Life Cycle of *Mesostephanus appendiculatus* (Ciurea, 1916) Lutz, 1935 (Trematoda: Cyathocotylidae)[1]

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FOR A NUMBER OF YEARS, the author has been studying trematode larvae which develop in the California horn-shell snail, *Cerithidea californica* Haldeman. One of these, a pharyngeate, furcocercous cercaria, proved to be the larva of *Mesostephanus appendiculatus*. The adults of this species were first described from the small intestines of Rumanian cats and dogs by Ciurea (1916). Ciurea, however, placed this species in the genus *Prohemistomum*. Price (1928) found this parasite in the small intestine of a dog that had lived in the vicinity of Washington, D.C. Lutz (1935) transferred this and some other species to his new genus, *Mesostephanus*, naming *M. fajardensis* (Price, 1934) as type species. Dubois (1953) includes the following species in the genus *Mesostephanus*: *M. fajardensis* (Price, 1934); *M. appendiculatus* (Ciurra, 1916); *M. appendiculatoides* (Price, 1934); *M. cubäensis* Allegret, 1941; *M. haliasturis* Tubangui and Masiluñgan, 1941; and *M. longisaccus* Chandler, 1950. Caballero, Grocott, and Zerecero (1954) added *M. microbursa* from the intestine of *Pelecanus occidentalis californicus*. Dubois (1953) believes that the members of the genus are natural parasites of certain fish-eating birds and accidental parasites of dogs.

MATERIAL AND METHODS

Infected *Cerithidea californica* were isolated in finger bowls. Emerged cercariae were studied alive and as fixed and stained whole mounts. Cercariae were fixed without pressure by forcibly ejecting them into cold Bouin's solution. Earlier larval stages and percentages of infection were obtained by crushing snails. Uninfected *Fundulus parvipinnis parvipinnis* (Girard) and *Gillichthys mirabilis* Cooper were collected in an isolated pool where there were no snails. These fish were exposed to cercariae and, following a lapse of 2–3 weeks, were fed to hatchery-raised chicks. The chicks were examined 9 days after the experimental feeding. The adult worms obtained were fixed in Bouin's solution under slight cover-glass pressure. Larval and adult stages were stained with paracarmine and mounted in Permount.

All measurements are in millimeters.

OBSERVATIONS

The sporocysts and cercariae of *Mesostephanus appendiculatus* develop in the digestive gland of the brackish-water snail, *Cerithidea californica*. During a 12-month survey (Martin, 1955), in which at least 1,000 snails were examined each month, only 7 infections of this parasite were found in 12,995 snails.

SPOROCYST (Fig. 2): Mother sporocysts were not observed. Daughter sporocysts are saccular and elongate. Measurements of 20 stained and mounted specimens are: length 1.368–3.355, av. 2.38; maximum width 0.173–.302, av. 0.236. The wall of the sporocyst has transverse contractile bands. At intervals there are thicker bands which give a false appearance of segmentation. One end of the sporocyst has a thick wall which is traversed by a birth canal.

CERCARIA (Figs. 3, 4): The cercariae are nonoculate and furcocercous. Though they lack eyespots, they show positive phototropism. The body surface is covered with minute, quincuncially arranged spines and scattered papillae

