SOME HEMIURID Tрематодес of Oregon Marine Fishes

by

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Typed by Betty McCauley
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INTRODUCTION

Trematodes belonging to the family Hemiuridae have been known on the west coast of North America only since 1927 when George Sleggs (73, p.71) first reported one from southern California. This rather late date is quite surprising, because the group is neither uncommon nor inconspicuous. Members of the family have been known for 270 years in Europe. Müller described one species, *Fasciola varica* (=*Derogenes varicus*) in 1784 (70, p.81). On the east coast of North America Edwin Linton (32,33) and H. S. Pratt (67) had written about representatives of the family before the end of the nineteenth century.

Sleggs (73, p.71) first report of a member of this family is of little value since the nearest one could come to identifying it would be to say it is an appendiculate hemiurid. He described it from a dried specimen.

McFarlane (52, pp.345-347) described two new species, *Dinurus nanaimoensis* and *Lecithochirium exodicum*, from the
waters of Departure Bay, British Columbia, and reported *Genolinea laticauda* Manter from the same area. Lloyd (36, pp. 111-123) found *Derogenea varicua* (Müller), *Lecithochirium exodicum*, *Lecithaster salmonis* Yamaguti, *Syncoelium filiferum* (Sars), and *Odhnerium calyptracotyle* (Monticelli) in Puget Sound fishes. He also described the following new species: *Genolinea manteri*, *G. robusta*, and *Parahemiurus platichthyi*. Acena (1, pp. 287-288) described *Lecithochirium medius* from Puget Sound, and in a later paper (2, pp. 134-136) described another species, *Intuscirrus aspicotti*. Gregoire and Pratt (19, p. 84) found *Lecithochirium exodicum* from the coastal waters of Oregon. Park (64, pp. 477-482) described *Sterrhurus magnatestis* and *Tubulovesicula californica* from littoral fishes from Dillon's Beach, California. Johnson and Copsey (23, pp. 78-81) described *Opisthadena bodegensis* from the same region. Anneraux (4, pp. 249-250) described *Genolinea montereyensis* from a tide-pool fish captured near Monterey, California. Manter and Van Cleave (51, pp. 335-336) found *Aponurus trachinoti* Manter, *Brachadena pyriformis* Linton and *Elytrophallus mexicanus* Manter in fish taken near La Jolla, California.

Manter (49, pp. 417-443) described or reported 19 hemiurids from the tropical American Pacific near the Galapagos Islands, but only three of these have been reported from the coastal waters of western North America; namely,
Elytrophallus mexicanus, Derogenes varicus, and Aponurus trachinoti.

Layman (28) described five new species from Peter the Great Bay, Vladivostok, Siberia, but none of these has been reported from the west coast of North America.

Yamaguti (93,94,95,96,97,98,99) listed 81 species of hemiurids from the waters of Japan and of these only Brachyphallus crenatus, D. varicus, Lecithaster salmonis, and Odhnerium calyptrocotyle have been found on the west coast of North America. Other Japanese workers, Ozaki (63) and Kobayashi (26,27) described new species from Japanese waters, but these forms have been included in the total list of those found by Yamaguti.

Tseng (89) and Wu (92) each described a single species from Chinese waters, but neither has yet been reported from fishes from western North America.

Annereaux (5) reported a hemiurid from a Philippine fish; Tubangui and Masilugan (87,88) reported another from the same area, but neither of these has been reported from the west coast of North America.

Crowcroft (14,15), Johnston (24), and Woolcock (91) recorded a total of seven hemiurids from Australian fishes, none of which has been found on the west coast of North America.

Hemiurids from Indian waters have been recorded by
Bhalerao (6, 7, 8), Chauhan (11), and Srivastava (74,75,76, 77,78,79,80,81). A total of 20 species has been recorded, but none of these has been reported from the west coast of North America.

Myers and Wolfgang (55) reported a hemiurid from the New Hebrides and Bovien (9) reported one from Java, but neither of these has been found on the west coast of North America.

Travassos, Artigas and Pereira (86); Sisdat, Angelescue, and Siccardi (85), and Sisdat (84) listed six hemi-urids from South American waters, but none of these are the same as any on the west coast of North America.

Numerous individuals recorded observations of hemi-urid trematodes from fishes from Europe and the east coast of North America. Dawes (16,17) reviewed the work of the European authors and summarized most of the knowledge of European forms. Linton (35) and Manter (43,44,45,46,50) reviewed and summarized the work of American writers. Dero-
genus varicus, Hemirus levisenii, Brachyphallus crenatus, Genolinea laticauda, Syncoelium filiferum, Brachadena pyri-
formis, and Odhnerium calyptrocotyle, have been reported from both Atlantic shores and from the west coast of North America.

Papers published since Dawes (17) and Manter (50), and therefore not included in these reviews, are those of Hanson (20), Heller (21), Nigrelli and Stunkard (60),
Pearse (65), Raymont (68), and Rees (69). These papers do not add any new species and are not pertinent here.

This paper has been prepared with the hope that a small contribution will be made to the meager knowledge of trematodes of the west coast of North America. Five genera and eight species of hemiurid trematodes are considered in this paper. Seven additional species are placed in synonymy and one new combination is proposed. There is need for more study of this group.

**MATERIAL AND METHODS**

During the entire year of 1953 every opportunity was taken to examine marine fishes for their parasites. In all 156 fish representing 34 species were examined and the parasites collected from them. Identification of the hosts was made by the writer for the most part with the use of standard keys to the fishes of this region. Clemens and Wilby (12), Schultz (72), and Alverson and Welander (3) proved to be the most useful keys to the hosts. Some of the forms were identified by Mr. Carl Bond of the Department of Fish and Game Management at Oregon State College.

Trematode parasites were removed from the fish and placed in water where debris and mucous were removed with teasing needles. Then the worms were flattened slightly
under a coverslip and fixed with Lavdowsky's solution. They were then stored in Lavdowsky's solution or in 70% ethyl alcohol until they could be prepared into slides. The worms were then stained with Mayer's carmalum and mounted in balsam. Identifications were made from whole mounts.

Material was collected for study from Yaquina Bay, the shore of the Pacific ocean near the mouth of Yaquina Bay, and from commercial fishermen fishing several miles off the coast near Yaquina Bay. Two fish were collected near Port Orford, but did not yield parasites. No opportunity was afforded to collect fish from any other location.

Specimens used in this study are in the author's personal collection. A representative of each species represented, with the exception of Derogenes varicus, is deposited in the parasitological collection at Oregon State College.

Genus Derogenes Lühe

The genus Derogenes was established by Lühe in 1900 with Derogenes ruber Lühe as the type species. The genus consists of small to middle sized forms with spindle-shaped bodies, oval in cross section, and smooth, not annulated skin. They have no ecsoma. The ventral sucker lies
posterior to the middle of the body in contrast to all previously described genera. A cirrus pouch is present, projecting into the genital atrium in the form of a blunt conical papilla and enclosing the ductus hermaphroditicus and the terminal ends of the vas deferens and the metraterm. The pars prostatica is long and lies outside of the cirrus pouch. The vesicula seminalis is short and lies anterior and dorsal to the ventral sucker. The testes are approximately symmetrical and lie close behind the ventral sucker. The ovary lies behind the testes and is median. Two compact vitellaria which show mulberry-like lobes on the surface lie symmetrically behind the ovary. The eggs are surprisingly thick shelled. A receptaculum seminalis is present, but Laurer's canal is absent. The crura of the excretory bladder unite dorsal to the pharynx. (41, pp.478-479).

The following species have been named for the genus:

*Ureogenes affinis* (Rudolphi 1819) Lühe 1901 (42, p.479); *U. cacozelus* Nicoll 1907 (56, pp.90-91); *U. crassus* Manter 1934 (46, pp.318-319); *U. fuhrmanni* Mola 1912; (54, pp.492-494); *U. kobayashi* Layman 1930 (26, p.99); *U. macrostoma* Yamaguti 1938 (95, pp.134-135); *U. minor* Looss 1901 (38, pp. 437-439); *U. parvus* Szidat 1950 (84, pp.246-248); *U. plenus* Stafford 1904 (82, p.484); *U. ruber* Lühe 1900 (41, pp. 507-509); *U. tropicus* Manter 1936
(47, pp.36-37); **D. urocotyle** (Parona 1899) Odhner 1905 (61, p.364); and **D. varicus** (O.F. Müller 1784) Lühe 1901 (42, p.479).

**Deroegenes kobayashi** was transferred to the genus **Conocerca** Manter by Manter (46, p.319) and Yamaguti (93, p.499). **D. plenus** was insufficiently described and Miller (53, p.43) was unable to find specimens in Stafford's collection so that this species is of doubtful validity. Manter (44, p.103) and Dawes (17, p.300) consider this form a synonym of **D. varicus**. **D. urocotyle** is considered a species **inquirende** by Manter (47, p.37). **D. cacozelus** was placed in synonymy with **Lecithaster gibbosus** by Nicoll (57, p.18). Dawes (16, p.271; 17, p.300) considers **D. minor**, **D. crassus** and **D. fuhrmanni** synonyms of **D. varicus** by others do not. (95, p.134; 15, pp.11-12; 47, p.37).

The following are considered valid species of **Deroegenes**: **D. affinis** (Rudolphi 1819), **D. crassus** Manter 1934, **D. fuhrmanni** Mola 1912, **D. macrostoma** Yamaguti 1938, **D. minor** Looss 1901, **D. parvus** Szidat 1950, **D. tropicus** Manter 1936, **D. ruber** Lühe 1900, and **D. varicus** (Müller 1784).

