and gonads of *Patella vulgata. Proc. Zool. Soc. London* 1: 45-53.

———— 1937. The anatomy and encystment of *Cercaria purpurae* Lebour, 1911. *Proc. Zool. Soc. London*, ser. B., Part 1.

———— 1939a. Studies on the germ cell cycle of the digenetic trematode, *Parorchis acanthus* Nicoll, Pt. 1. *Parasitology* 31 (4): 417-433.

———— 1939b. *Cercaria strigata* Lebour from *Cardium edule* and *Tellina tenuis. Parasitology* 31 (4): 458-463.

———— 1940. Studies on the germ cell cycle of the digenetic trematode, *Parorchis acanthus* Nicoll, Pt. II. Structure of the miracidium and germinal development in the larval stages. *Parasitology* 32 (4): 372-391.

———— 1948. A study of the effect of light, temperature and salinity on the emergence of *Cercaria purpurae* Lebour from *Nucella lapillus. Parasitology* 38 (4): 228-242.

REES, W. J. 1935. The anatomy of *Cercaria buccini* Lebour, 1911. *Proc. Zool. Soc. London* 2: 309-312.

———— 1936a. Note on an ubiquitous cercaria from *Littorina rudis, L. obtusata* and *L. littorea. Jour. Marine Biol. Assoc. United Kingdom* 20 (3): 621-624.

———— 1936b. The effect of parasitism by larval trematodes on the tissues of *Littorina littorea* (Linne). *Proc. Zool. Soc. London*, Part 2: 357-368.

———— 1947. A cercaria of the genus *Haplocladus* from *Nucula nucleus* (L.). *Jour. Marine Biol. Assoc. United Kingdom* 26: 602-604.

ROBINSON, H. W. 1952. A preliminary report on the life cycle of *Cloacitrema michiganensis* McIntosh, 1938. (Trematoda). *Jour. Parasitol.* 38 (4): 368.

ROTHSCHILD, MIRIAM 1935a. The trematode parasites of *Turritella communis* Lmk. from Plymouth and Naples. *Parasitology* 27: 152-170.

———— 1935b. Note on the excretory system of *Cercaria ephemera* Lebour, 1907 (nec. Nitzsch). *Parasitology* 27: 171-174.

———— 1936a. Preliminary note on the trematode parasites of *Peringia ulvae* (Pennant) 1777. *Novitates Zool.* 39 (4): 268-269.

———— 1936b. Gigantism and variation in *Peringia ulvae* (Pennant) 1777, caused by infection with larval trematodes. *Jour. Marine Biol. Assoc. United Kingdom* 20: 537-546.

———— 1936c. A note on the variation of certain cercariae (Trematoda). *Novitates Zool.* 40 (1): 170-175.

———— 1937. Note on the excretory system of the trematode genus *Maritrema* Nicoll, 1907, and the systematic position of the Microphallinae Ward, 1901. *Ann. Mag. Nat. Hist.* 19: 355-365.

———— 1938a. Preliminary note on the life history of *Cryptocotyle jejuna* Nicoll, 1907 (Trematoda). *Ann. Mag. Nat. Hist.* 1 (2): 238-239.

———— 1938a. *Cercaria sinitsini* n. sp., a cystophorous cercaria from *Peringia ulvae* (Pennant, 1777). *Novitates Zool.* 41: 42-57.

———— 1938c. Notes on the classification of cercariae of the superfamily Notocotyloidea (Trematoda), with special reference to the excretory system. *Novitates Zool.* 41: 75-83.

———— 1938d. Further observations on the effect of trematode parasites on *Peringia ulvae* (Pennant) 1777. *Novitates Zool.* 41: 84-102.

———— 1938e. The excretory system of *Cercaria coronanda* n. sp. together with notes on its life history and the classification of cercariae of the superfamily Opisthorchioidea Vogel, 1934. (Trematoda). *Novitates Zool.* 41: 148-163.

