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Some hemiurid trematodes of marine fishes of California

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SOME HEMIURID TREMATODES OF MARINE FISHES OF CALIFORNIA

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INTRODUCTION

The hemiurids include some of the most common trematodes of marine fishes. The family was established by Luhe (1901) to include the typical ecsomate forms such as Hemiurus and non-ecsomates such as Derogenes and Accacoelium. Looss (1907) revised the family excluding Derogenes and Accacoelium from the group. Odhner (1911) pointed out that Derogenes is very closely related to other hemiurids and should not be separated from the rest of the group. As to Accacoelium, Odhner erected for it a new subfamily, the Accacoeliinae. Nicoll (1915) accepted the broader concept of the family as established by Odhner and recognized six subfamilies: Hemiurinae, Dinurinae, Sterrhurinae, Lecithasterinae, Syncoeliinae and Accacoeliinae. Whether the latter two subfamilies should be considered as hemiurids or be raised to family ranks remained unsettled. Dollfus (1923) recognized the family Accacoeliidae, presumably, as distinctively characterized by the long oesophagus and the H-shaped intestine. Poche (1925) disagreed with this point of view, but Odhner (1927)

concurred and raised the Syncoeliinae to family rank. Fuhrmann (1928) agreed but transferred such typical hemiurids as Genolinea and Derogenoides to the Suncoeliidae. Lloyd (1938) reviewed the history of the family and concluded that "while there are decided differences between the groups under discussion, the undoubted similarities of the Syncoeliidae and Accacoeliidae to the Hemiuridae are such that they cannot be logically separated from the latter as separate families."

At the present time, it is generally agreed to separate those two groups - the Syncoeliidae and Accacoeliidae - from the hemiurids but possibly forming with them the superfamily Hemiuroidea. The family has been revised recently, according to Yamaguti (1958) by Skrjabin and Guschanskaja and by Yamaguti (1953,1958).

The first hemiurids from California were collected by Linton in 1898. Eight specimens of Genarches infirmus Linton 1940 were taken from Oncorhynchus tshawytscha at Pinole, San Pablo Bay, California (Linton 1940). He also collected six specimens of an unidentified species of Genarches " from stomach of young salmon at Battle Creek, California". Sleggs (1927) collected a Distomum appendiculatum (Rudolphi 1802) Looss 1899 from Paralichthyes

californicus in Monterey, California. Park (1936) described Sterrhurus magnatestis from Citharichthys sordidus and Tubulovesicula californica from Enophrys bison. Annereaux (1947) described Genolinea montereyensis from Clinocottus analis. The unpublished works of Gale, Hughes, Fisk and Copsey - graduate students at College of the Pacific Marine Station at Dillon Beach, California - were summarized by Johnson (1949 - unpublished). He reported new hosts for Sterrhurus magnatestis and Tubulovesicula californica (See Table I). An Opisthadena species was reported by Gale (1947 - unpublished) from Blennicottus sp. and the same species was reported from Cebidichthys violaceus by Johnson and by Copsey (Johnson 1949) and was named Opisthadena bodegensis (1953). Johnson (1949) also gave the description of two unidentified hemiurids, one from Hexagrammos sp. and the other from " either Hexagrammos superciliosus or Sebastodes rastrilliger - records uncertain". These unidentified species are believed by the writer to be, respectively, a Genolinea species and Sterrhurus exodicus (McFarlane 1936) McCauley 1954. This conclusion is based on the description and drawings given by Johnson. Unfortunately, his slides are not available for study. Manter and Van Cleave (1951) reported Brachadena pyriformis Linton 1910

from Anisotremus davidsonii and Porichthys sp., Elytrophallus mexicanus Manter 1940 from Paralabrax clathratus, and Aponurus trachinoti Manter 1940 from Porichthys sp. Montgomery (1957) described a new genus and species Myosaccium ecaude from Sardinops caerulea and a new species of Genolinea, G. tanyopa from Midialuna californiensis and Hypsypops rubicunda. He also reported Lecithochirium magnaporum Manter 1940 from Pneumatophorus japonicus diego. Table I is a summary of hemiurids described from the West Coast of North America. Table II summarizes the present survey.

MATERIALS AND METHODS

The hemiurids described in this study are taken from the helminthological collection of Dr. Alden E. Noble of the College of the Pacific. Dr. Noble had spent the summers of 1936 and 1937 at the Hopkins' Marine Station, Pacific Grove, California, where he examined hundreds of fishes for trematodes. The hemiurids were fixed in formalin-alcohol-acetic acid solution, stained with Henneguy's acid alum carmine and mounted in balsam. Whenever more than one trematode were collected, one or more individuals were stored in a mixture of glycerin and 70 % ethyl alcohol after flattening and fixation. Some of this material was used by the writer for sectioning purposes. Two specimens of Genolinea laticauda Manter 1925 were sectioned, one frontally and the other laterally. The sections, 15 micra thick, were doubly sealed with celloidin, after removal of paraffin, refixed in mercuric chloride solution and stained with Harris' hematoxylin and eosin. All drawings were made with the aid of a micro-projector.

SPECIES ENCOUNTERED

Dissosaccus laevis (Linton 1898) Manter 1947

Fig. 10

Syn.: Distomum laeve Linton 1898
Hemiurus laeve (Linton 1898) Looss 1898
Sterrhurus laeve (Linton 1898) Manter 1934
Lecithochirium laeve (Linton 1898) Crowcroft 1946

Host: Glyptocephalus zachirus (Stomach)
Locality: Monterey Bay, California
Date: July 7, 1936

Description

Body elongate; ecsoma about two thirds length of soma, tapering posteriorly; soma widest at level of vitellaria; preoral lip present. Cuticle smooth. Oral sucker subterminal; ventral sucker in anterior third of body proper, twice the size of oral sucker. Pharynx globular; oesophagus

short; intestinal caeca extending a short distance into ecsoma. Testes somewhat oblique, the left testis being slightly anterior, immediately post-acetabular; seminal vesicle conspicuously bipartite, the two parts connected by a thick duct and the posterior portion extending slightly beyond acetabulum; prostatic duct surrounded by prostate cells and forming prostate vesicle within sinus sac. Ovary subglobular, in posterior third of soma, separated from testes by uterine coils; vitellaria two compact masses, unlobed or slightly lobed, side by side and overlapping, post-ovarian; uterine seminal receptacle tubular; uterus not extending into ecsoma; eggs oval. Sinus sac muscular, pear-shaped, tapering anteriorly. Hermaphroditic duct short; gonopore ventral and at anterior level of pharynx. Excretory ducts uniting at junction of pharynx and oral sucker; excretory pore subterminal.