**D. varicus** and **D. crassus** were found in this investigation.
Derogenes varicus (Müller 1784) Lühe 1901 (42, pp. 479). See fig. 1.

Synonymy:

Fasciola varica Müller 1784 [fide Rudolphi 1802 (70, p. 81)].

Distoma varicium Zeder of Rudolphi 1809 (71, pp. 395-397).

Distoma dimidiatum Creplin 1829:55-56 in part [fide Dawes 1947 (17, p. 300)].

The following description is based on one specimen from the tomcod Micropogus proximus (Girard) from Yaquina Bay, Oregon.

External features. Small spindle-shaped trematode with the posterior end somewhat pointed. This animal is 1.3 mm long and 0.37 mm wide. It has no ecsoma. The oral sucker is overhung by a preoral lip 0.04 mm in thickness. This sucker measures 0.12 mm in longitudinal diameter and 0.16 mm in transverse diameter. The ventral sucker is 2.3 times as large as the oral sucker and measures 0.27 x 0.27 mm. The ventral sucker lies immediately behind the middle of the body. The genital pore is located behind the oral sucker at the level of the bifurcation of the intestine. The excretory pore is located at the posterior tip of the body.
Digestive system. There is no prepharynx. The pharynx lies in contact with the oral sucker and measures 0.07 x 0.10 mm. This is followed by a short esophagus which bifurcates to form two intestinal crura. The crura continue posteriorly to the posterior end of the worm. They do not appear to be twisted as in *D. crassus*.

Genital systems. The "sex glands" are all crowded into the posterior quarter of the body. The spherical testes lie laterally behind the ventral sucker and both at about the same body level. They measure 0.11 mm in diameter. The globular seminal vesicle lies some distance in front of the ventral sucker and measures 0.07 x 0.09 mm. Extending forward from the seminal vesicle, a pars prostatica leads to the sinus sac. The pars prostatica, which is surrounded with many prostatic gland cells, combines with the uterus before it enters the sinus sac to form the hermaphroditic duct. The hermaphroditic duct passes across the sinus sac to the genital papilla which lies in the genital atrium. Lloyd (36, p.112) doubts the presence of the sinus sac in *D. varicus* and states that while it may appear present in whole mounts and living specimens, it is actually represented by only a few isolated muscle fibers in cross sections.

The ovary is 0.13 mm in diameter and lies closely behind the right testis. Details of the shell gland-complex are not visible on the specimen. The vitellaria are
0.15 mm in diameter and lie laterally behind the ovary. Both are at approximately the same level of the body. The uterus contains 16 large eggs measuring 53 x 31 microns. The uterus has a coil that first goes posteriorly and then anteriorly to the hermaphroditic duct.

The excretory system. Details of the excretory system are not visible, but there appear to be excretory crura passing above the oral sucker. It could not be determined whether they joined. The excretory pore is at the posterior end of the body.

This parasite, considered to be present in more host fish than any other trematode, was found here in the tomcod, Microgadus proximus. Forty-four hosts have been reported from British waters by Nicoll (58, pp.353-372); five hosts from the arctic region of Russia by Issaitschikow (46, p.318); six hosts from the waters of Maine by Manter (44, p.103); five from the deep waters of Tortugas, Florida, by Manter (46, p.319); two from the Galapagos region of the Pacific by Manter (48, p.431; 49, p.533); and three from Friday Harbor, Washington by Lloyd (36, p.111).

Host species from the Pacific coast of North America include Ophiodon elongatus (Girard) and Sebastodes maliger (Jordan and Gilbert) from Friday Harbor, Washington, and Leptocottus armatus Girard from Seattle, Washington (36, p.111). There do not appear to be other species recorded
from this area so that *Microgadus proximus* (Girard) is the fourth host on this coast.

*Derogenes crassus* Manter 1934 (46, pp. 318-319).

See fig. 2.

The following description is based on five specimens collected from two fish of two different species. Four from *Sebastodes paucispinus* (Ayres), and one from *Ophiodon elongatus* Girard.

**External Features:** Small spindle-shaped trematodes measuring 2.1-4.1 mm in length and 0.6-1.44 mm in width. The posterior end is rounded and there is no ecsoma. The oral sucker is subcircular, measuring 0.13-0.37 x 0.16-0.38 mm, the longitudinal measurement being slightly less than the transverse. The ventral sucker is from 1.9 to 2.8 times as large as the oral sucker and lies behind the middle of the body. The ventral sucker measures 0.36-0.80 x 0.33-0.77 mm and is also subcircular. The genital pore is located behind the oral sucker at the level of the bifurcation of the intestine. The excretory pore is located at the posterior tip of the body. The skin is smooth and unarmed.

**Digestive System.** The globular pharynx lies next to the oral sucker. There is no prepharynx. The pharynx measures 0.07-0.14 x 0.10-0.16 mm. Posterior to the
pharynx there is a short esophagus which bifurcates posteriorly to form two unbranched intestinal crura which progress through a somewhat convoluted course to the posterior end of the worm and appear somewhat twisted.

The genital systems. The testes, ovary, and vitelline glands are all concentrated in the posterior fourth of the body. The testes lie immediately behind the ventral sucker transversely symmetrical on the lateral margins of the body. They measure 0.11-0.22 mm in diameter. The globular seminal vesicle measuring 0.07 x 0.11 mm in one of the smaller specimens and obscured in the larger specimens, lies anterior to the ventral sucker close to or a little in front of the middle of the body. The pars prostatica consists of a long duct leading from the seminal vesicle to the sinus sac. This duct is completely surrounded by many prostate gland cells. The prostate gland enters the sinus sac where it is joined by the anterior end of the uterus to form the hermaphroditic duct. The hermaphroditic duct opens anteriorly in the top of a conical genital papilla.

The ovary is ovoid, 0.13-0.28 mm in diameter, and lies in the posterior part of the body closely behind the right testis. A short duct leads from the ovary to the ootype which is surrounded by the rather large Mehlis gland. A seminal receptacle is present, lying antero-medial to the ovary. A short Laurer's canal opens into the base of the
seminal receptacle and continues to the oootype. The vitelline ducts are not visible. Vitelline glands are compact, unlobed organs lying postero-lateral on the left side of the ovary. They measure 0.15-0.40 x 0.15-0.35 mm. The uterus is filled with eggs which measure 61-76 x 31-38 microns. The uterus courses posteriorly to the posterior tip of the animal and then coils anteriorly to the sinus sac where it joins the terminal portion of the pars prostatica before it enters the sinus sac. These ducts when joined become the hermaphroditic duct.

The excretory system. Details of the excretory system have not been worked out. There is a pore at the posterior end of the body and branches of the excretory bladder can be seen passing above the oral sucker, but it can not be determined whether these join each other in a typical hemiurid manner.

In addition to the hosts from which these specimens were collected, other fish have been reported as hosts of *D. crassus*. Manter (50, p.318) obtained this parasite from *Callionymus agassizii* Goode and Beane, a deep water fish off Tortugas, Florida. Yamaguti (95, p.134) found this species in the gall bladder of *Coelorhynchus* sp. at Naisaka, Japan.

Dawes (16, p.271; 17, p.300) states that this form is a synonym of *D. varicus*. However, he gives no reason
for placing these forms in synonymy and cites no reference for such action. The material at hand came from the Pacific Ocean west of Newport, Oregon, from depths of forty fathoms or more. Manter suggests that certain trematodes, parasitizing deep-sea fishes may be very widespread (50, p. 357). All representatives of this species have been collected from deep sea fishes. They differ from \( D. \text{ varicus} \) in the rounded posterior end, the more convoluted intestinal crura, and the markedly larger size of the eggs. Since these characters appear to be constant, there is no justification for placing \( D. \text{ crassus} \) and \( D. \text{ varicus} \) in synonymy.

**Genus Genolinea Manter**

The genus *Genolinea* was established by Manter in 1925 with *G. laticauda* as the type species. He described the genus as follows: "Small to middle sized forms, with flattened body, tapering slightly and broadly pointed anteriorly, but broadly rounded posteriorly. Body almost uniformly wide. Cuticula smooth. Tail appendage lacking. Oral sucker embedded in body overlapped dorsally by a fleshy ligula. Ventral sucker about \( \frac{1}{2} \) times the size of the oral sucker, located about at end of first body third. No pre-pharynx, pharynx broad, esophagus very short, ceca wide,
extending to posterior tip of body. Excretory system as in other Hemiuridae, branches uniting dorsal to the pharynx. Genital pore ventral, median, at about the level of the forking of the intestine. Testes globular, obliquely behind one another some distance behind ventral sucker. Ovary large, globular behind testes. Vitellaria behind one another posterior to the ovary. Uterus sends two lateral coils posterior to the vitellaria to near the body tip. Between the ovary and the ventral sucker, the uterus is in large transverse coils. Genital sinus short, sinus sac present, pars prostatica short, seminal vesicle much coiled just anterior or slightly overlapping the ventral sucker. Eggs 28-31 x 12-15 μ." (43, p.15)

The following species have been named in the genus:

**Genolinea aburame** Yamaguti 1934 (93, p.440-442); **G. anurus** (Layman 1930) Yamaguti 1934 (93, p.443); **G. laticauda** Manter 1925 (43, p.15); **G. manteri** Lloyd 1938 (36, pp.114-115); **G. montereyensis** Annereaux 1947 (4, pp.249-250); and **G. robusta** Lloyd 1938 (36, pp.113-114). None of the named species has yet been removed from the genus or placed in synonymy.