———— 1938f. A note on the finfolds of cercariae of the superfamily Opisthorchioidea Vogel 1934 (Trematoda). *Novitates Zool.* 41: 170-173.

———— 1939a. A note on the life cycle of *Cryptocotyle lingua* (Creplin) 1825 (Trematoda). *Novitates Zool.* 41: 178-180.

———— 1939b. Large and small flame-cells in a cercaria (Trematoda). *Novitates Zool.* 41:376.

———— 1940a. *Cercaria imbricata* Looss 1896, nec. 1893. A note on nomenclature. *Novitates Zool.* 42 (1): 215-216.

———— 1940b. A note on the systematic position of *Cercaria coronanda* Rothschild, 1938. *Proc. Helm. Soc. Wash.* 7 (1): 13-14.

———— 1941a. The effect of trematode parasties on the growth of *Littorina neritoides* (L.). *Jour. Marine Biol. Assoc. United Kingdom* 25: 69-80.

———— 1941b. Note on life histories of the genus *Paramonostomum* Luhe, 1909 (Trematoda: Notocotylidae), with special reference to the excretory vesicle. *Jour Parasitol.* 27 (4): 363-365.

———— 1941c. Observations on the growth and trematode infections of

Peringia ulvae (Pennant) 1777 in a pool in the Tamar Saltings, Plymouth. *Parasitology* 33 (4): 406-415.

1941d. The metacercaria of a pleurolophocerca cercaria parasitizing *Peringia ulvae* (Pennant, 1777). Parasitology 33 (4): 439-444.

and NORA G. SPROSTON 1941. The metacercaria of *Cercaria doricha* Roths. 1934, or a closely related species. *Parasitology* 33 (3): 359-362.

SARKISIAN, L. N. 1957. *Maritrema uca*, new species (Trematoda: Microphallidae), from the fiddler crab, *Uca crenulata* (Lockington). *Wasmann Jour. Biol.* 15 (1): 35-48.

SCHECHTER, VICTOR 1943. Two flatworms from the oyster-drilling snail *Thais floridana haysae* Clench. *Jour. Parasitol.* 29 (5) 362.

SCHELL, S. C. and L. J. THOMAS 1955. Parasite-host relationships in a brackish water lake. *Trans. Amer. Microscop. Soc.* 74 (1): 21-27.

SCHILLER, E. L. 1959. Observations on the morphology and life cycle of *Microphallus pirum* (Afanas'ev, 1941). *Trans. Amer. Microscop. Soc.* 78 (1): 65-76.

SEWELL, R. B. S. 1922. Cercariae Indicae. *Indian Jour. Med. Res.* Suppl. No. 10, 370 p.

SHAW, C. RUTH 1933. Observations on *Cercariaeum lintoni* Miller and Northup and its metacercarial development. *Biol. Bull.* 64: 262-275.

SHORT, ROBERT B. and RHODES B. HOLLIMAN 1961. *Austrobilharzia penneri*, a new schistosome from marine snails. *Jour. Parasitol.* 47 (3): 447-452.

SINDERMANN, C., A. ROSENFIELD and L. STROM 1957. The ecology of marine dermatitis producing schistosomes. *Jour. Parasitol.* 43 (3): 382.

SINITZIN, D. TH. 1909. Studien über die Phylogenie der Trematoden. II. *Bucephalus* v. Baer und *Cercaria ocellata* de la Vall. *Zeit. wiss. Zool.* 94 (2): 299-325.

1910. Studien über die Phylogenie der Trematoden. II. *Cercaria plicata* nihi und Tetracotyle Brandes als dimorphe Larven der Distomiden, nebst einer Hypothese über die Enstehung des Wirtswechsels bei den Trematoden. *Zool. Zhur. Moscow* 1 (2): 106-144; 1 (3): 169-190.

1911. Parthenogenetic generation of trematodes and its progeny in molluscs of the Black Sea (Translation). *Records of the Imperial Acad. Sci., St. Petersburg*, ser. 8, vol. 30 (5): 127 p.