Measurements

The following measurements, based on two specimens, are given in mm except where stated otherwise. Soma 1.785 (1.75-1.82); ecsoma 1.125 (1.10-1.15); width at level of vitellaria 0.55 (0.53-0.58); oral sucker 0.140 x 0.135 (0.14 x 0.13-0.14); ventral sucker 0.29 x 0.29 (0.28-0.30 x 0.28-0.30); sucker ratio 1:2-2.1; pharynx 0.085 x 0.085

(0.08-0.09 x 0.08-0.09); anterior testis 0.17 x 0.21 (0.16-0.18 x 0.20-0.22); posterior testis 0.18 x 0.21; ovary 0.18 x 0.24; sinus sac 0.175 x 0.110 (0.17-0.18 x 0.10-0.12); eggs 24 x 8 micra.

Discussion

The specimens at hand closely resemble the ones described by Manter except in the following features. (1) Manter states that the right testis is usually anterior whereas in the present material, the left one is slightly anterior. (2) The duct separating the two portions of the seminal vesicle seems shorter and thicker than that shown in Manter's drawing (1934). This can be explained by the degree of body contraction in the acetabular region and by the amount of sperm congestion within. An examination of four paratypes lent by Dr. Manter indicates a variation in this feature. (3) The ecsoma in the present material is longer than that described by Manter, measuring about two thirds the length of soma. Manter gives an ecsoma length of 0.684 mm in a specimen with a soma length of 2.09 mm. In fact, in all six measurements that he gives (Manter 1934) none has an ecsoma-soma ratio of 2:3. The writer hesitates to consider these minor deviations as justifying the establishment of a new species.

Genolinea laticauda Manter 1925

Figs. 3,4 and 9

Syn.: Genolinea robusta Lloyd 1938

Genolinea oncorhynchi Margolis and Adams 1956 new synonymy

Hosts: Clinocottus analis (stomach)

Isopsetta isolepis (intestine)

Scorpaenichthys marmoratus (stomach)

Locality: Monterey Bay, California

Date: June 29,1936 (Clinocottus analis, Isopsetta isolepis)

July 9, 1936 (Scorpaenichthys marmoratus)

Description

Body cylindrical; anterior end surmounted by a conspicuous fleshy lip, posterior end rounded. Cuticle smooth. Oral sucker subterminal; ventral sucker, with powerful sphincter muscles, in anterior third of body. Pharynx globular; oesophagus short; intestinal caeca broad, wavy and extending to posterior extremity of body. Testes ovoid or spherical, one behind the other; seminal vesicle voluminous and convoluted, antero-dorsal to ventral

sucker; prostatic duct, surrounded by prostate cells, and entering ovoid muscular sinus sac where it unites with metraterm to form hermaphroditic duct. Ovary spherical or ovoid, smaller than testes; seminal receptacle dorsal to and larger than ovary; uterus extending posterior to vitellaria; vitellaria two compact masses, one behind the other, the anterior mass a little larger than the posterior one and usually overlapping ovary; eggs oval. Gonopore on ventral side at level of intestinal bifurcation.

Measurements

The following measurements, based on nineteen specimens from the three hosts, are given in mm except where stated otherwise. Length 2.29 (1.40-3.39); width 0.42 (0.30-0.54); oral sucker 0.18 x 0.19 (0.13-0.20 x 0.15-0.23); ventral sucker 0.30 x 0.31 (0.22-0.42 x 0.22-0.42); sucker ratio 1:1.7 (1:1.45-1.90); pharynx 0.09 x 0.10 (0.07-0.13 x 0.08-0.13); anterior testis 0.18 x 0.19 (0.10-0.23 x 0.14-0.26); posterior testis 0.17 x 0.20 (0.12-0.21 x 0.14-0.26); ovary 0.15 x 0.19 (0.10-0.18 x 0.10-0.26); seminal receptacle 0.24 x 0.23 (0.18-0.30 x 0.18-0.26); anterior vitellaria 0.17 x 0.23 (0.140-0.235 x

0.15-0.26); posterior vitellaria 0.16 x 0.20 (0.12-0.21 x 0.14-0.25); sinus sac 0.11 x 0.20 (0.12-0.24 x 0.10-0.16); eggs 33 x 17 micra (26-42 x 14-24 u).

Discussion

The genus Genolinea was established by Manter in 1925 with G. laticauda as type species. Since then ten species have been described: (1) G. laticauda Manter 1925, (2) G. aburame Yamaguti 1934, (3) G. anura (Layman 1930) Yamaguti 1954, (4) G. argentinae (Manter 1934) Yamaguti 1954, (5) G. dactylopagri Manter 1954, (6) G. manteri Lloyd 1938, (7) G. montereyensis Annereaux 1947, (8) G. oncorhynchi Margolis and Adams 1956, (9) G. robusta Lloyd 1938, (10) G. tanyopa Montgomery 1957.

G. oncorhynchi was described from two individuals collected from Oncorhynchus gorbuscha in British Columbia. This species - like G. laticauda - has sphincter muscles in its acetabulum, but, according to Margolis and Adams (1956), " it differs from the previously known species in body size (it is the smallest) and in possessing relatively larger gonads with a more compact arrangement, lengths of testes and ovary are 1/7 - 1/8 of total body length". It also "differs from G. laticauda in that the acetabulum is more posteriorly located and the testes are

less tandem and closer to the acetabulum". The writer feels that these differences are without taxonomic significance. Size is variable. As to position of acetabulum, a certain degree of variation is expected in a species like G. laticauda with thick musculature. Similar variations have been observed in the present material although none of the mature trematodes is actually as small as those described by Margolis and Adams. Johnson (1949), however, reports mature specimens with body lengths of 0.9 (0.705-1.28) mm. This species is here regarded as a synonym of G. laticauda.

Genolinea robusta was described by Lloyd in 1938. Lloyd discussed the similarities and differences between this species and the genotype, G. laticauda Manter 1925. Like G. laticauda, it is characterized by the presence of sphincter muscles in the ventral sucker. " It differs only in the shape of the gonads which are decidedly wider than long in G. robusta, globular in G. laticauda, and in possessing a generally more robust, muscular body". Manter (1954) placed G. robusta in synonymy with G. laticauda. McCauley (1954 unpublished) considered it a distinct species but now (in personal correspondence) accepts the synonymy.

The material at hand agrees in description and measurements with those given by Manter and Lloyd. The following observations, however, are herein noted. (1) The specimens from Isopsetta isolepis are more muscular than those from the other two hosts; (2) the position of the testes is variable, depending on the degree of body contraction. In some, the anterior testis almost touches the acetabulum; in others, it is separated from it by one or more uterine coils; (3) a distinct prostate and a long winding hermaphroditic duct are present in each of the specimens from Isopsetta isolepis and Clinocottus analis. However, variations exist with respect to this latter structure. In the specimens from Scorpaenichthys marmoratus, the short hermaphroditic duct is dilated posteriorly. Such a dilation is not seen in specimens from the other two hosts. The length and thickness of the hermaphroditic duct is also variable. In some it is a long, thin, winding tube; in others it is a thick protruding muscular structure that looks like a cirrus.

The thickness of the musculature, it seems, is disregarded as a character of taxonomic significance. Apparently the identification of the species can be based solely on the nature of the ventral sucker. The sphincter muscles are certainly characteristic and can be seen easily in

lateral views whether optical or actual.