**Genolinea manteri**, **G. montereyensis**, and **G. robusta** were found in the present study.
See fig. 3.

The following description is based on 55 worms collected from Yaquina Bay, Oregon. Six of these worms came from the stomach of the eel-blenny Lumpenus anguillaris (Pallas); 47 from the stomach, one from the pyloric ceca, and one from the intestine of the buffalo sculpin Enophrys bison (Girard).

The mature worms from Enophrys bison are 1.62-3.48 mm long while those from Lumpenus anguillaris are somewhat smaller, measuring from 1.42-1.80 mm long. The worms appear to be identical except for the smaller size of those from the eel-blenny. It is assumed that they are the same species although they do not get quite as large in the eel-blenny. Description will be made from the material from Enophrys bison with a table to show measurements for the two hosts.

External features. Rather slender trematodes, gradually attenuated anteriorly and broadly rounded posteriorly. The part of the body anterior to the ventral sucker is sub-conical and tapers all the way from the ventral sucker to the anterior end of the body. The part of the body posterior to the ventral sucker is sub-cylindrical and of almost uniform diameter to the posterior end of the body. The oral sucker, overhung by a fleshy lip, measures 0.14-0.18 x
0.14-0.16 mm. The ventral sucker measures 0.23-0.35 x 0.28-0.35 mm. The genital pore is located posterior to the bifurcation of the intestinal crura on the ventral surface of the worm. The excretory pore is at the posterior tip of the body. There is no esoma. The cuticle is smooth and unarmed.

The digestive system. The oral sucker opens directly into the globular pharynx; there is no propharynx. The pharynx measures 0.08-0.10 x 0.10-0.13 mm. The esophagus is short or absent, and the two intestinal crura appear to arise directly from the pharynx. These crura continue posteriorly to the posterior end of the body.

The genital systems. Two ovoid testes lie one behind the other some distance behind the ventral sucker. The anterior margin of the anterior testis is behind the ventral sucker a distance equal or greater than the diameter of the sucker. The seminal vesicle arises from the level of the middle of the ventral sucker and consists of a long coiled tube which enters the short spherical pars prostatica. The pars prostatica is surrounded by many prostate gland cells. The metraterm joins the male ducts at the anterior end of the pars prostatica and both enter the strongly muscular sinus sac as the hermaphroditic duct. In the sinus sac the hermaphroditic duct is coiled as an eversible intromittent organ. In many of the specimens a
portion of this organ is everted.

The ovoid ovary lies behind the testes and is separated from the posterior testis by several loops of egg-filled uterus. A large seminal receptacle is anterior to and about the same size as the ovary. The details of the shell gland-complex are not visible, but Lloyd (36, p.114-115) discusses them and figures them (36, p. 129, fig. 15). He shows a large seminal vesicle which opens into an unbranched duct that leads directly to the oviduct. The oviduct passing through a Mehlis gland, where vitelline ducts enter, continues as the uterus. There is no Laurer's canal. Two rather polygonal compact vitellaria lie behind the ovary and may be in tandem or obliquely placed. They are never side by side. The uterus arises near the ovary at the Mehlis gland and passes posteriorly with a few loops lying behind the posterior vitellarium, and then courses anteriorly with many loops to the metraterm. This begins near the anterior border of the ventral sucker. The metraterm joins the pars prostatica to form the hermaphroditic duct before entering the sinus sac.

The excretory system. Lloyd (36, p.114-115) states that the excretory system is of the typical hemiurid type with the excretory crura uniting dorsal to the oral sucker. Details could not be observed in the material at hand.

Measurements. Comparative measurements for specimens
of this worm from the buffalo sculpin, *Enophrys bison* (Girard), and the eel-blenny, *Lumpenusanguillaris* (Pallas) are shown in Table 1.

<table>
<thead>
<tr>
<th>Measurements of worms from:</th>
<th><em>E. bison</em></th>
<th><em>L. anguillaris</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>1.68-3.84</td>
<td>1.36-1.80</td>
</tr>
<tr>
<td>Width</td>
<td>0.40-0.63</td>
<td>0.30-0.32</td>
</tr>
<tr>
<td>Suckers oral</td>
<td>0.10-0.16x0.10-0.18</td>
<td>0.08-0.10x0.10-0.12</td>
</tr>
<tr>
<td></td>
<td>0.21-0.25x0.21-0.25</td>
<td>0.20-0.23x0.20-0.24</td>
</tr>
<tr>
<td></td>
<td>0.06-0.11x0.09-0.13</td>
<td>0.06x0.07-0.08</td>
</tr>
<tr>
<td>Pharynx</td>
<td>0.16-0.20x0.16-0.21</td>
<td>0.11-0.15x0.12-0.14</td>
</tr>
<tr>
<td>Testes anterior</td>
<td>0.22-0.23x0.23-0.24</td>
<td>0.11-0.13x0.12-0.14</td>
</tr>
<tr>
<td></td>
<td>0.17-0.18x0.22-0.24</td>
<td>0.11-0.15x0.13-0.15</td>
</tr>
<tr>
<td></td>
<td>0.22-0.25x0.22-0.25</td>
<td>0.17x0.14</td>
</tr>
<tr>
<td>Ovary</td>
<td>0.12-0.22x0.12-0.27</td>
<td>0.10-0.14x0.10-0.14</td>
</tr>
<tr>
<td>Sem. Recept.</td>
<td>0.12-0.22x0.12-0.21</td>
<td>0.08-0.14x0.09-0.14</td>
</tr>
<tr>
<td>Vitellaria anterior</td>
<td>19-33x16-19</td>
<td>33-34x15-20</td>
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<tr>
<td></td>
<td>posterior</td>
<td></td>
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<tr>
<td>Eggs</td>
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<td></td>
</tr>
</tbody>
</table>

Table 1. Comparison of measurements of *Genolinea manteri* from the buffalo sculpin *Enophrys bison* Girard and the eel-blenny *Lumpenusanguillaris* (Pallas). All measurements are in millimeters except the eggs which are in microns.

This species has been collected from *Enophrys bison* and *Lumpenusanguillaris* in this study. It is essentially a stomach parasite of these hosts but two specimens from the sculpin have come from sources other than the stomach: one from the pyloric ceca and one from the intestine. It is entirely possible that these two had migrated from the stomach on the death of the host. Both hosts had been dead
some hours before they were examined. Lloyd (36, p.114) has found this species in the stomach of Leptocottus armatus Girard at Seattle, Washington. This study increases the members of host species to three.

Genolinea montereyensis Annereaux 1947 (4, pp.249-250), See fig. 4.

The following description is based on 16 specimens from the stomach of a single smooth sculpin, Leptocottus armatus Girard. This fish came from Yaquina Bay, Oregon.

**External features.** This small cylindrical trematode is smaller than either of the other two species of this genus discussed herein. It measures 0.46-0.86 mm in length by 0.23-0.31 mm in width. The subterminal oral sucker is overhung by a well developed preoral lip. The oral sucker is 0.08-0.10 x 0.10-0.11 mm in diameter. The ventral sucker lies about one third of the way back and measures 0.22-0.24 mm in diameter. The genital pore lies posterior to the oral sucker about one third of the way back to the anterior margin of the ventral sucker. The excretory pore is at the posterior end of the body. There is no ecsoma. The general body shape is cylindrical with the part anterior to the ventral sucker gradually attenuated so as to form a conical anterior end. The posterior end is broadly
rounded. The skin is smooth and unarmed.

The digestive system. The digestive system is like that of other members of this genus. There is neither prepharynx nor esophagus. The globular pharynx, measuring 0.05-0.06 x 0.07-0.08 mm, opens directly into the oral sucker on the anterior end and into the point of bifurcation of the intestine on the posterior. The intestinal crura extend to the posterior end of the worm.

The genital systems. The two ovoid testes lie one behind the other posterior to the ventral sucker. They are separated from the ventral sucker by one or two loops of uterus. The anterior one measures 0.13-0.24 x 0.14-0.16 mm and the posterior one measures 0.15-0.18 x 0.13-0.22 mm. The seminal vesicle consists of a coiled tube starting at the level of the middle of the ventral sucker and extending forward to the prostatic vesicle. This latter organ is surrounded by prostate gland cells and opens anteriorly into the sinus sac where it is joined by the uterus. The sinus sac is quite muscular and encloses the coiled hermaphroditic duct which functions as an eversible copulatory organ.

The subspherical ovary lies behind the posterior testis in contact with it. It measures 0.13-0.15 x 0.15-0.16 mm. The spherical seminal receptacle lies lateral to the ovary and measures 0.09 mm in diameter in a specimen.
1.46 mm long. The two vitelline glands lie one behind the other immediately behind the ovary. The anterior one measures 0.12–0.16 x 0.14–0.18 mm and the posterior one measures 0.12–0.15 x 0.13–0.16 mm. Details of the shell gland-complex can not be seen, but Annereaux (4, p. 250) stated that Laurer’s canal is present. The uterus consists of coils passing posterior to the vitellaria and then winding anteriorly to the posterior end of the sinus sac. A metraterm is absent. The uterine eggs measure 30–37 x 16–20 microns.