STAFFORD, J. 1912. On the fauna of the Atlantic Coast of Canada. Third report—Gaspé, 1905-1906. *Contrib. Canadian Biol.* 1906-1912: 45-67.

STUNKARD, H. W. 1929. Further observations on the cercaria which occurs in the marine annelid, *Hydroides dianthus*. *Jour. Parasitol.* 16 (2): 106.

1930a. The life history of *Cryptocotyle lingua* (Creplin), with notes on the physiology of the metacercariae. *Jour. Morphol.* and *Physiol.* 50 (1): 143-191.

1930b. An analysis of the methods used in the study of larval trematodes. Parasitology 22 (2): 268-273.

1932. Some larval trematodes from the coast in the region of Roscoff, Finistére. *Parasitology* 24 (3): 321-343.

1936. The life cycle of *Cercariaeum lintoni* Miller and Northup. *Jour. Parasitol.* 22: 542-543.

1938a. The morphology and life cycle of the trematode *Himasthla quissetensis* (Miller and Northup, 1926). *Biol. Bull.* 75 (1): 145-164.

1938b. *Distomum lascium* Leidy, 1891. (syn. *Cercariaeum lintoni* Miller and Northup, 1926), the larval stage of *Zoogonus rubellus* (Olsson, 1868) (syn. *Z. mirus* Looss, 1901). *Biol. Bull.* 75 (2): 308-334.

1940. Life history studies and the development of parasitology. *Jour. Parasitol.* 26 (1): 1-15.

1941. Specificity and host-relations in the trematode genus *Zoogonus*. *Biol. Bull.* 81 (2): 205-214.

1943. The morphology and life history of the digenetic trematode, *Zoogonoides laevis* Linton, 1940. *Biol. Bull.* 85 (3): 227-237.

1946. Interrelationships and taxonomy of the digenetic trematodes. *Biol. Rev., Cambridge Phil. Soc.* 21 (4): 148-158.

1950. Further observations on *Cercaria parvicaudata* Stunkard and Shaw, 1931. *Biol. Bull.* 99 (1): 136-142.

1951a. Observations on the morphology and life history of *Microphallus limuli* n. sp. (Trematoda: Microphallidae). *Biol. Bull.* 101 (3): 306-318.

1951b. Causative agents of swimmer's itch in Narragansett Bay, Rhode Island. *Jour. Parasitol.* Suppl. 37: 26-27.

1953a. Natural hosts of *Microphallus limuli* Stunkard, 1951. *Jour. Parasitol.* 39: 225.

1953b. Life histories and systematics of parasitic worms. *Syst. Zool.* 2 (1): 7-18.

1956. Studies on parasites of the green crab, *Carcinides maenas*. *Biol. Bull.* 111: 295.

1957. The morphology and life history of the digenetic trematode *Microphallus similis* (Jagerskiold, 1900), Baer, 1943. *Biol. Bull.* 112 (2): 254-266.

and R. M. CABLE 1932. The life history of *Parorchis avitus* (Linton), a trematode from the cloaca of the gull. *Biol. Bull.* 62 (3): 328-338.

——— and M. C. Hinchliffe 1952. The morphology and life history of *Microbilharzia variglandis* (Miller and Northup, 1926) Stunkard and Hinchliffe, 1951, avian blood flukes whose larvae cause "swimmer's itch" of ocean beaches. *Jour. Parasitol.* 38 (3): 248-265.

——— and C. Ruth Shaw 1931. The effect of dilution of sea water on the activity and longevity of certain marine cercariae, with descriptions of two new species. *Biol. Bull.* 61 (2): 242-271.

——— and J. R. Uzmann 1955. The killifish, *Fundulus heteroclitus*, second intermediate host of the trematode *Ascocotyle (Phagicola) diminuta*. *Biol. Bull.* 109 (3): 475-483.