All the other species of Genolinea are considered valid. Manter's key (1954) is herein revised - page 35 - to include G. argentinae and G. tanyopa.

Lecithaster salmonis Yamaguti 1934

Fig. 8

Host: Clupea pallasi (intestine)

Locality: Monterey Bay, California

Date: July 9, 1936

Description

Body rounded at both ends, widest at level of acetabulum; preoral lip present. Oral sucker subterminal; ventral sucker in anterior third of body. Pharynx globular; intestinal caeca extending beyond posterior level of vitellaria. Gonads in middle third of body. Testes spherical, oblique and close to acetabulum; seminal vesicle dorsal to acetabulum. Ovary four-lobed and post-testicular; uterus extending posterior to intestinal caeca but not to base of body; eggs oval; vitellaria seven-lobed. Hermaphroditic duct elongate, within an

elongated sinus sac that extends from posterior level of pharynx to middle of oral sucker. Excretory ducts not seen anteriorly, but posteriorly a flask-shaped excretory bladder is present and connects with terminal excretory pore by a narrow duct.

Measurements

The following measurements, based on s single specimen, are given in mm except where stated otherwise. Body length 1.15; width 0.39 at level of acetabulum; oral sucker 0.11 x 0.12; ventral sucker 0.18 x 0.18; sucker ratio 1:1.5; pharynx 0.08 x 0.07; testes 0.12 x 0.12; sinus sac 0.12 x 0.04; eggs 21 x 15 micra (20-22 x 14-16 u).

Discussion

Lecithaster salmonis was described by Yamaguti in 1934 from Oncorhynchus keta (Salmo keta). Lloyd (1938) reported the same species from Oncorhynchus tshawytscha from Puget Sound, Washington. The present report is the second from the West Coast and adds a new host to the record.

The material at hand agrees with those of Yamaguti and Lloyd in description and measurements except in the

character of the sinus sac. The sinus sac described by Yamaguti is oval, measuring 0.074 x 0.053 mm, and opens on the ventral side of the pharynx. Lloyd's drawing shows a more elongated sinus sac that opens ventrally at the junction of the pharynx and oral sucker. The sinus sac in the present material, measuring 0.12 x 0.04 mm, is more elongated and extends from the posterior level of the pharynx to about the middle of the oral sucker.

Parahemiurus merus (Linton 1910) Woolcock 1935

Fig. 2

Syn.: Hemiurus merus Linton 1910
Parahemiurus atherinae Yamaguti 1938
Parahemiurus harengulae Yamaguti 1938
Parahemiurus platichthyi Lloyd 1938
Parahemiurus parahemiurus Vaz & Pereira 1930

Hosts: Clupea pallasi (stomach & intestine)
Sardinops caerulea (intestine)

Locality: Monterey Bay, California

Date: July 9, 1936

Description

Body elongate; soma with cuticular denticulations, the rings becoming wider and less distinct posteriorly; ecsoma less than half length of soma; preoral lip small. Oral sucker subterminal; ventral sucker larger than oral sucker and in anterior fourth of body proper. Pharynx slightly longer than wide; oesophagus short; intestinal caeca extending to ecsoma. Testes globular, sub-globular or ovoid, tandem; seminal vesicle ovoid or pear-shaped, antero-dorsal to anterior testis; prostatic duct, long and winding, extends to about midacetabular level. Ovary wider than long, post-testicular, smaller than testes; uterine seminal receptacle tubular; uterus extends to ecsoma posteriorly and joins prostatic duct anteriorly above mid-acetabular level to form long hermaphroditic duct; eggs oval; vitellaria, lobed or unlobed, post-ovarian, side by side. Sinus sac thin-walled and elongate. Gonopore ventral and at mid-level of oral sucker.

Measurements

The following measurements, based on seven specimens, are given in mm except where stated otherwise. Soma 1.12 (0.96-1.30); ecsoma 0.52 (0.44-0.63); width at level of vitellaria 0.31 (0.24-0.38); oral sucker

0.08 x 0.08 (0.07-0.09 x 0.07-0.09); ventral sucker 0.15 x 0.15 (0.11-0.17 x 0.14-0.17); pharynx 0.065 x 0.050; anterior testis 0.12 x 0.18 (0.08-0.16 x 0.11-0.22); posterior testis 0.11-0.17 (0.08-0.15 x 0.11-0.18); ovary 0.08 x 0.15 (0.07-0.10 x 0.12-0.17); seminal vesicle 0.10 x 0.15 (0.12-0.17 x 0.06-0.15); eggs 23 x 8 micra (22-24 x 8-9 u).

Discussion

The genus Parahemiurus was established by Vaz and Pereira in 1930 with P. parahemiurus as type species. It was separated from the closely related genus Hemiurus on the basis of the undivided nature of the seminal vesicle. Linton (1910), in describing Hemiurus merus from Clupanodon pseudohispanicus, drew attention to the undivided seminal vesicle and suggested that it might be of generic significance. Manter (1934) expressed doubt about the generic significance of such a single character but later (1940) agreed. Yamaguti (1958) lists the following species: (1) P. parahemiurus Vaz & Pereira,1930 (2) P. anchoviae Vaz & Pereira 1930, (3) P. atherinae Yamaguti 1938, (4) P. australis Woolcock 1935, (5) P. clupeae Yamaguti 1953, (6) P. dogieli Skrjabin & Guschanskaja 1954, (7) P. ecuadori Manter 1940, (8) P. harengulae Yamaguti 1938,

(9) P. lovettiae Crowcroft 1947, (10) P. merus (Linton 1910) Woolcock 1935, (11) P. oatesi (Leiper & Atkinson 1914) Skrjabin & Guschanskaja 1954, (12) P. platichthyi Lloyd 1938, (13) P. sardinae Yamaguti 1934, (14) P. seriolae Yamaguti 1934. Manter (1940) considers P. atherinae, P. harengulae, P. parahemiurus and P. platichthyi as synonyms of P. merus.

Characters used to differentiate between species are: (1) extent of cuticular denticulations, (2) size of eggs, (3) shape of seminal vesicle, (4) ratio of suckers, (5) shape of pharynx.

Egg size seems to be variable in this genus. Manter (1940) reports a range limit of 18-30 by 8-10 micra in three specimens measured. If P. harengulae is accepted as a synonym of P. merus, then the egg size range becomes 18-34 by 8-14 micra. As to cuticular rings, Manter states, " the cuticular denticulation seems fairly constant. The body folds or rings extend entirely across the dorsal surface only as far back as the acetabular region, whereas on the ventral side they continue to the level of the ovary, or in some specimens to the posterior edge of the vitellaria or, in a few specimens, slightly beyond". Manter's study is based on 26 specimens from 9 hosts.