The excretory system. Details of the excretory system can not be seen and Annereaux does not mention them in his species description.

I have found this worm in the stomach of one Leptocottus armatus where there were 16 worms along with 55 specimens of Tubulovesicula lindbergi (Layman). Annereaux (4, p. 249) found a single specimen of G. montereyensis in a tide pool sculpin, Clinocottus analis (Girard) at Monterey, California. These two fish are the only recorded hosts of this parasite.
*Genolinea robusta* Lloyd 1938 (36, pp.113-114).

See fig. 5.

The following description is based on 26 specimens collected from Yaquina Bay, Oregon. Seven came from the stomach and one from the intestine of the smooth sculpin, *Leptocottus armatus* Girard; 16 came from the stomach of the buffalo sculpin, *Enophrys bison* (Girard); and two came from the stomach of the silver spot, *Eilepsias cirrhosus* (Pallas).

**External features.** These are cylindrical trematodes with the part of the body anterior to the ventral sucker remarkably strong and not attenuated but rounded off rather broadly. The part of the body posterior to the ventral sucker is cylindrical and of a uniform diameter. These worms are 0.90-3.06 mm long and 0.17-0.53 mm wide at the widest place. The oral sucker is overhung by a preoral lip that is so well developed as to make a contracted specimen appear as though the oral sucker were inside the body. The oral sucker measures 0.06-0.14 x 0.07-0.14 mm, and the ventral sucker measures 0.15-0.28 x 0.13-0.28 mm. The ventral sucker is rather extraordinary in that there is a strong sphincter muscle which can be seen in optical section. Lloyd has shown this in his material. (36, p.129, fig. 14.) The genital pore is located behind
the oral sucker at the level of the bifurcation of the intestinal crura. The excretory pore is located at the posterior tip of the worm. There is no ecsoma or caudal appendage. The cuticle is smooth and unarmed.

**Digestive system.** The oral sucker opens into the globular pharynx which is in contact with it, no prepharynx being present. The pharynx is somewhat shorter than it is broad and measures 0.04-0.08 x 0.04-0.11 mm. There is no esophagus; the intestinal crura arise directly from the posterior end of the pharynx and pass posteriorly to the tip of the body.

**The genital systems.** Two testes lie in the middle of the body, one behind the other. The anterior testis is at least the distance of the diameter of the ventral sucker behind it and measures 0.10-0.25 x 0.08-0.15 mm. The posterior testis lies immediately behind the anterior one in contact with it and measures 0.11-0.22 x 0.10-0.22 mm. The seminal vesicle arises from some point in front of the middle of the ventral sucker and passes anteriorly with many loops to the spherical prostatic vesicle. This latter organ is surrounded by many prostatic cells. The prostatic vesicle and the metraterm both enter the base of the sinus sac where they join to form the hermaphroditic duct. The sinus sac is surrounded with a heavy layer of muscle which encloses the coiled hermaphroditic duct. This
duct serves as an eversible copulatory organ. The proximal portion of this duct has an enlargement as indicated by Lloyd (36, p.114). In some of the specimens the "cirrus" is everted.

The ovary measures 0.08-0.20 x 0.09-0.18 and lies some distance behind the posterior testis. The large seminal receptacle measures 0.22 x 0.18 mm in one of the larger specimens. The details of the shell gland-complex are not visible but Lloyd (36, p.129, fig. 15) showed them in his paper. The uterus is filled with eggs and there are many coils first passing posteriorly almost to the posterior tip of the body and then anteriorly to the metraterm. The metraterm extends from the level of the anterior margin of the ventral sucker to the base of the sinus sac, where it joins with the prostatic vesicle to form the hermaphroditic duct. The uterine eggs measure 30 x 14-19 microns.

The excretory systems. According to Lloyd (36, p.114) the excretory system is of the usual hemiurid type with the crura of the excretory bladder joining dorsal to the pharynx.

I found this form in *Leptocottus armatus* and *Enophrys bison* from Yaquina Bay, Oregon. Lloyd (36, p.113) found it in the marbled sculpin * Scorpaenichthys marmoratus* Girard from False Bay on San Juan Island, Washington, and from
the lingcod *Ophiodon elongatus* Girard from Seattle, Washington. This study brings the host list to four for this species. In all cases except one the worms came from the stomach, and it can be assumed that the one from the intestine had probably migrated there on the death of the host.

Five species have been added to the genus *Genolinea* since it was erected by Manter in 1925 (43, p.15). Except for minor variations all forms conform to Manter's description. Manter did not record a seminal receptacle in his *G. laticauda*, and I was not able to see one in his type specimen. However, Lloyd (36, p.113) states that one is present in the paratype which he obtained from Manter. The following key is proposed for the species in this genus:

1. Sphincter muscle present in ventral sucker 2
1. Sphincter muscle not present in ventral sucker 3

2. Body robust; gonads wider than long
2. Body cylindrical, thin; gonads spherical

3. Metraterm absent; testes close to ventral sucker; sex "glands" filling most of area behind ventral sucker
   3. Metraterm present; testes at least diameter of ventral sucker behind it; sex "glands" filling less than half the area behind the ventral sucker

4. Length 2.35 mm or more; eggs 27-29 x 13-16 microns; ventral sucker 2.0 times the diameter of the oral sucker
   4
4. Length 2.60 or less; eggs 34-49 x 18-21 microns; ventral sucker 2.5 times the diameter of the oral sucker

5. Seminal vesicle voluminous, extending posteriorly to the level of the anterior testis. \( G.\textit{aburame} \)

5. Seminal vesicle lying mostly anterior to the ventral sucker. \( G.\textit{manteri} \)

Genus \textit{Hemiurus} Rudolphi 1809

The genus \textit{Hemiurus} was established by Rudolphi in 1809 (71, p.38) with \textit{Hemiurus appendiculatus} (Rudolphi 1802) as the type species. His description of the animal, based on external characteristics, was incomplete. Since the genus was erected many of the appendiculate trematodes have been placed in this genus at one time or another until about the beginning of the twentieth century. Rudolphi's description states "Pari modo, quae cauda appendiculata, tenuiore et retactile utuntur, satis bene genus novum, \textit{Hemiurus} (\textit{\eta}emi, semis; ov\textalpha, cauda) dicendum constituerent". (71, p.38).

Looss (39, p.590) has described the genus as containing forms of middle size. The abdomen is well developed and when fully outstretched can reach the length of the body; The vesicula seminalis is strongly bipartite, the anterior part with more or less strong muscular stratification; and the vitellaria are distinctly separated to the two
body sides. Since this description serves to separate the

genus from all other genera in the subfamily it probably
does not need amplification.

The following species have been named for the genus:

*Hemiurus appendiculatus* (Rudolphi 1802) Rudolphi 1809 (71,
p.38); *H. arelisci* Yamaguti 1938 (95, pp.107-108); *H.
bothryophorus* Looss 1899 (37, pp.041,728-729); *H. communis*
Odhner 1905 (61, p.351); *H. crenatus* (Rudolphi 1802) Lühe
1901 (42, pp.397); *H. laevis* (Linton 1898) Lühe 1901 (42,
p.400); *H. levinseni* Odhner 1905 (61, pp.348-351); *H.
lühei* Odhner 1905 (61, p.352); *H. mehriansis* Srivastava
1933 (74, p.42); *H. merus* Linton 1910 (34, p.66-61); *H.
Oatesi* Leiper et Atkinson 1914 (29, p.224: 30, p.34); *H.
ocreatus* (Rudolphi 1802) Lühe 1901 (42, p.400); *H. odhneri*
Yamaguti 1934 (93, p.432-434); *H. rugosus* Looss 1907 (29,
p.591); *H. spindale* Srivastava 1933 (74, p.46); *H. stoss-
sich**i* (Monticelli 1891) Lühe 1901 (42, p.398); *H. digitat-
tum* Looss 1899 (37, pp.729); and *H. rufoviride* (Rudolphi,
1819) Looss 1899 (25, pp.47).

*Hemiurus crenatus* has been transferred to the genus
brachynphallus by Odhner (61, p.350). *H. merus* has been
transferred to the genus *Parahemiurus* by Woolcock (91,
p.320). *H. laevis* was transferred to the genus *Serrhurus*
by Manter (46, pp.307-308). *H. digitatus* became the type
species of the genus *Plerus* Looss 1907 (47, pp.604-605).


The only species encountered in this study was *H. levinseni*.

**Hemiurus levinseni** Odhner 1905 (61, pp.348-351).¹

See fig. 6.

This description is based on 17 specimens taken from the stomach of the tomcod, *Microgadus proximus* (Girard).

**External features.** Small cylindrical trematodes with the ends gradually attenuated. Mature specimens measure

¹Odhner's type specimen was collected by the Swedish Expedition to the east coast of Greenland in 1900. Odhner believed that Olsson's 1867 *Distoma appendiculatum* (e.p.) and Levinsen's 1881 *Distomum appendiculatum* (e.p.?) were identical with *H. levinseni*. 
1.52-2.08 mm in length and 0.35-0.40 mm in width under slight coverglass pressure. The ecsoma, which is extended in varying degrees, measures 0.15-0.40 mm in length and is separated from the rest of the body by rather shallow indentations. Dawes reported that the tail is never extended (16, p.260; 17, p.277) as did Odhner in his description of the species (61, p.349). The oral sucker is overhung by a weakly developed preoral lip and measures 0.11-0.18 x 0.14-0.20 mm. The ventral sucker is located one fourth of the body length from the anterior end and measures 0.11-0.17 x 0.12-0.15. The oral and ventral suckers are approximately equal in size as they are in H. odhneri. The genital pore is very far forward beside the oral sucker. The excretory pore is at the posterior tip of the ecsoma. There is no preacetabular pit. Cuticular striations, which appear in profile like posteriorly directed saw teeth, are present on the surface of the body and extend from the anterior end of the body posteriorly to the level of the posterior testis or the ovary.

