

Some Helminth Parasites of Marine Planktonic Invertebrates

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ABSTRACT Helminth parasites, 11 species of trematodes, 4 species of cestodes and 6 species of nematodes, are described from marine planktonic invertebrates collected in Japanese waters and the East and South China Seas. The trematodes are: a *Guschanskiana* sp. metacercaria (Accacoeliidae) from *Sagitta enflata*; *Tetrochetus* sp. metacercariae (Accacoeliidae) from *S. enflata*, *S. macrocephala* and *Sagitta* sp.; Accacoeliidae gen. sp. metacercariae I, possibly of the genus *Accacladium*, from *S. crassa* f. *naikaiensis*, *S. enflata*, *S. hexaptera*, *S. macrocephala*, *Sagitta* sp. and chaetognaths; Accacoeliidae gen. sp. metacercariae II from *S. crassa* f. *naikaiensis*; an Accacoeliidae gen. sp. metacercaria III, perhaps belonging to the genus *Accacladocoelium*, from *S. crassa* f. *naikaiensis*; *Tergestia* sp. metacercariae (Fellodistomidae), probably of *T. laticollis* (Rudolphi, 1819) Stossich, 1899, from *S. crassa* f. *naikaiensis*; *Lecithocladium* sp. metacercariae (Hemiuriidae), possibly of *L. excisum* (Rudolphi, 1819) Lühe, 1901, from *S. enflata*, *S. nagae* and *Sagitta* sp.; a *Parahemiurus* sp. metacercaria (Hemiuridae) from a chaetognath; Hemiuridae gen. sp. metacercariae, related to the subfamily Dinurinae, from *Heterokrohnia* sp., *Sagitta* sp. and chaetognaths; metacercariae of *Pseudopecoelus japonicus* (Yamaguti, 1938) von Wicklen, 1946 (Opecoelidae), from *Euphausia similis*; and a *Paronatrema* sp. metacercaria (Syncoeliidae) found free in a plankton haul. The cestodes are: *Echinobothrium* sp. larvae (Diphyllidea: Echinobothriidae) from *Leptochela* sp. pasiphaeids; *Scolex pleuronectis* Mueller, 1788 (Tetraphyllidea), from *Sagitta* sp.; Phyllobothriidae gen. sp. larvae (Tetraphyllidea) from *Eukrohnia hamata* and *S. crassa* f. *naikaiensis*; and larvae of *Pseudonybelinia odontacantha* Dollfus, 1966 (Trypanorhyncha: Tentaculariidae) from *Euphausia recurva*. The nematodes are: a larva of *Anisakis* sp. larva (I) of Berland (1961) (Ascaridoidea: Anisakidae) from *Euphausia nana*; and *Thynnascaris* spp. larvae (Anisakidae) classified into five different types from *S. crassa* f. *naikaiensis*, *S. nagae* and *Calanus sinicus*. The metacercarial development including progenesis in *E. similis* and the life cycle of *P. japonicus* are discussed. The systematic position of *P. odontacantha* is discussed, and a diagnosis of the genus is given. A list of some other helminth or metazoan parasites obtained is appended.

Formalin-preserved or fresh marine planktonic invertebrates which had been collected by me unless otherwise stated were examined for helminth parasites. Some of them had been so greatly damaged that they could not be identified. Trematode and cestode parasites found were stained with alum carmine and mounted in Canada balsam in as much flattened a state as possible. Nematodes obtained were cleared in glycerine. The excretory system

in the metacercarial stage of *Pseudopicoelus japonicus* was studied also in the living condition. Body muscles of *Euphausia similis* harboring very young *P. japonicus* metacercariae were stained with hematoxylin and eosin or with carmine and mounted in balsam. Some parasites were made into serial paraffin sections and stained with hematoxylin and eosin. The parasite specimens are deposited in the collection of the National Science Museum (Natural History), Tokyo.

TREMATODA

Accacoeliidae

Guschanskiana sp. metacercaria

Host. Trunk coelom of *Sagitta enflata* (Chaetognatha), Suruga Bay, Japan, September 10-12, 1977.

Specimen No. NSMT-PI 2515.

Description. A single specimen. The same unencysted metacercaria as Shimazu (1978, pp.108-109, Figs. 3-4) described. Body 0.95 mm long by 0.39 mm wide. Oral sucker 0.12 mm long by 0.14 mm wide. Pharynx 0.12 mm long by 0.04 mm wide. Anterior intestinal ceca having six lateral diverticles each. Ventral sucker 0.25 mm long by 0.22 mm wide.

Discussion. It is uncertain whether or not this metacercaria is of *G. alveolata* (Robinson, 1934) Skrjabin, 1959, the only species of the genus, owing to its sexually immature form. Any adult stage of the genus has not as yet been recorded from Japanese waters.