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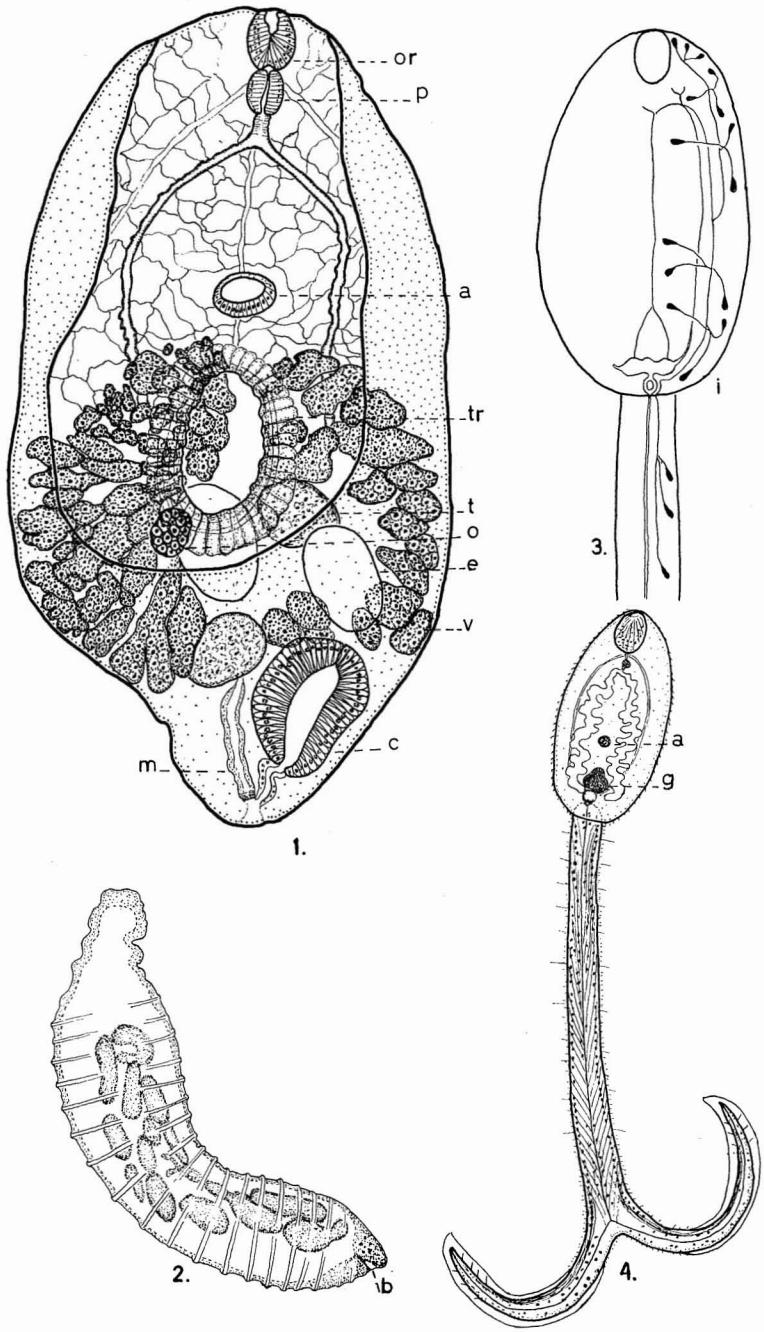
with bristles. Tubular glands are plentiful laterally and sparse dorsoventrally in the anterior half of the body. Ten to 12 glands have their cell bodies near the oral sucker and have ducts opening near the mouth. Measurements based on 20 stained and mounted specimens are: body length 0.18–.258, av. 0.192; maximum body width 0.078–.115, av. 0.094; oral sucker length 0.031–.045, av. 0.038; oral sucker width 0.025–.037, av. 0.03; ventral sucker midventral, rudimentary, 0.009–.012, av. 0.01 in diameter; lengths of prepharynx and esophagus approximate that of pharynx; pharynx oval to spherical, 0.006–.012, av. 0.011 long and 0.012–.016, av. 0.013 wide; intestinal caeca sinuous, terminating near excretory bladder; genital primordium median, immediately anterior to excretory bladder, 0.006–.022, av. 0.019 long and 0.019–.025, av. 0.021 wide; excretory bladder small, transversely elongate, with exit duct entering tail, dividing into two ducts which pass around the "Island of Cort" and rejoin, extending to the furcal region to divide into two ducts, each of which opens to the outside at the tip of a furca. Four collecting ducts empty into the bladder, two laterally and two medial to the lateral ducts on the anterior wall of the bladder. The two medial ducts pass around the genital primordium to unite and proceed as a single duct to a point near the bifurcation of the gut where it joins the lateral ducts which have proceeded anteriorly from the bladder. As the lateral ducts bend medially, each gives off a duct whose proximal portion contains a tuft of cilia. The latter duct extends posteriorly to about mid-body level where it divides into anterior and posterior branches each of which collects from three groups of three flame cells each. Three of the flame cells emptying into the posterior branch are located in the tail. The excretory formula is $2\ [(3+3+3) + (3+3+(3)] = 36$. Short, moniliform concretions occur in the main collecting tubes. The tail is set in a dorsal socket near the posterior end of the body. The tail surface bears bristles and minute spines. The tail stem length is 0.358–.407, av. 0.376, and maximum width near the junction with furcae 0.014–.022, av. 0.021. The furcae are 0.18–.2, av. 0.19 long and 0.019–.022, av. 0.021 in maximum width near the junction with the tail stem. Each furca bears a dorsoventral fin over the distal four-fifths of its length.

METACERCARIA: *Fundulus parvipinnis parvipinnis* and *Gillichthys mirabilis* were exposed to cercariae which rapidly penetrated the skeletal muscles and encysted. Penetration of large numbers of cercariae killed the fish. Death of the second intermediate host due to the penetration of large numbers of cercariae has been noted by Vernberg (1952) for a related parasite. Metacercariae approximately 3 weeks old were dissected from the fish and were fed, along with some muscle tissue, to hatchery-raised chicks.