**Digestive system.** The cavity of the oral sucker opens into the pharynx. There is no pre-pharynx. The pharynx measures 0.04-0.09 mm in length and 0.07-0.09 mm in width. Posterior to the pharynx the very short esophagus bifurcates into two intestinal crura which continue posteriorly well into the ecsoma. Odhner stated that the intestinal crura
did not enter the ecsoma, (61, p. 349) but none of his specimens had the ecsoma everted.

**Genital systems.** The testes consist of two subspherical bodies lying obliquely just anterior to the middle of the body. These organs measure 0.15–0.20 x 0.12–0.15 mm. The seminal vesicle consists of two lobes separated by a strong constriction near the middle. The approximately equal halves of this organ lie behind the posterior margin of the ventral sucker and in front of the anterior margin of the anterior testis. The long sinuous prostate gland arises from the anterior, more lateral, lobe of the seminal vesicle, and winds anteriorly, dorsal to the ventral sucker, to the hermaphroditic duct at the level of the bifurcation of the intestine. The pars prostatica is surrounded for its entire length by many prostate gland cells. The sinus sac which arises at the level of the bifurcation of the intestine where the uterus and prostate gland meet, contains an eversible cirrus-like structure which is not a true cirrus because of the hermaphroditic nature of the ducts. This opens anteriorly in the genital atrium which is at the level of the middle of the oral sucker.

The ovary is an ovoid body 0.13–0.16 x 0.16–0.24 mm which is located behind the testes just posterior to the middle of the body. Details of the shell gland-complex have apparently never been worked out for this species and
it is doubtful if the material at hand will be of much help. The vitellaria consist of two spherical masses measuring 0.11-0.14 mm in diameter and lying transversely just behind and in contact with the ovary. These organs show no signs of lobulation. The uterus is greatly coiled and filled with eggs. It passes posteriorly and almost completely fills the ecsoma in the specimens at hand. Odhner, (61, p.350) and Manter (44, p.93) both worked with material in which the ecsoma was not extended and both men stated that the uterus rarely if ever entered the ecsoma. After coursing into the ecsoma, the uterus passes anteriorly with many coils to the metraterm, which in turn enters the sinus sac. The metraterm extends from the level of the ventral sucker to the posterior end of the sinus sac which lies at a point about half way between the suckers. The eggs measure 21-26 x 11-15 microns.

The excretory system. Odhner (61, p.349) did not observe the excretory system but assumed that it was probably like that of other members of the genus; i.e. a posterior median stem which bifurcates at the level of the testes into two branches which reunite dorsal to the pharynx. The material at hand does not show this system. Apparently no one has described this system.

Hosts. All specimens collected came from the tomcod, Microgadus proximus (Girard). Of six fish examined four
were found to be infested with the parasite. One fish contained eight parasites; one, six parasites; one, two parasites; and one, a single parasite.

This parasite has been reported from the following species of fish: *Gadus saida* Lepechin, *G. morrhue f. ovak* (Linnaeus), and *Cottus scoriopis* Linnaeus (61, p.348); from *G. collarias* (Linnaeus) and *Clupea harengus* Linnaeus (53, p.41); from *Urophycus chusa* Walbaum (44, p.92); and from *Uncorhynchus tachawytse* (Walbaum), *Sebastodes ruberrimus* Cramer, *Ophiodon elongatus* (Girard), and *Sebastodes caurinus* (Richardson) (36, p.115).

This species is closely related to *H. odhneri* Yamaguti 1934 but differs in the size of the body. *H. odhneri* is 2.3-2.8 mm long and the seminal vesicle lies longitudinally rather than transversely (93, p.433-434). It is probable that these species are identical, and that these characters are not sufficient to separate species, but until material is available which shows a definite overlap, both species should stand.

Genus *Sterrhurus* Looss 1907

The genus *Sterrhurus* was established by Looss in 1907 with *S. musculus* Looss as the type species. (39, p.342).

In this genus he included smooth bodied ecosomate forms
without a preacetabular pit. The testes were symmetrical and preovarian. The vitellaria were lobed, the lobes being either short or long. The seminal receptacle was small or absent. The sinus sac was short, pyriform, or spherical. The prostate gland was short and lay immediately behind the sinus sac. The seminal vesicle was thin walled and did not extend posterior to the acetabulum.

The following species of Sterrhurus have been described: Sterrhurus branchialis Stunkard and Nigrelli 1934 (83, p.435-440); S. brevicirrus Nicoll 1915 (58, p.32-33); S. floridensis Manter 1934 (46, pp.305-307); S. fusiformis (Luhe 1901) Looss 1907 (39, p.602); S. grandiporus (Rudolphi 1819) Looss 1907 (39, pp.601-602); S. gymnothoracis Yamaguti 1940 (97, pp.91-92); S. imocavus Looss 1907 (39, p.601); S. intimici Yamaguti 1934 (93, pp.444-447); S. knarachii Srivastava 1941 (79, pp.47-48); S. laevius (Linton 1898) Manter 1934 (46, pp.307-308); S. macrorchis Crowcroft 1945 (14, p.39-42); S. magnacetabulum Yamaguti 1942 (98, pp.380-381); S. magnateatis Park 1936 (64, pp.477-480); S. magnus Yamaguti 1938 (95, pp.129-130); S. microcercus Manter 1947 (50, p.346-347); S. monolecithus Srivastava 1941 (79, pp.45-47); S. monticelli (Linton 1898) Linton 1910 (34, pp.61-62); S. musculus Looss 1907 (39, pp.600-601); S. musigarei Yamaguti 1938 (95, pp.128-129); S. pagrosomus Yamaguti 1939 (96, pp.226-227); S. praeclarus Manter 1934 (46, pp.309-311); S. profundus Manter 1934
The genus Sterrhurus has often been confused with the closely related Lecithochirium which Looss (40, pp.139-141) thought could be separated on the presence of muscular swellings on the interior or the oral sucker, the presence of a preacetabular pit and the highly muscular preoral lip. Species added to both genera have tended to decrease the validity of these characters for separating the genera. Jones (25, p.56) suggested that more descriptive work on the genera was necessary in order to separate them or to place them in synonymy (whichever the case should be.) Crowcroft (14, pp.42-46) has again pointed out the weaknesses of Looss's characters for generic determination and proposed that the terminal portions of the genital ducts be utilized for this purpose. He states, "In all the adequately described species of Lecithochirium the bladder within the muscular pouch or sinus-sac is a portion of the pars prostatica. All those species in which the bladder is derived from a portion of the ejaculatory duct are included in the genus Sterrhurus but several species in which the bladder represents a portion of the pars prostatica have been included in this genus, namely, S. fusiformis, S. floridensis, and S. laevis." Crowcroft (14, p.46) then returned S. fusiformis to Lecithochirium where Mihe had originally
described it and transferred *S. floridensis* and *S. laevis*
to the same genus. Subsequently Manter erected the new
genus *Dissomaccus* and *S. laevis* became the type species.
(50, p.343).

Manter considered *S. gymnothoracis* to be a synonym of
*S. fusiformis* (50, p.343) thereby transferring this species
to *Lecithochirium*. *S. monolecithus* was transferred to the
genus *Aphanurus* by Manter (50, p.344). *S. monticelli* was
considered by Crowcroft to belong probably in *Lecithochirium*
(14, p.46). Manter (50, p.343) considered that *S. karachii*
belonged in *Derogenes* or some closely related genus, but
did not actually place it in any other genus. This cannot
be considered a species of *Sterrhurus* and needs further
study.

Manter erected new genera for *S. robustus* and *S. profundus*, the former becoming the type species of the genus
*Adinosoma* and the latter becoming the type species of the
genus *Lethadema* (50, p.344). Manter transferred *S. texanus*
to *Lecithochirium* (50, p.342). *S. vitellograndis* was trans-
ferred to *Aponurus* by Yamaguti (95, p.125).

Lloyd (36, p.121) pointed out that *S. magnatestis* was
a synonym of *Lecithochirium exodicum* McFarlane 1936 and
Manter (50, p.344) agreed with this view. Crowcroft pointed
out that *Sterrhurus magnatestis* conformed to the generic
characters which he proposed for *Sterrhurus*, and included
it in his paper (14, p.45). Material at hand indicates that this species contains a bladder which is part of the ejaculatory duct and which certainly belongs in the genus *Sterrhurus*, as shown by Crowcroft. I, therefore, place this form in the genus *Sterrhurus* and it becomes *S. exodicus* n. comb. Crowcroft apparently was not aware of *L. exodicum* for he did not mention it in his paper.