The material at hand agrees with the descriptions of P. merus. The following observations, however, are noted with respect to the extent of the cuticular denticulations. In the single specimen from Sardinops caerulea, the rings extend ventrally to near base of soma, laterally to level of anterior vitellaria and dorsally to anterior testis. In the six specimens from Clupea pallasi, the rings extend ventrally and laterally to near the base of the soma; dorsally, the extent of the rings is variable. In one specimen, they extend almost to the base of the soma; in another, to the level of the anterior testis, and in the remaining four specimens to different levels of the vitellaria. It is very possible that the extent of the rings on the dorsal surface is not a constant feature. These hemiurids are known to inhabit both stomach and intestine and it is possible that different habitats might affect the extent of the denticulations.

Sterrhurus exodicus (McFarlane 1936)McCauley 1954

Figs. 6 & 7

Syn.: Lecithochirium exodicum McFarlane 1936

Lecithochirium medius Acena 1941

Hosts: Sebastodes constellatus (stomach)

Ophiodon elongatus (stomach, oesophagus, mouth cavity)

Eopsetta jordani (stomach)

Caularchus meandricus (mesenteries)

Unidentified sole (stomach)

Locality: Monterey Bay, California

Date: June 29,1936 (Ophiodon elongatus)

July 7, 1936 (sole)

July 8 & 13,1936 (Ophiodon elongatus)

Oct.8, 1936 (Sebastodes constellatus)

Feb.20,1937 (Caularchus meandricus)

Description

Body elongate; ecsoma about one sixth length of soma, usually retracted; preoral lip present. Oral sucker subterminal; ventral sucker in second fourth of body

proper. Preacetabular pit present. Pharynx globular; oesophagus short; intestinal caeca not extending into ecsoma. Testes globular or subglobular, side by side, close to acetabulum; seminal vesicle tripartite, entirely or mostly anterior to ventral sucker; prostatic duct short, surrounded by prostate cells and opening into ejaculatory vesicle. Ovary globular or ovoid, post-testicular, separated from testes by uterine coils; uterine seminal receptacle tubular; uterus not extending into ecsoma; metraterm present; eggs oval; vitellaria post-ovarian, two compact masses slightly lobed, the right gland being four-lobed and the left one three-lobed. Hermaphroditic duct short; sinus sac not well developed. Gonopore anterior to intestinal bifurcation. Excretory ducts uniting anteriorly at level of pharynx.

Measurements

The following measurements, based on thirteen specimens, are given in mm except where stated otherwise. Soma 3.32 (2.27-4.93); ecsoma retracted in majority of specimens; width at level of acetabulum 0.86 (0.61-1.30); oral sucker 0.23 x 0.25 (0.18-0.26 x 0.20-0.30); ventral sucker 0.61 x 0.55 (0.54-0.70 x 0.49-0.68); ratio of suckers about 2:5; pharynx 0.15 x 0.13 (0.10-

0.21 x 0.11-0.15); right testis 0.25 x 0.26 (0.18-0.31 x 0.19-0.30); left testis 0.25 x 0.25 (0.17-0.31 x 0.18-0.29); ovary 0.24 x 0.30 (0.14-0.31 x 0.21-0.39); eggs 23 x 11 micra (20-24 x 8-12 u).

Discussion

The genus Sterrhurus was established by Looss in 1907 with S. musculus as type species. The genus is very closely related to Lecithochirium Lühe (1901) with which it has been confused since various characters have been used as bases for distinction. Looss (1907) gave the following characters for Sterrhurus: (1) Oral sucker without inner swellings; (2) preoral lip only slightly muscular; (3) preacetabular pit small or absent. Looss also revised the genus Lecithochirium and gave as characters: (1) Oral sucker with two muscular swellings; (2) preoral lip highly muscular; (3) preacetabular pit present.

Since then about 48 species have been added to the two genera, very few of which actually have the three characters of one or the other genus. A majority of species, in fact, have a combination of characters. Jones (1943), Crowcroft (1945) and Manter (1954) discussed the significance of these characters. Jones concluded that

the differences are really those of degree and that Sterrhurus is "defined entirely on negative features". Crowcroft noticed that the adequately described species fall in one or the other of two categories with respect to a structure in the sinus sac referred to by Looss as "Pr Bl". In some this structure vesicle has a simple wall of longitudinal fibers; in others, the wall is lined inside with tall cells similar to those of the pars prostatica. The former is derived from a portion of the ejaculatory duct and the latter from the pars prostatica. The terms " ejaculatory vesicle" and " prostate vesicle" are applied, respectively, to these two structures. Manter (1954) did not agree with Crowcroft. According to him, the genotype, Lecithochirium rufoviridae (Rudolphi 1819) Lühe 1901 is characterized by an ejaculatory vesicle rather than a prostate vesicle. Manter's opinion is based on Looss' figures 42 and 43 (1907). Looss has labelled the vesicle in his drawings "Pr Bl" inspite of the fact that it shows a thin wall. Apparently Looss did not consider the nature of the wall of the vesicle important and used the term "Pr Bl" for any vesicle within the sinus sac. Jones (1943) redescribed L. rufoviridae and gave a drawing that shows a thin-walled vesicle but described it as " prostatic vesicle lined by a membrane similar to that of the pars prostatica". Yamaguti appa-

rently, accepts Crowcroft's suggestion and on that basis transferred all Lecithochirium species with ejaculatory vesicles to the genus Sterrhurus and all species of Sterrhurus devoid of it to the genus Lecithochirium. However, as Manter points out, Looss' figure 41 (1907) of Sterrhurus imocavus shows a prostate vesicle, yet the species was retained in the genus Sterrhurus. If the nature of the vesicle is to be accepted as the basis for generic differentiation, S. imocavus must be transferred to the genus Lecithochirium. It seems to the writer that Crowcroft's suggestion is logical and it is herein adopted.

Lloyd (1938) described the sinus sac in the specimens from Ophiodon elongatus as incomplete. This is confirmed in the present study except that it is noticed that the degree of development of the sinus sac is variable. In some, it is an aggregation of loose fibers around the ejaculatory vesicle and hermaphroditic duct; in others, the fibers are more compact and more definite in outline. This is noticed in specimens from the same as well as from different hosts.

Acena (1941) described Lecithochirium medius taken from the stomach of Sebastodes ruberrimus at Friday Harbor,

Washington. It differs from S. exodicus in egg size only. Acena reports 30 x 10 micra compared with an egg size range of 20-24 x 8-12 u for S. exodicus. McCauley (1954) regards this species as a synonym of S. exodicus.

Sterrhurus monticelli (Linton 1898) Linton 1910

Fig. 5

Syn.: Distomum monticelli Linton 1898
Hemiurus monticelli (Linton 1898) Looss 1899
Sterrhurus monticelli (Linton 1898) Linton 1910

Host: Sebastodes sp. (stomach)
Locality: Monterey Bay, California
Date: July 27, 1936

Description

Body cylindrical; ecsoma short and mostly retracted. Cuticle smooth. Oral sucker subterminal, wider than long; ventral sucker almost 3 times size of oral sucker. Pharynx slightly longer than wide; oesophagus short; intestinal caeca not extending into ecsoma. Testes ovoid, lateral

and immediately post-acetabular; seminal vesicle, tripartite with large posterior portion and two convoluted anterior parts, located anterior to acetabulum; prostatic tube short; ejaculatory vesicle present. Ovary ovoid, post-testicular; uterus extending only to post-vitellarian level; eggs oval; vitellaria two-lobed masses, the right mass being four-lobed and the left one three-lobed. Sinus sac not well evident. Gonopore ventral and posterior to pharynx.