ADULT (Fig. 1): Adult *Mesostephanus appendiculatus* were obtained from the small intestines of hatchery-raised chicks fed fish muscle and metacercariae. The chicks were examined 9 days after the experimental feeding. The following description and measurements are based on nine specimens. Body surface covered with scale-like spines arranged quincuncially. Body length 0.547–.763, av. 0.68; body width 0.346–.518, av. 0.41; oral sucker length 0.04–.059, av. 0.049; oral sucker width 0.047–.078, av. 0.055; acetabulum 0.04–.068, av. 0.06 in diameter; tribocytic organ well developed, opening usually slitlike; prepharynx very short; pharynx 0.037–.058, av. 0.05 long and 0.031–.044, av. 0.037 wide; esophagus approximately one-half pharyngeal length, with transverse muscle fibers; intestinal caeca sinuous, with occasional short diverticula, reaching to near posterior end of body; testes oblique, in posterior half of body, 0.109–.124, av. 0.116 long and 0.072–.087, av. 0.079 wide; cirrus sac and cirrus well developed; male genital opening communicates with common genital exit at posterior end of body; ovary intertesticular, 0.05–.08, av. 0.065 long and 0.04–.065, av. 0.05 wide; metraterm elongate, muscular, with sphincter at distal end where it empties into common genital exit; eggs yellow, operculate, 0.084–.137, av. 0.108 long and 0.058–.081, av. 0.07 wide; vitellaria composed of discrete follicles arranged in a circle in posterior half of body but not entering posterior conical body extension; excretory system more complex than in cercaria, anastomosing branches arise from main collecting ducts, some branches end blindly near body surface.



FIGS. 1–4: 1, Adult *Mesostephanus appendiculatus,* ventral view; 2, sporocyst; 3, diagram to show most of excretory system; 4, cercaria, ventral view. Abbreviations: *a,* Acetabulum; *b,* birth pore; *c,* cirrus sac; *e,* egg; *g,* genital primordium; *i,* Island of Cort; *m,* metraterm; *o,* ovary, or oral sucker; *p,* pharynx; *t,* testis; *tr,* tribocytic organ; *v,* vitellaria. All drawings made with the aid of a camera lucida unless otherwise stated.

DISCUSSION

The body dimensions of the adult *M. appendiculatus* described in this paper are smaller than those listed for the species by Dubois (1938). This may be due to the fact that the duration of the infection was only 9 days so that the worms probably had not attained their full size even though they were sexually mature. The range of egg size and the number of eggs (1–7) in the uterus were greater in my specimens that in those listed by Dubois (1938), which include measurements given by Ciurea (1916) and Prendel (1930). The anterior extent of the cirrus was greater in some specimens than is shown in Figure 1. The extent of the cirrus in Figure 1 resembles that of *M. microbursa* Caballero, Grocott, and Zerecero (1954), recovered from the intestines of pelicans, *Pelecanus occidentalis californicus,* collected in Panama and in the Coronado Islands off Mexico. However, the sucker ratio, spination, and extent of the posterior appendix are different in the two species.

The present work extends the range of *M. appendiculatus* to the west coast of the United States. It has been found on the east coast of this country by Price (1928), in Rumania by Ciurea (1916), and in the Ukraine by Prendel (1930).

Dubois (1953) states that pelicans are the natural hosts of this species. Since this parasite can develop also in dogs, cats, and chicks, the present author believes that other fish-eating birds probably serve as additional natural hosts.

Maxon and Pequegnat (1949) examined *Cerithidea californica* collected at Newport Bay, California, between October, 1947, and May, 1949. They found 21 per cent of the snails infected with furcocercous cercariae. They described one of the latter with 16 flame cells but did not describe the cercaria of *Mesostephanus appendiculatus.*

SUMMARY

The life cycle of *Mesostephanus appendiculatus* (Ciurea, 1916) Lutz, 1935 has been demonstrated experimentally. Sporocysts and cercariae develop in the brackish-water snail, *Cerithidea californica* Haldeman, collected at Newport Bay, California. The cercaria is furcocercous and has a flame-cell pattern expressed by the formula 2 [(3+3+3) + (3+3+(3)] = 36. Second intermediate hosts are *Fundulus parvipinnis parvipinnis* (Girard) and *Gillichthys mirabilis* Cooper. Experimentally infected fish were fed to hatchery-raised chicks. After a lapse of 9 days, egg-bearing worms were removed from the small intestines of the chicks.

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