The following species have not been removed from the genus and are probably valid species: *S. branchialis* Stunkard and Mirelli 1934; *S. brevicirrus* Nicoll 1915; *S. exodicus* (McFarlane 1936) new comb.; *S. grandiporus* (Rudolphi 1819); *S. imocavus* Looss 1907; *S. inimici* Yamaguti 1934; *S. macrorchis* Crowcroft 1946; *S. magnace-tabulum* Yamaguti 1942; *S. magnus* Yamaguti 1938; *S. micro-cercus* Manter 1947; *S. musculus* Looss 1907; *S. musigarei* Yamaguti 1938; *S. pagrosomi* Yamaguti 1939; and *S. praeclarus* Manter 1934. The only species which I encountered in this study was *S. exodicus*.
Sterrurus exodicus (McFarlane 1936) n. comb.
See figs. 7 and 8.

Synonyms:

Lecithochirium exodicum McFarlane 1936 (52, p. 346)
Sterrurus magnatestis Park 1936 (64, pp. 477-480)
Lecithochirium medius Acena 1941 (1, p. 287), (50, p. 338).

This description is based on 10 specimens from the stomachs of two lingcod, Ophiodon elongatus Girard.

External features. Stout cylindrical trematodes with the ends rather sharply attenuated. Mature specimens measure 2.22-5.6 mm in length and 0.52-1.4 mm in width under slight cover glass pressure. The ecsoma is partially extended in all but two specimens and measures 0.47-1.38 mm in length in those in which it is partially extended. The oral sucker is overhung by a preoral lip which measures 0.02-0.05 mm. The ventrally directed oral sucker ranges from 0.12-0.24 mm in longitudinal diameter by 0.15-0.29 mm in transverse diameter. The ventral sucker is located at the posterior margin of the anterior third of the body and is 0.32-0.64 mm in longitudinal diameter by 0.31-0.67 mm in transverse diameter. The two dimensions are approximately equal in any one individual. The genital pore is located between the oral sucker and the ventral sucker at the level of the bifurcation of the intestinal crura. The excretory
pore is located at the posterior tip of the ecsoma. A weakly developed preacetabular pit lies anterior to the ventral sucker and appears as a transversely oval opening from which faint radiating lines may be observed in the cuticle. Park referred to this structure as a rudimentary genital sucker (64, p.478). The cuticle is smooth and unarmed.

**Digestive system.** The pharynx is globular and lies immediately behind the oral sucker. The pharynx measures 0.09-0.11 mm in length by 0.10-0.15 mm in width. The pharynx is followed by a short esophagus measuring from 0.01-0.35 mm in length. The esophagus bifurcates into two intestinal crura which proceed unbranched into the ecsoma, but do not come to the posterior end of the ecsoma.

**Genital systems.** The male system consists of two ovoid testes 0.16-0.41 x 0.16-0.33 mm which lie transversely just posterior to the ventral sucker and separated from each other by approximately their diameter. The seminal vesicle arises at the level of the anterior margin of the ventral sucker and courses forward to the sinus sac. The seminal vesicle consists of three parts, the most posterior of which is slightly more than one half the length of the vesicle and is about half as broad as it is long. The middle portion is tubular, somewhat narrower, and separated from the other two by constrictions. The anterior portion
is sac-like and small, its diameter being only slightly larger than the middle portion, and often smaller than this. Anteriorly the seminal vesicle enters the pars prostatica, which is surrounded by prostate gland cells. The prostate gland opens into a vesicle formed from the ejaculatory duct. This vesicle is enclosed in the sinus sac. The prostate gland opens into this bladder in the form of a papilla which bears small spines and serves as a cirrus. (See fig. 8.) This bladder is not surrounded by prostate gland cells and therefore cannot be considered an enlargement of the prostate. The metraterm enters the sinus sac ventrally to the prostate and the ejaculatory vesicle is formed from the union of the two ducts. This vesicle opens to the exterior through the genital pore.

The ovary is ovoid and lies at the middle of the body. The ovary measures 0.16-0.35 mm in longitudinal diameter and 0.19-0.42 mm in transverse diameter, the transverse diameter always being slightly larger. The seminal receptacle is present close to the ovary and empties into the oviduct near the point of egress of the oviduct from the ovary. (18, p.10; 64, p.478). The oötype appears as a spherical structure lying in the interspace between the ovary and two vitellaria, and is reported by Gregoire to be enclosed in the same muscular capsule as the seminal vesicle (18, p.10), but this could not be determined from the whole
mount. Gregoire reported that no Laurer's canal is present (18, p.10), but Park stated that a blind pouch on the side of the seminal receptacle represents Laurer's canal (64, p.478). The true situation cannot be determined from the material at hand.

There are two slightly lobed vitelline glands located immediately posterior to the ovary. The right vitelline gland usually contains three lobes and the left four, but Park shows four lobes in each (64, p.479, fig. 7) and in some of the material at hand there is no lobulation in one or the other. A receptaculum seminalis uterinum is present at the beginning of the uterus and is full of sperm cells. The course of the uterus varies with the age of the individual, but in the larger specimens progresses posteriorly to the middle of the ecsoma and then anteriorly with numerous loops to the muscular metraterm which opens into the sinus sac.

The sinus sac opens at the level of the bifurcation of the intestinal crura into a genital atrium or genital pore.

The uterine eggs measure 19-27 x 11-15 microns.

The excretory system. The excretory system is typical of the hemiurids, consisting of a pore at the posterior end of the ecsoma. The pore opens into a median, unpaired excretory bladder. This bladder extends forward anteriorly
to the level of the testes where it bifurcates to form two crura which run laterally to a position dorsal to the pharynx where they unite (18, p.7-8).

**Host.** These parasites were found in the stomachs of two lingcod *Ophiodon elongatus* Girard which were taken from about forty fathoms, nine miles west of Newport, Oregon. Three came from one host and seven from the other. Only two lingcod were examined.

This form has been reported from *Citharichthys sordidus* (Girard) from Dillon Beach, California as *Sterrhurus magnatetis* by Park (64, p.480); from *Sebastodes ruberimus* Cramer as *Lecithochirium medius* by Acena (1, p.287); from *Ophiodon elongatus* Girard from Departure Bay, British Columbia, as *L. exodicum* by McFarlane (52, p.346); from *Ophiodon elongatus* and *Sebastodes maliger* (Jordan and Gilbert) from Friday Harbor, Washington, as *L. exodicum* by Lloyd (36, p. 119); and from *Hostettia jordani* (Lockington) as *L. exodicum* by Gregoire and Pratt (19, p.84).

As far as can be determined, the anatomy of these specimens agree completely with the descriptions of *Sterrhurus magnatetis* Park 1936 and *Lecithochirium exodicum* McFarlane 1936. Since these forms agree with the modified description of the genus *Sterrhurus* as presented by Crowcroft (14, p.42-46) and *L. exodicum* has priority over *S. magnatetis* these forms become *S. exodicus.*
Genus *Tubulovesicula* Yamaguti 1934

The genus *Tubulovesicula* was established by Yamaguti in 1934 with *T. sparti* as the type species. He presented the following generic diagnosis: (93, p.474-475)

present. Uterus descending into tail, ascending on opposite side of ovary and then between testes. Metraterm present. Eggs thick shelled, embryonated. Excretory stem bifurcating at level of anterior border of testes into arm uniting on dorsal side of pharynx. Parasitic in marine fishes."

The following species have been named for the genus:

- *T. anguillae* Yamaguti 1934 (93, pp.470-472);
- *T. angusticauda* (Nicoll 1915) Yamaguti 1934 (93, p.474);
- *T. californica* Park 1936 (64, pp.481-482);
- *T. lindbergi* (Layman 1930) Yamaguti 1934 (93, p.470);
- *T. madurensis* Mignelli 1940 (59, pp.263-265);
- *T. magnacetabulum* Yamaguti 1939 (96, pp.225-226);
- *T. muraenosocis* Yamaguti 1934 (93, pp.472-474);
- *T. nanaimoensis* (McFarlane 1936) Manter 1947 (50, p.350);
- *T. pinensis* (Linton 1940) Manter 1947 (50, p.350);
- *T. pseudorhombi* Yamaguti 1938 (95, pp.121-122);
- *T. sparti* Yamaguti 1934 (93, pp.468-470).

Characters used for the differentiation of the species have been 1.) the variations in the vitelline pattern such as the number of lobes and the placement of the lobes on each side of the body; 2.) the extent to which the uterine coils enter or do not enter the ecsoma; 3.) the length and placement of the seminal vesicle; 4.) the relative length of the ecsoma; 5.) the location of the pars prostatica; and 6.) the degree to which the prostatic cells enclose the posterior end of the prostate vessel.
Nigrelli (59, p.265) gives the following key to the species of *Tubulovesicula*:

"A. Vitelline lobes 7 (3-4)
B. Vitelline gland with three right and four left lobes.
C. Uterine coils extending into the tail for some distance.
D. Seminal vesicle long and slender; tail shorter than body proper.

DD. Seminal vesicle short and slender; tail longer than body proper. **T. sparsi**

CC. Uterus extending into the tail a short distance or not at all.**\(^2\)**
E. Seminal vesicle long and broad.
F. Pars prostatica originating at middle of the acetabulum. **T. muraenosocis**

FF. Pars prostatica originating posterior to acetabulum. **T. lindborgi**
EE. Seminal vesicle short and slender; pars prostatica originating at the level of the anterior border of the acetabulum. **T. angusticauda**

BB. Vitelline glands with four right and three left lobes.
G. Seminal vesicle long and slender; pars prostatica originating at level of anterior border of acetabulum. **T. pseudorhombi**

GG. Seminal vesicle short and broad; pars prostatica originating some distance posterior to acetabulum. **T. madurensis**

AA. Vitelline lobes 8 (4 & 4) **T. californica"**

This key does not include **T. magumacetabulum**, **T. pinguis** or **T. nanaimoensis**. **T. magumacetabulum** can be separated from all other species by the large ratio of diameter of ventral sucker to diameter of oral sucker, this ratio being close to 3.8 (96, p.225). **T. pinguis** can be separated from

\(^2\)This line was omitted from Nigrelli's key and has been substituted by the present author.
all other species by the much smaller egg size of 16 by 12 microns (35, p.138). The description of *T. nanaimoensis* (52, pp.345-346) does not permit it to be separated from all other species.