——— and ——— 1958. Studies on digenetic trematodes of the genera *Gymnophallus* and *Parvatrema*. *Biol. Bull.* 115 (2): 276-302.

——— and ——— 1959. The life cycle of the digenetic trematode *Proctoeces maculatus* (Looss, 1901) Odhner, 1911 (syn. *P. subtenuis* (Linton 1907) Hanson, 1950) and description of *Cercaria adranocerca* n. sp. *Biol. Bull.* 116 (1): 184-193.

Talbot, S. B. 1936. Studies on Schistosome dermatitis. 2. Morphological and life history studies on three dermatitis-producing schistosome cercariae, *C. elvae* Miller, *C. stagnicolae* n. sp. and *C. physellae* n. sp. *Amer. Jour. Hyg.* 23 (2): 372-384.

Tennent, D. H. 1905. Feeding experiments for determining the life history of an oyster parasite. *Biol. Bull.* 8: 233-235.

——— 1906. A study of the life history of *Bucephalus haimeanus*, a parasite of the oyster. *Quart. Jour. Microscop. Sci.* 49: 635-690.

——— ——— 1909. Account of experiments for determining the complete life cycle of *Gasterostomum gracilescens*. *Science* 29: 432-433.

Thomas, A. P. W. 1883. The life history of the liver-fluke. (*Fasciola hepatica*). *Quart. Jour. Microscop. Sci.* n.s. (89), 23: 99-133.

Timon-David, J. 1933. Contribution à l'étude du cycle évolutif des Zoogonides (Trématodes). *Compt. Rend. Acad. des Sci., Paris* 196 (2): 1923-1924.

——— 1934. Recherches sur les Trématodes parasites des Oursins en Méditerranée. *Bull. Inst. Oceanogr. Monaco*, No. 652. 16 p.

——— 1953. Sur une métacercaire de la sardine et ses affinités avec le groupe Rhodometopa. *Compt. Rend. Acad. des Sci., Paris* 237: 1182-1184.

Uzmann, J. R. 1952. *Cercaria myae* sp. nov., a fork-tailed larva from the marine bivalve, *Mya arenaria*. *Jour. Parasitol.* 38 (2): 161-164.

——— 1953. *Cercaria milfordensis* nov. sp., a microcercous trematode larva from the marine bivalve, *Mytilus edulis* L. with special reference to its effect on the host. *Jour. Parasitol.* 39 (4): 445-451.

von La Valette, St. George, A. J. H. 1855. *Symbolae ad trematodum evolutionis historiam*. Diss. Berolini. 38 p.

Vaullegeard, Achille 1894. Note sur le présence du *Bucephalus haimeanus* (Lacaze-Duthiers) dans le *Tapes decussatus* (Linné) et dans le *Tapes pullastra* (Montagu.) *Bull. Soc. Linn. Normandie* 4 (ser. 7): 23-29.

——— 1896. Notices Helminthologiques. *Bull. Soc. Linn. Normandie*, ser. 4, 10: 50-60.

Vigueras, I. P. 1941. Nota sobre varios vermes encontrados en el "flamenco," (*Phoenicopterus ruber*). *Mem. Soc. Cubana Hist. Nat.* 15 (3): 327-336.

Villot, F. C. A. 1875a. Sur la faune helminthologique des côtes de la Bretagne (Roscoff). *Compt. Rend. Acad. des Sci., Paris.* 80 (10): 1098-1101.

——— 1875b. Sur les migrations et les métamorphoses des trématodes endoparasites marins. *Compt. Rend. Acad. des Sci., Paris* 81 (11): 475-477.

——— 1875c. Recherches sur les helminthes libres ou parasites des côtes de la Bretagne. *Arch. Zool. Exp. et Gen.* 4 (3): 451-482.

——— 1878. Organization et développment de quelques espéces de Trématodes endoparasites marin, (1). *Ann. sci. nat. Zool.*, v. 49, 6 s., v. 8 (2-3), art. 2, 40 p.