Measurements

The following measurements, based on the single specimen collected, are given in mm except where stated otherwise. Soma 2.3; ecsoma 0.44 retracted; width just posterior to acetabulum 0.92; oral sucker 0.15 x 0.27; ventral sucker 0.58 x 0.65; pharynx 0.10 x 0.085; right testis 0.26 x 0.29; left testis 0.21 x 0.29; ovary 0.17 x 0.32; eggs 20-24 x 8-9 micra.

Discussion

The most characteristic feature in this individual is its large acetabulum which is about three times that of the oral sucker. When the trematode was removed from the stomach of the host, it was still alive and during

the process of flattening and fixation, according to a notation by Dr. Noble at the time, " it reduced length to less than half probably due to larger ventral sucker".

This individual is more closely related to Sterrhurus monticelli than to any other Sterrhurus species. The following observations, however, are noted: The vitellaria in the present material are less deeply lobed than those described by Linton. Linton (1940), however, shows in figures 101-107 that variations exist in this structure. The testes are side by side and not diagonal. This is possibly a dislocation due to retraction of ecsoma during fixation and consequent pressure upon the posterior testis.

Tubulovesicula lindbergi (Layman 1930) Yamaguti 1934

Fig. 1

Syn.: Lecithaster lindbergi Layman 1930

Lecithurus lindbergi Pigulewski 1938

Dinurus nanaimoensis McFarlane 1936

Tubulovesicula nanaimoensis (McFarlane 1936) Manter 1947

Tubulovesicula madurensis Nigrelli 1940

Hosts: Ophiodon elongatus (stomach)

Platichthys stellatus (stomach)

Locality: Monterey Bay, California

Date: July 7, 1936 (Platichthys stellatus)

July 25, 1936 (Ophiodon elongatus)

Description

Body fusiform with bluntly pointed ends; soma about twice length of ecsoma. Cuticle thick and smooth; preoral lip present. Oral sucker subterminal; ventral sucker larger than oral sucker, located at posterior end of anterior third of soma. Sucker ratio 1:1.7-2.1 .

Pharynx globular; oesophagus short; intestinal caeca extending to posterior extremity of ecsoma. Testes ovoid and diagonally asymmetrical; seminal vesicle tubular and S-shaped, between testes and acetabulum; long prostatic tube, enclosed with prostate cells along its entire length, has its posterior end at the post-acetabular level and extends anteriorly to oval sinus sac where it joins metraterm and continues as hermaphroditic duct. Ovary ovoid and post-testicular; uterine seminal receptacle small; uterus extends into ecsoma in one specimen only; eggs oval in shape; vitellaria tubular and seven-lobed. Two specimens showed four right and three left vitelline lobes; six specimens showed three right and four left lobes. Sinus sac oval. Gonopore opens ventrally posterior to intestinal bifurcation. Excretory stem bifurcates between testes and its ducts extend anteriorly to reunite at level of pharynx; excretory pore at posterior tip of ecsoma.

Measurements

The following measurements, based on eight specimens, are given in mm except where stated otherwise. Soma 2.63 (1.58-3.60); ecsoma 1.21 (0.53-1.93); width at level of vitellaria 0.82 (0.56-1.14); oral sucker

0.27 x 0.28 (0.24-0.32 x 0.25-0.33); ventral sucker 0.49 x 0.47 (0.43-0.53 x 0.38-0.54); ratio of suckers 1:1.9 (1:1.7-2.1); pharynx 0.14 x 0.13 (0.12-0.16 x 0.12-0.14); right testis 0.19 x 0.24 (0.12-0.30 x 0.17-0.32); left testis 0.18 x 0.25 (0.12-0.26 x 0.12-0.32); ovary 0.20 x 0.28 (0.17-0.26 x 0.26-0.35);seminal vesicle 0.52 x 0.038 (0.44-0.56 x 0.035-0.044); prostatic tube 0.92 x 0.19 (0.79-1.05 x 0.18-0.21); eggs 31 x 19 micra (28-36 x 16-26 u).

Discussion

The difference in size of gonads in specimens from the two hosts was striking. Such a difference is probably due to age and is not uncommon. A difference in sucker ratio was also noticed. The specimens from Ophiodon elongatus have a constant sucker ratio of 1:2.1. Those from Platichthys stellatus have a range of 1:1.7-1.9. Except for these two deviations, the specimens from both hosts are very much alike. McCauley (1954) and Manter (1954) seem to admit that a variation exists in this feature when they placed many Tubulovesicula species in synonymy. The specimens from Platichthys stellatus encountered in this study are not as well flattened as those from Ophiodon elongatus. This was taken into consideration

and in the absence of other distinctive features, the author had no alternative but to consider the two as belonging to the same species.

The genus Tubulovesicula was established by Yamaguti in 1934 with T. spari as type species. Since then twelve species came to be recognized: (1) T.spari Yamaguti 1934, (2) T. anguillae Yamaguti 1934, (3) T. angusticauda (Nicoll 1915) Yamaguti 1934, (4) T. californica Park 1936, (5) T. lindbergi (Layman 1930) Yamaguti 1934, (6) T. madurensis Nigrelli 1940, (7) T. magnacetabulum Yamaguti 1939, (8) T. muraenesocis Yamaguti 1934, (9) T. nanaimoensis (McFarlane 1936) Manter 1947, (10) T. pinguis (Linton 1940) Manter 1947, (11) T. pseudorhombi Yamaguti 1938, (12) T. serrani Nagaty 1956.

The following characters are used to differentiate between species: (1) relative length of ecsoma compared with body proper, (2) ratio of sucker sizes, (3) size of eggs, (4) posterior extension of uterus and involvement of ecsoma, (5) size and extent of seminal vesicle, (6) degree to which pars prostatica is enclosed by prostatic cells, (7) posterior limit and location of pars prostatica, (8) number and position of vitelline lobes.

Nigrelli (1940) gives a key to eight of the species

based primarily on the number and position of vitelline lobes. McCauley (1954) found 9 vitelline patterns in 82 worms of the same species collected from eight different hosts, and he concluded that this character is unsatisfactory for separation of species in the genus. Manter (1954) concurs in this conclusion as related to twelve specimens. He states that " the number of tubes is either seven or eight and they may be arranged in various ways. The usual 3 right and 4 left occured in 5 specimens, but 2 specimens had 4 right and 3 left; three had 4 on each side; one had 3 on each side with 1 median; one had 6 right and 2 left".