I examined 82 worms of this genus and was able to separate them, with the aid of Migrelli's key, into six species. Six fit the key as *T. muraenosocia*, four as *T. sparti*, 13 as *T. californica*, 22 as *T. madurensis*, 18 as *T. pseudorhombi*, six as *T. linabergi*, and 13 could not be identified with the key. Those that could not be carried thru the key fell down on the first character which dealt with the vitelline pattern; these had neither 7 (3 & 4) nor 8 (4 & 4). Instead there were four which had three lobes on the right and five on the left; three which had five on the right and three on the left; one that had five on the right and four on the left; two that had four on the right and five on the left; one that had six on the right and three on the left; and two that had three on each side. If I were to follow Migrelli's key it would appear as though I should erect six new species to include these 13 individuals!

My six "species" derived from Migrelli's key were treated as groups and the mean calculated for each on length, sucker dimensions and egg size. These means were compared to a description of *Tubulovesicula nanaimoensis* (52, pp.345-
346 and in every case the means were close to, or entirely within the limits set forth in the description of this species. Likewise, the means for this entire group of animals examined were found to fall within the limits set forth for *T. nanaimoensis*. While the means fall within the limits of this species, some of the individuals exceed the limits rather greatly in one or two characteristics. It appears then that the variation in this species is much greater than has previously been recorded and that several of the species of *Tubulovesicula* must be placed in synonymy.

I found nine vitelline patterns in 82 worms which conform to the description of *T. nanaimoensis*. This is a considerable variation of vitelline pattern and therefore this character is unsatisfactory for separation of species in this genus! Variation of other characters can be caused by various conditions. First, it is probable that a younger animal that has just reached sexual maturity will not contain as many eggs as an older form and therefore the uterus will not extend as far posteriorly. It is also probable that the more the uterus is distended the more the anterior part of the body will be compressed and the more anterior will be the organs within this part of the body. Secondly, an animal that is much contracted will have the organs nearer the ends of the body than will an animal that is fully extended. This is especially true of the ecosomate.
forms such as Tubulovesicula. In the third place, the degree to which cells enclose the prostatic vessel may also be due to the stage of development of the worm. An animal in which the prostatic vessel is not completely enclosed may be developing and not yet completely developed. Finally, the degree to which a specimen is flattened during fixation may cause an increase to two times the size and may make a smooth organ to be lobulated. (90, pp.149-150).

Looss (40, p.84) considered the following characters to be of little value for genus and species determination: relationship between the sizes of the body proper and the ecsoma, extent of intestinal crura and uterine coils, and relative position of the organs in the post-acetabular portion of the body proper. He considered (40, p.97) the structure of the genital organs particularly the terminal portions, the form of the excretory vesicle, the nature of the cuticle and the suckers, the general body form, and the presence or absence of the ecsoma as more important.

Stunkard and Mignelli (83, p.54) have shown that an enormous variation exists between individuals of Sterrhurus branchialis Stunkard and Mignelli. Cort (13, p.26) has shown a great variation in egg size in Pneumoneces similedplexus Stafford as shown by three individuals, one of which had eggs averaging 37.6 microns long with a range of 34-40, and the other two with an average egg length of 34.2 and a
range of 30-37.4.

It is not unlikely that a great variation exists in *Tubulovesicula*. Since all my specimens appear to belong to the same species and vary only in the details discussed above, since all fit the description of *T. nanaimoensis* to a varying degree, and since individuals of this collection can be separated to the various other species by Nigrelli's key, one must assume that the characters used to separate species are not valid. It would appear then that several of these species must be placed in synonymy.

None of my specimens could be keyed to *T. anaullae*, *T. angusticauda*, *T. magnacetabulum*, or *T. binguis*, so these species cannot be considered here. *T. madurensis* and *T. muraenosocis* both fit into Nigrelli's key, but the former was stated to have eggs that are much smaller (59, p.264) and the latter is supposed to have eggs that are much larger (93, p.274) than those encountered in this study. Even though they fit the key, one cannot assume with certainty that they were encountered here.

*T. lindbergi* is slightly larger than *T. nanaimoensis*, but the size range presented for the species by Layman (28, p.98) is only slightly larger than the range found in this study. No other characters vary from the description of *T. nanaimoensis* so I consider these two forms to be identical. By the law of priority, *T. lindbergi* becomes the
proper designation for the species. Since these two forms are synonymous, all species which fit the specific descriptions of either must also be placed in this synonymy.

*T. pseudorhombi* has eggs that are slightly larger than the average of those encountered here (95, p.122). This may be of significance; however, I am inclined to place this species in synonymy with *T. lindbergi*. *T. spari* was described from a single specimen (93, p.468) and supplemented with a description of one additional specimen (96, p.225). These two differ from each other more than either differs from *T. nanaimoensis*. The descriptions of *T. spari* are both extremely limiting, especially regarding characters which I consider to be variable. On the other hand, the description of *T. nanaimoensis* does not limit these variable characters in the species diagnosis, and most of the measurements of *T. spari* fall within the range given for *T. nanaimoensis*. Furthermore all the measurements of *T. spari* are included in the range of material examined in this study. These two species are synonymous and *T. spari* also becomes *T. lindbergi*.

*T. californica* was described from a single specimen (64, p.481) and fits the description of *T. nanaimoensis* except for a slightly larger ventral sucker in *T. californica*. Considering the tremendous variation found in this study, especially when some forms had ventral suckers as
large as that described for *T. californica*, one must consider *T. californica* a synonym of *T. lindbergi*.

*T. californica*, *T. lindbergi*, *T. nanaimoensis*, *T. pseudorhombi*, and *T. spari* are here placed in synonymy. *T. lindbergi* becomes the proper designation for the species.

*Tubulovesicula lindbergi* (Layman 1930). See fig. 9.

Synonyms:

*Lechinaster lindbergi* Layman 1930 (26, pp.32-33).

*Tubulovesicula lindbergi* (Layman 1930) Yamaguti 1934 (93, p.470).

*Lechinurus lindbergi* (Layman 1930) Pigulewsky 1938 (60, p.397).

*Vinurus nanimoensis* McFarlane 1936 (64, pp.345-346).


*Tubulovesicula spari* Yamaguti 1934 (93, pp.408-470).

*Tubulovesicula californica* Park 1936 (64, pp.481-482).

*Tubulovesicula pseudorhombi* Yamaguti 1938 (95, pp.121-122).

This description of the species is based on 82 specimens collected from Yaquina Bay, Oregon. Table 2 shows the hosts involved, the incidence, the habitats, and the number of this worm collected from each host.
<table>
<thead>
<tr>
<th>Host</th>
<th>Hosts examined</th>
<th>Hosts infested</th>
<th>Habitat</th>
<th>Worms per host</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anoplarchus purpureascens</td>
<td>21</td>
<td>1</td>
<td>stomach</td>
<td>1</td>
</tr>
<tr>
<td>Citharichthys sordidus</td>
<td>4</td>
<td>2</td>
<td>stomach</td>
<td>2</td>
</tr>
<tr>
<td>Citharichthys stigmatus</td>
<td>1</td>
<td>1</td>
<td>intest.</td>
<td>1</td>
</tr>
<tr>
<td>Enophrys bison</td>
<td>12</td>
<td>3</td>
<td>stomach</td>
<td>3</td>
</tr>
<tr>
<td>Leptocottus armatus</td>
<td>16</td>
<td>2</td>
<td>stomach</td>
<td>1</td>
</tr>
<tr>
<td>Ophiobon elongatus</td>
<td>2</td>
<td>1</td>
<td>stomach</td>
<td>3</td>
</tr>
<tr>
<td>Platicthys stellatus</td>
<td>11</td>
<td>4</td>
<td>stomach</td>
<td>1</td>
</tr>
<tr>
<td>Petichthys melanostictus</td>
<td>9</td>
<td>4</td>
<td>stomach</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>rectum</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>stomach</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>76</td>
<td>18</td>
<td></td>
<td>82</td>
</tr>
</tbody>
</table>

Table 2. Distribution of *Tubulovesicula lindbergi* (Layman) among host fish examined.

**External features.** Spindle shaped worms, often with the ends sharply attenuated but occasionally with the anterior end broadly rounded. Mature specimens measure 1.10-3.80 mm in length exclusive of the ecsoma with a mean length of 2.26 mm. The worms are 0.30-1.20 mm in width (mean
0.66). There is a prominent ecsoma at the posterior end that may be extended in varying amounts. In the most extended specimen the ecsoma measures 1.95 mm in length; the mean ecsoma length is 0.96 mm. The subterminal oral sucker is ventrally directed and measures 0.10-0.23 mm in length by 0.10-0.38 mm in width, with mean measurements of 0.19 x 0.22 mm. The ventral sucker is from 1.7 to 2.3 times the diameter of the oral sucker and is located about one fourth of the body length from the anterior end. This organ measures 0.23-0.65 mm in diameter (average 0.39 mm.) The genital pore is located behind the oral sucker at the level of the pharynx. The excretory pore is located at the posterior tip of the ecsoma. No precocetabular pit was seen in any of the specimens examined. The cuticle is smooth and unarmed.