Willey, C. H. and Paul R. Gross 1957. Pigmentation in the foot of *Littorina littorea* as a means of recognition of infection with trematode larvae. *Jour. Parasitol.* 43 (3): 324-327.

Wolfgang, R. W. 1954a. Studies of the trematode *Stephanostomum baccatum* Nicoll, 1907: I. the distribution of the metacercariae in eastern Canadian flounders. *Jour. Fisheries Research Board Can.* 11 (6): 954-962.

——— 1954b. Studies of the trematode *Stephanostomum baccatum* Nicoll, 1907: II. Biology, with special reference to the stages affecting the winter flounder. *Jour. Fisheries Research Board Can.* 11: 963-987.

——— 1955. Studies on the trematode *Stephanostomum baccatum* Nicoll, 1907: III. Its life cycle. *Can. Jour Zool.* 33 (3): 113-128.

Wright, C. A. 1953. Probable relationship between the Rhodometopa group of cercariae and the trematode genus *Renicola* Cohn. *Nature* 171: 1072-1073.

——— 1956. Studies on the life history and ecology of the trematode genus *Renicola* Cohn, 1904. *Proc. Zool. Soc. London* 126 (1): 1-49.

Yamaguti, S. 1934. Studies on the helminth fauna of Japan. Part 3. Avian trematodes, II. *Jap. Jour. Zool.* 5: 543-550.

---------- 1958. Systema Helminthum. Vol. 1, Parts 1 and 2. *The Digenetic Trematodes of Vertebrates.* Interscience Publishers, Inc., New York, 1575 p.

YOUNG, R. T. 1936. A fork-tailed cercaria from Bering Sea, with a note on the marine furcocercous cercariae hitherto described. *Jour. Parasitol.* 22 (3): 255-258.

---------- 1938. The life history of a trematode (*Levinseniella cruzi*?) from the shore birds (*Limosa fedoa* and *Catoptrophorus semipalmatus inornatus*). *Biol. Bull.* 74 (2): 319-329.

---------- 1953. *Postmonorchis donacis*, a new species of monorchid trematode from the Pacific coast, and its life history. *Jour. Wash. Acad. Sci.* 43 (3): 88-93.

VIII. ABSTRACT

A morphological and taxonomic study of the trematode cercariae from 39 species of marine mollusks from Apalachee Bay, Gulf of Mexico, was conducted during the period September, 1956 to September, 1959. It is the first comprehensive report of these parasitic forms from the Gulf of Mexico, and all host and locality records therein are new.

A historical review of the literature on marine cercaria is given, and techniques and methods for cercarial study are discussed.

Twenty four new species of cercariae are described: 1 cyathocotylid, 1 schistosome, 2 aporocotylids, 4 furcocercous fellodistomatids, 1 tailless fellodistomatid, 1 bucephalid, 6 echinostomoids, 4 plagiorchioids, 2 monorchiids, 2 opecoelids, 3 opisthorchioids, and 1 "hemiuroid".

Four previously reported larvae are redescribed: cercaria of *Parorchis acanthus* (Nicholl, 1906), *Cercaria caribbea* III Cable, 1956, cercaria of *Himasthla quissetensis* (Miller and Northup, 1926), and *Cercaria caribbea* XXXVI Cable, 1956.

Each of the cercarial descriptions in the study contains a general diagnosis of the group where known, a telegraphic description of the species, a description of larval behavior, and a discussion of affinities including a comparison of the larva with its most closely related form.

Nineteen species of gastropods were examined involving 13,961 individuals. Of this total, 2477 or 17.7% were infected with larval trematodes (18 species). Ten species of pelecypods were examined involving 2616 individuals. Of this total, 145 or 5.5% were infected with larval trematodes (10 species).

A survey of the literature on marine cercariae of the world revealed 334 descriptions up to January, 1960. All of these larvae were taxonomically separated into family groups and placed in the key to cercariae proposed by LaRue (1957). References to all known marine cercariae are included in the bibliography.