The extension of the uterus into the ecsoma apparently varies with age and it is generally agreed that this character is unsatisfactory for species differentiation. On the basis of the other characters, McCauley (1954) considers T. californica, T. nanaimoensis, T. pseudorhombi and T. spari as synonyms of T. lindbergi. Manter (1954) recognizes T. spari and T. lindbergi as two separate species with T. californica, T.pseudorhombi and T. muraenesocis as synonyms of the former and T. nanaimoensis and T. madurensis as synonyms of the latter. T. lindbergi differs from T. spari in the posterior extent of the pars prostatica. In T. lindbergi, the pars prostatica originates posterior to the acetabulum whereas in T. spari,

this structure begins at about the midacetabular level. This character seems to be constant. Dr. McCauley , however, maintains (in personal correspondence) that the " placement of the prostate may be the result of several factors: namely, the degree of development of the worm, the effect of eggs distending the uterus and forcing the other organs forward, the degree of contraction at the time of fixation and the degree of flattening of the worm ". Dr. McCauley is probably correct in his conclusions. His arguments are certainly logical but in all eleven specimens encountered here, many of which fit into one or more of the above factors, the posterior end of the pars prostatica is post-acetabular. Manter's synonymy is accepted here except for T. muraenesocis . T. muraenesocis Yamaguti 1934 is characterized by a " strongly recurved, voluminous " seminal vesicle. Its pars prostatica originates at the midacetabular level like that of T. spari. According to Yamaguti (1958), Yeh (1954) places T. muraenesocis as a synonym of T. angusticauda. Yamaguti disagrees with both Manter and Yeh and holds that " it differs from either of these two species ".

The key, presented on page 36, is based on Manter (1954). It includes one additional species, T. serrani, and separates T. muraenesocis from T. spari.

KEY TO SPECIES OF GENOLINEA

1. a. Seminal vesicle extending posterior to acetabulum ---------- *G. aburame*
   b. Seminal vesicle not extending posterior to acetabulum ---------- 2
2. a. Sphincter muscles in acetabulum ---- *G. laticauda*
   b. Sphincter muscles lacking in acetabulum ---------- 3
3. a. Aperture of acetabulum a longitudinal slit ---------- *G. tanyopa*
   b. Aperture of acetabulum a transverse opening ---------- 4
4. a. Body truncated posteriorly --------- *G. argentinae*
   b. Body not truncated posteriorly ---------- 5
5. a. Anterior testis close to acetabulum------ 6
   b. Anterior testis well separated from acetabulum by uterus ---------- 7
6. a. Sucker ratio 1:2.3-2.9 ---------- *G. dactylopagri*
   b. Sucker ratio 1:1.45-1.65 ---------- *G. montereyensis*
7. a. Eggs 35-38 x 19-20 micra ---------- *G. manteri*
   b. Eggs 27-32 x 14-19 micra ---------- *G. anura*

KEY TO SPECIES OF TUBULOVESICULA

1. a. With prostatic gland cells from posterior edge of acetabulum ---------- 2
   b. With prostatic gland cells beginning at mid-acetabular level ---------- 3
   c. With prostatic gland cells near the anterior margin of acetabulum ---------- *T. angusticauda*
2. a. Prostatic gland cells interrupted opposite acetabulum ---------- *T. pinguis*
   b. Prostatic gland cells not interrupted opposite acetabulum ---------- *T. lindbergi*
3. a. Ecsoma as long or longer than soma ---------- 4
   b. Ecsoma shorter than soma ---------- 5
4. a. Pars prostatica much longer than seminal vesicle ---------- *T. anguillae*
   b. Pars prostatica shorter than seminal vesicle ---------- *T. serrani*
5. a. Ratio of ventral to oral sucker more than 3:1 ---------- *T. magnacetabulum*
   b. Ratio of ventral to oral sucker less than 3:1 ---------- 6
6. a. Seminal vesicle long and slender --------*T. spari*
   b. Seminal vesicle recurved and voluminous--*T. muraenesocis*

TABLE I

HEMIURIDS FROM THE WEST COAST OF NORTH AMERICA

Name of Trematode	Host	Locality	Date	Author
Aponurus trachinoti	Porichthys sp.	La Jolla, Calif.	1951	Manter & Van Cleave
Brachadena pyriformis	Anisotremus davidsoni	La Jolla, Calif.	1951	Manter & Van Cleave
	Porichthys sp.	La Jolla, Calif.	1951	Manter & Van Cleave
Brachyphallus crenatus	Oncorhynchus tshawytscha	Puget Sound, Wash.	1938	Lloyd
Derogenes crassus	Sebastodes paucispinus	Yaquina Bay, Oregon	1954	McCauley
	Ophiodon elongatus	Yaquina Bay, Oregon	1954	McCauley
Derogenes varicus	Ophiodon elongatus	Friday Harbor, Wash.	1938	Lloyd
	Sebastodes maliger	Friday Harbor, Wash.	1938	Lloyd
	Leptocottus armatus	Seattle, Wash.	1938	Lloyd
	Microgadus proximus	Yaquina Bay, Oregon	1954	McCauley
Distomum appendiculatum	Paralichthys californicus	Monterey, Calif.	1927	Sleggs
Elytrophallus mexicanus	Paralabrax clathratus	La Jolla, Calif.	1951	Manter & Van Cleave
Genarches infirmus	Oncorhynchus tshawytscha	Pinole, Calif.	1940	Linton

TABLE I (Cont'd.)

Name of Trematode	Host	Locality	Date	Author
Genarches sp.	Oncorhynchus tshawytscha	Battle Creek, Calif.	1940	Linton,
Genolinea laticauda	Scorpaenichthys marmoratus	Friday Harbor, Wash.	1933	Kohlruss
	S. marmoratus	British Columbia	1936	McFarlane
	S. marmoratus	San Juan Island	1938	Lloyd
	Ophiodon elongatus	Seattle, Wash.	1938	Lloyd
	Blepsias cirrhosus	Yaquina Bay, Oregon	1954	McCauley
	Enophrys bison	Yaquina Bay, Oregon	1954	McCauley
	Leptocottus armatus	Yaquina Bay, Oregon	1954	McCauley
	Oncorhynchus gorbusha	British Columbia	1956	Margolis & Adams
Genolinea manteri	Leptocottus armatus	Seattle, Wash.	1938	Lloyd
	Enophrys bison	Yaquina Bay, Oregon	1954	McCauley
	Lumpenus anguillaris	Yaquina Bay, Oregon	1954	McCauley

TABLE I (Cont'd.)