**Digestive system.** The globular pharynx lies close behind the oral sucker and measures 0.08-0.12 mm in diameter. This organ is followed by a short esophagus which bifurcates to form two intestinal crura which pass posteriorly, usually going to near the tip of the ecsoma. At the bifurcation of the intestinal crura there appears to be two sphincters, one at the anterior end of each branch, which probably allows the two crura to be closed independently.

**The genital systems.** The two spherical or ovoidal testes lie slightly behind the ventral sucker and are
laterally placed. They measure 0.12-0.20 x 0.10-0.30 mm. The seminal vesicle is tubular, narrow or broad, and winds from its point of origin near the level of the ventral sucker anteriorly to the posterior end of the prostate gland. The posterior end of the prostate gland usually lies at a level between the anterior and posterior margins of the ventral sucker, though in cases of extreme contraction or extension of the worm may arise anterior to or posterior to the ventral sucker respectively. The prostate vessel is long and tubular with some convolutions. In some individuals it is entirely surrounded with prostate gland cells, and in other individuals the posterior portion, usually 0.1 the length of the gland or less, may be devoid of prostate gland cells. At its anterior end the prostate opens into the sinus sac. The sinus sac is pear-shaped and enclosed with a strong muscular sheath. The prostatic duct is joined with the metraterm in the base of the sinus sac and continues anteriorly as the hermaphroditic duct which first has an enlargement in it and then narrows as it approaches the genital pore.

The ovary lies behind the testes, generally more ventral and medial. It measures 0.14-0.33 x 0.12-0.35 mm. The oviduct leads postero-ventrally from the ovary to the shell gland. The seminal receptacle lies along the oviduct and empties into the duct before it enters the Mehlis gland.
The common vitelline duct also empties into the mehlis gland near the place where the oviduct enters. The vitellaria consist of two masses, one on either side of the body. These masses are made up of several tubular lobes arising from a point near the ovary and winding about among the organs. The number and arrangement of these tubes is quite variable. There may be from three to six on either side of the body; there is no regular pattern. The uterus is filled with oval eggs and when filled may reach well into the ecsoma, while in some specimens the uterus may not even enter the ecsoma. The uterus coils posteriorly and then turns anteriorly where it passes with many coils to the metraterm which lies just behind the sinus sac. The metraterm enters the sinus sac and joins with the male ducts to form the hermaphroditic duct. The uterine eggs average 32 x 20 microns with a range of 27-35 x 16-22 microns.

The excretory system. The excretory system consists of the typical hemiurid type with the median excretory vessel opening at the posterior tip of the ecsoma and bifurcation at the level of the testes into two excretory crura which unite dorsal to the oral sucker.

Hosts. Table 2 indicates the hosts from which this parasite was found in the present study. In addition to these hosts this worm has been found in "Verschiedene Meerkörbe (vorzugsweise Pleuronectidae)" from Peter the Great
Bay by Layman (28, p.99). They have been reported from Departure Bay, British Columbia, from the lemon sole, *Parophryra vetulus* Girard, and the marbled sculpin, *Scorpaenichthys marmoratus* Girard, by McFarlane (52, p.346). They have been reported from the buffalo sculpin, *Enophryra bison* (Girard), from Dillon Beach, California by Park (64, p.482). Yamaguti has found this parasite in Japanese waters. He reported it in *Petrosomus unicolor* (Quoy and Gaimard) from the Inland Sea (96, p.225), from *Sparus macrocephalus* Valenciennes from the same location (93, p.468), and from *Pseudorhombus pentophthalmus* Gunther from Maisaka and Obama (95, p.122).

**HOST LIST**

The following is a list of the fishes in which adult hemiurid trematodes were found, together with a list of the hemiurids from each host. The number in parentheses indicates the number of hosts examined. New host records are marked with an asterisk (*).

- *Anoplarchus purpureascens* Gill, crested blenny (21)
- *Tubulovesicula lindbergi* (Layman)*
- *Blepsias cirrhosus* (Pallas), silver spot (1)
- *Genolinea robusta* Lloyd*
- *Citharichthys sordidus* (Girard), mottled sand dab (4)
- *Tubulovesicula lindbergi* (Layman)*
Citharichthys stigmatus Jordan and Gilbert, speckled sand dab (1)
   Tubulovesicula lindbergi (Layman)*

Enophrys bison (Girard), buffalo sculpin (12)
   Genolinea manteri Lloyd*
   Genolinea robusta Lloyd*
   Tubulovesicula lindbergi (Layman)*

Leptocottus armatus Girard, smooth sculpin (16)
   Genolinea montereyensis Annereaux*
   Genolinea robusta Lloyd*
   Tubulovesicula lindbergi (Layman)*

Lumpenus anguillaris (Pallas), eel blenny (1)
   Genolinea manteri Lloyd*

Microgadus proximus (Girard), tomcod (6)
   Derogenes varicua (Muller)*
   Hemius levinseni Odhner*

Ophiodon elongatus Girard, lingcod (2)
   Derogenes crassus Manter*
   Sterrhurus exodicus (McFarlane)
   Tubulovesicula lindbergi (Layman)*

Platichthys stellatus (Pallas), starry flounder (11)
   Tubulovesicula lindbergi (Layman)*

Psettichthys melanostictus Girard, sand sole (9)
   Tubulovesicula lindbergi (Layman)*

Sebastes paucispinis (Ayres), bocaccio (1)
   Derogenes crassus Manter*

The following fish did not contain hemiurid trematodes:

Aulorhynchus flavidus Gill, tube snout (2)
   Acipenser medirostris Ayres, green sturgeon (2)
   Anarrichthys ocellatus Ayres, wolf-eel (1)
   Clupea pallasii Valenciennes, herring (9)
   Cymatogaster aggregatus Gibbons, yellow shiner (9)
   Dallichthys wae Girard, dusky sea-perch (2)
   Embiotoca lateralis Agassiz, blue sea-perch (9)
   Holocentrus rhodotus Agassiz, porgy (4)
   Lethus superciliosus (Pallas), fringed greenling (6)
   Merluccius productus (Ayres), hake (2)
   Oncorhynchus tshawytscha (Walbaum), chinook salmon (1)
Phanerodon furcatus Girard, white sea perch (3)
Pholis ornatus (Girard), saddled blenny (1)
Raja binocularis Girard, big skate (1)
Scorpaenichthys marmoratus Girard, giant marbled sculpin (3)
Salmo clarkii Richardson, cut-throat trout (1)
Syngnathus criseo-lineatus Ayres, pipe-fish (4)
Sebastodes brevispinis Bean, shortspine rockfish (1)
Sebastodes crameri Jordan, blackmouth rockfish (1)
Sebastodes melanops (Girard), black rockfish (5)
Sebastodes pinninger (Gill), orange rockfish (2)
Sicyogaster meandricus (Girard), common cling-fish (2)

SUMMARY

An examination of 156 fish from 34 species yielded the following eight species of hemiurid trematodes: Derogenes crassus Manter 1934, Derogenes varicus (Müller 1784), Genolinea manteri Lloyd 1938, Genolinea montereyensis Annereaux 1947, Genolinea robusta Lloyd 1938, Hemiurus levinseni Odhner 1905, Sterrhurus exodicus (McFarlane 1936) new comb., and Tubulovesicula lindbergi (Layman 1930).

Sterrhurus magnatensis Park 1936, Lecithochirium exodicum McFarlane 1936, and L. medius Acena 1941, are placed in synonymy with Sterrhurus exodicus (McFarlane) n. comb.

Tubulovesicula spari Yamaguti 1934, T. nanaimoensis (McFarlane 1936), T. californica Park 1936, and T. pseudohombi Yamaguti 1938 are placed in synonymy with T. lindbergi (Layman 1930).

A key to the species of Genolinea is included.

New host records are listed for all parasites studied.


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PLATE I

All figures are drawn with the aid of a B&L triple purpose projector.

Figure 1. *Derogenes varicus* (Muller) from the tomcod, *Microgadus proximus*.

Figure 2. *Derogenes crassus* Manter from the boccacio, *Sebastodes paucispinus*.

Figure 3. *Genolinea manteri* Lloyd from the buffalo sculpin, *Enophrys bison*.

Figure 4. *Genolinea montereyensis* Annereaux from the smooth sculpin, *Leptocottus armatus*.

Figure 5. *Genolinea robusta* Lloyd from the buffalo sculpin, *Enophrys bison*. 
PLATE II

All figures, except figure 8, are drawn with the aid of the B&L triple purpose projector.

Figure 6. *Hemiurus levinaeni* Odhner from the tomcod, *Microgadus proximus*.

Figure 7. *Sternhurus exodicus* (McFarlane) from the lingcod, *Ophiodon elongatus*.

Figure 8. Terminal genital organs of *Sternhurus exodicus*, after Park 1936 (64, p. 479, fig. 2)
c--cirrus, ev--ejaculatory vesicle, gp--genital pore, met--metraterm, pg--prostate gland, pp--pars prostatica, sem--seminal vesicle, ss--sinus sac.

Figure 9. *Tubulovesicula lindbergi* Layman from the mottled sand-dab, *Citharichthys sordidus*. 