Name of Trematode	Host	Locality	Date	Author
Genolinea montereyensis	Clinocottus analis	Monterey, Calif.	1947	Annereaux
	Leptocottus armatus	Yaquina Bay, Oregon	1954	McCauley
Genolinea tanyopa	Medialuna californiensis	La Jolla, Calif.	1957	Montgomery
	Hypsypops rubicunda	La Jolla, Calif.	1957	Montgomery
Genolinea sp.	Hexagrammos sp.	Dillon Beach, Calif.	1949	Johnson
	Oligocottus snyderi	Dillon Beach, Calif.	1949	Johnson
	Scorpaenichthys marmoratus	Dillon Beach, Calif.	1949	Johnson
Hemiurus levinsini	Ophiodon elongatus	Friday Harbor, Wash.	1933	Kohlruss
	Sebastodes ruberrimis	Friday Harbor, Wash.	1933	Kohlruss
	Sebastodes caurinus	Friday Harbor, Wash.	1933	Kohlruss
	Oncorhynchus tshawytscha	Puget Sound, Wash.	1938	Lloyd
	Microgadus proximus	Yaquina Bay, Oregon	1954	McCauley

TABLE I (Cont'd.)

Name of Trematode	Host	Locality	Date	Author
Intuscirrus aspicotti	Aspidocottus bison	Puget Sound, Wash.	1947	Acena
Lecithaster salmonis	Oncorhynchus tshawytscha	Puget Sound, Wash.	1938	Lloyd
Lecithochirium magnaporum	Pneumatophorus jap.diego	La Jolla, Calif.	1957	Montgomery
	Trachurus symmetricus	La Jolla, Calif.	1957	Montgomery
Lecithophyllum anteroporum	Merluccius productus	British Columbia	1958	Margolis
	Oncorhynchus nerka	British Columbia	1958	Margolis
	Oncorhynchus gorbuscha	British Columbia	1958	Margolis
Myosaccium ecaude	Sardinops caerulea	La Jolla, Calif.	1957	Montgomery
Parahemiurus merus	Platichthys stellatus	Friday Harbor, Wash.	1938	Lloyd
Opisthadena bodegensis	Blennicottus sp.	Dillon Beach, Calif.	1947	Gale
	Gebidichthys violaceus	Dillon Beach, Calif.	1953	Johnson & Copsey

TABLE I (Cont'd.)

Name of Trematode	Host	Locality	Date	Author
Sterrhurus exodicus	Ophiodon elongatus	British Columbia	1936	McFarlane
	O. elongatus	Friday Harbor, Wash.	1938	Lloyd
	O. elongatus	Yaquina Bay, Oregon	1954	McCauley
	Sebastodes maliger	Friday Harbor, Wash.	1938	Lloyd
	Sebastodes ruberrimus	Friday Harbor, Wash.	1941	Acena
	Eopsetta jordani	Oregon	1952	Gregoire & Pratt
	Unidentified host	Dillon Beach, Calif	1949	Johnson
Sterrhurus magnatestis	Citharichthys sordidus	Dillon Beach, Calif.	1936	Park
	Ophiodon elongatus	Dillon Beach, Calif.	1948	Copsey
Tubulovesicula lindbergi	Enophrys bison	Yaquina Bay, Oregon	1954	McCauley
	Anoplarchus purpurescens	Yaquina Bay, Oregon	1954	McCauley
	Citharichthys sordidus	Yaquina Bay, Oregon	1954	McCauley
	Citharichthys stigmaeus	Yaquina Bay, Oregon	1954	McCauley
	Leptocottus armatus	Yaquina Bay, Oregon	1954	McCauley

TABLE I (Cont'd.)

Name of Trematode	Host	Locality	Date	Author
Tubulovesicula lindbergi	Ophiodon elongatus	Yaquina Bay, Oregon	1954	McCauley
	Psetichthys melanosticus	Yaquina Bay, Oregon	1954	McCauley
	Platichthys stellatus	Yaquina Bay, Oregon	1954	McCauley
Tubulovesicula spari	Enophrys bison	Dillon Beach, Calif.	1936	Park
	Leptocottus armatus	Tomales Bay, Calif.	1948	Copsey
	Leptocottus sp.	Tomales Bay. Calif.	1948	Copsey

TABLE II

HEMIURIDS FROM MONTEREY BAY ENCOUNTERED IN THIS STUDY

Name of Trematode	No. of specimens		Host	Location	Date
* *Dissosaccus laevis*	2		*Glyptocephalus zachirus*	stomach	July 7,1936
Genolinea laticauda	143		*Scorpaenichthys marmoratus*	stomach	July 9,1936
	4	#	*Clinocottus analis*	stomach	June 29,1936
	17	#	*Isopsetta isolepis*	intestine	June 29,1936
Lecithaster salmonis	1	#	*Clupea pallasi*	intestine	July 9,1936
Parahemiurus merus	6	#	*Clupea pallasi*	stomach intestine	July 9,1936
	1	#	*Sardinops caerulea*	intestine	July 9,1936
Sterrhurus exodicus	1	#	*Sebastodes constellatus*	stomach	Oct. 8,1936
	157		*Ophiodon elongatus*	stomach oesophagus mouth cavity	June 29,1936

* First report from the West Coast of North America

New host record on the West Coast of North America

TABLE II (Cont'd.)

Name of Trematode	No. of specimens	Host	Location	Date
Sterrhurus exodicus	1	Eopsetta jordani	stomach	July 16,1936
	2 (immature)	#Caularchus meandricus	mesenteries	Feb.20,1937
	14	sole	stomach	July 7,1936
* Sterrhurus monticelli	1	Sebastodes sp.	stomach	July 27,1936
Tubulovesicula lindbergi	5	Ophiodon elongatus	stomach	July 25,1936
	6	Platichthys stellatus	stomach	July 7,1936

* First report from the West Coast of North America

New host record on the West Coast of North America

SUMMARY

The following seven species of hemiurid trematodes, some with new host records, are reported in this study: Dissosaccus laevis, Genolinea laticauda, Lecithaster salmonis, Parahemiurus merus, Sterrhurus exodicus, Sterrhurus monticelli and Tubulovesicula lindbergi. Dissosaccus laevis and Sterrhurus monticelli are reported for the first time from the West Coast of North America.

Genolinea oncorhynchi Adams and Margolis 1958 is placed in synonymy with Genolinea laticauda Manter 1925. Keys for Genolinea and Tubulovesicula species, modified from Manter (1954) are included. Two tables, one summarizing the hemiurids reported from the West Coast of North America, the other a summary of hemiurids from Monterey Bay, California, encountered in this study, are also included.

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EXPLANATION OF PLATES

Fig. 1 Tubulovesicula lindbergi (Layman 1930) Yamaguti 1934 from Ophiodon elongatus, dorsal view x 30

Fig. 2 Parahemiurus merus (Linton 1910) Woolcock 1935 from Clupea pallasi, dorsal view x 65

Fig. 3 Genolinea laticauda Manter 1925 from Isopsetta isolepis x 27

Fig. 4 Reconstructed sketch of terminal genital organs of G. laticauda from Isopsetta isolepis

Fig. 5 Sterrhurus monticelli (Linton 1898) Linton 1910 ventral view x 27

Fig. 6 Sterrhurus exodicus (McFarlane 1936) McCauley 1954, from Sebastodes constellatus, ventral view x 30

Fig. 7 Sterrhurus exodicus from Ophiodon elongatus showing seminal vesicle congested with sperms x 30

Fig. 8 Lecithaster salmonis Yamaguti 1934, x 65

Fig. 9 Genolinea laticauda Manter 1925 from Scorpaenichthys marmoratus, x 27

Fig.10 Dissosaccus laevis (Linton 1898) Manter 1947 x 27

ABBREVIATIONS

C	caecum
Ec.	ecsoma
Ej.V.	ejaculatory vesicle
Ex.b.	excretory bladder
Ex.d.	excretory duct
G.p.	gonopore
H.D.	hermaphroditic duct
Met.	metraterm
Oes.	oesophagus
O.S.	oral sucker
Ov.	ovary
Ph.	pharynx
P.D.	prostatic duct
P.V.	prostate vesicle
S.R.	seminal receptacle
S.V.	seminal vesicle
S.S.	sinus sac
Sph.m.	sphincter muscle
T.	testis
Ut.S.R.	uterine seminal receptacle
Ut.	uterus
V.S.	ventral sucker
Vit.	vitellaria

PLATE

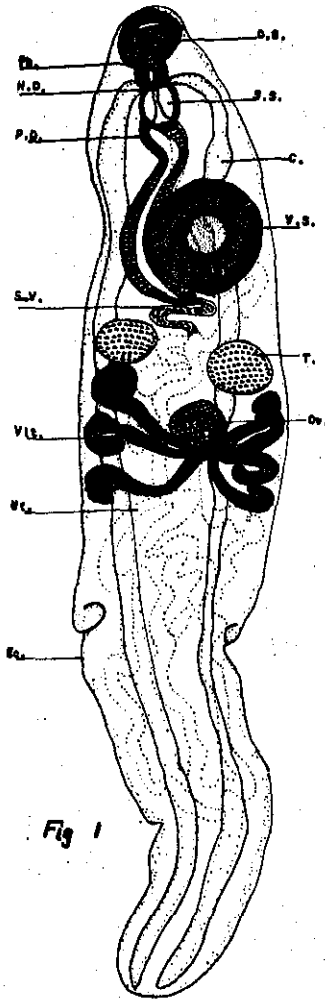


Fig 1

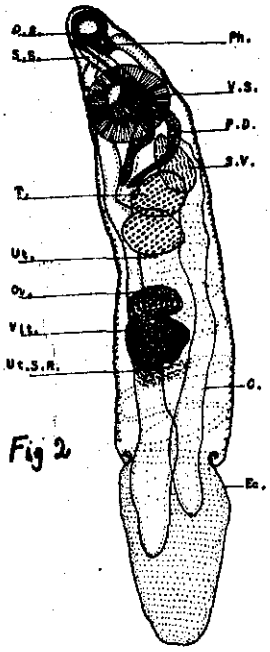
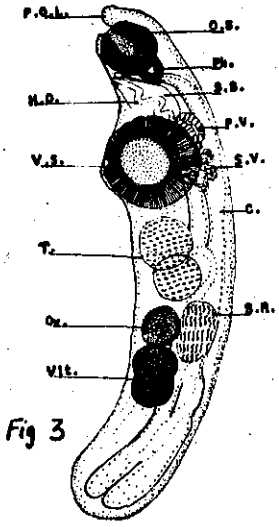


Fig 2



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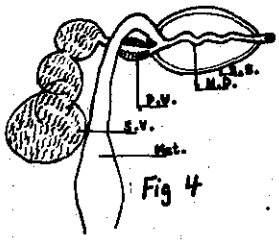

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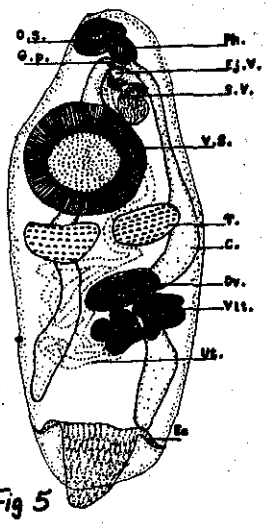

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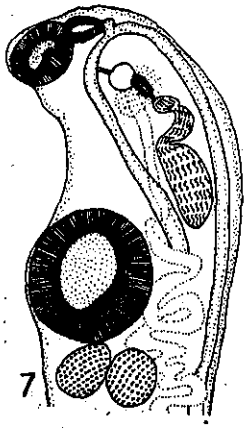

Fig 7

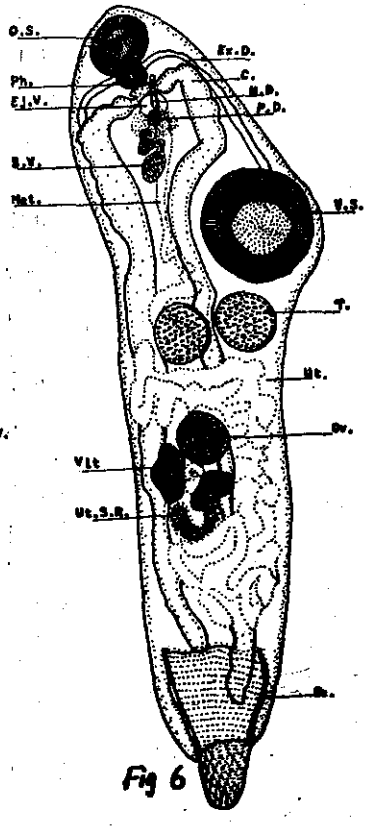

Fig 6

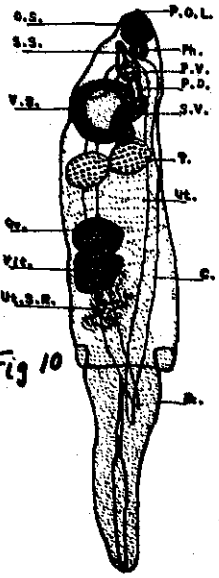

Fig 10

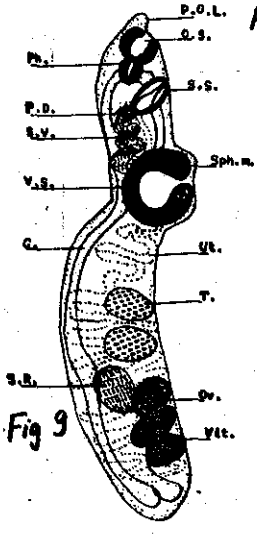

Fig 9

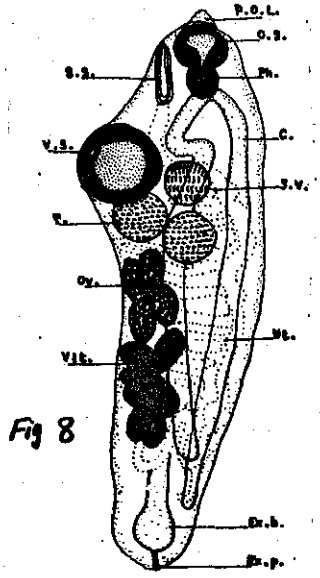

Fig 8