Tetrochetus sp. metacercaria

Hosts. Trunk coelom of *Sagitta enflata*, *S. macrocephala* and *Sagitta* sp. (= *S. enflata*?), Suruga Bay, September 10-12, 1977.

Specimens Nos. NSMT-PI 2535-2537.

Description. Six specimens were obtained, one each from one host. The same unencysted metacercariae as Shimazu (1978, pp.105-108, Figs. 1-2) described. Body 0.55-0.92 mm long by 0.35-0.60 mm wide. Oral sucker 0.09-0.17 mm long by 0.15-0.20 mm wide. Pharynx with narrow anterior extension into base of oral sucker, 0.09-0.11 mm long by 0.05-0.10 mm wide. Ventral sucker 0.20-0.35 mm long by 0.18-0.32 mm wide; sucker width ratio 1 : 1.23-1.62. Testes dorsal or posterior to ventral sucker, 0.05-0.15 mm long by 0.07-0.25 mm wide. Ovary 0.05-0.12 mm long by 0.07-0.16 mm wide.

Discussion. It is still impossible to identify these metacercariae to species.

Accacoeliidae gen. sp. metacercaria I

Hosts. Trunk coelom of chaetognaths (damaged), South China Sea (2°24'N, 109°52'E; and 2°30'N, 109°51'E), July 22-23, 1970; and *Sagitta crassa* f. *naikaiensis*, *S. enflata*, *S. hexaptera*, *S. macrocephala*, *Sagitta* sp. (= *S. enflata*?) and chaetognaths (damaged), Suruga Bay, September 10-12, 1977.

Specimens Nos. NSMT-P1 2538-2544.

Description. Twenty-two specimens were obtained, one each from one host. Measurements based on 18 of them. The same unencysted metacercariae as Shimazu (1978, pp. 109-110, Figs. 5-6) described as *Guschanskiana*(?) sp. metacercaria. Body 0.25-0.85 mm long by 0.13-0.47 mm wide. Oral sucker 0.05-0.12 mm long by 0.06-0.17 mm wide. Pharynx elongate-pyriform, extending anteriorly into base of oral sucker, 0.05-0.12 mm long by 0.03-0.10 mm wide. Ventral sucker 0.08-0.27 mm long by 0.09-0.27 mm wide; sucker width ratio 1 : 1.16-1.55. Testes usually behind ventral sucker, sometimes anterior one shifting dorsally to ventral sucker, 0.02-0.12 mm long by 0.05-0.22 mm wide. Ovary post-testicular or rarely lateral to posterior testis, 0.02-0.10 mm long by 0.02-0.12 mm wide. Vitellaria composed of many transverse tubules in testicular zone.

Discussion. These metacercariae have the cuticular thickening of unknown nature and function at the posterior end of the body like the foregoing *Guschanskiana* metacercaria, but they differ from it largely in that the intestines are simple. Without regard to the cuticular thickening, they seem related to the genus *Accacladium* Odhner, 1928, in having the genital cone enclosing the hermaphroditic duct and the simple intestines and in lacking glandular esophageal outgrowths. *A. serpentulus* Odhner, 1928, was recorded by Yamaguti (1934) from the intestine of *Mola mola* at Kuki, Mie Prefecture.

Accacoeliidae gen. sp. metacercaria II

(Fig. 1)

Host. Trunk coelom of *Sagitta crassa* f. *naikaiensis*, Suruga Bay, September 10-12, 1977.

Specimens No. NSMT-P1 2531.

Description. Two specimens were obtained, one each from one infected host. With characters of the family. Metacercariae, not encysted. Body subcylindrical, papillated in forebody, 1.20-1.30 mm long by 0.40-0.45 mm wide, with anterior extremity bending ventrally. Ventral pit in front of ventral sucker absent. Cuticular thickening of posterior end of body present. Oral sucker subterminal, 0.10-0.12 mm long by 0.12-0.17 mm wide. Pharynx elongate-pyriform, projecting anteriorly into base of oral sucker, 0.10-0.11 mm long by 0.06 mm wide. Esophagus fairly long, narrow, bifurcating posterodorsal to ventral sucker, with about four glandular outgrowths at its bifurcation. Clusters of (glandular?) cells present on each side of anterior part of esophagus. Intestine H-shaped; anterior ceca simple, reaching oral sucker; posterior ceca simple, probably forming uroproct. Ventral sucker slightly pedunculated, a little anterior to midlevel of body, 0.30 mm long by 0.20-0.25 mm wide, with circular flange; sucker width ratio 1 : 1.47-1.66. Genital pore ventral to pharynx; other genital organs not discernible. Excretory system not studied.

Discussion. These metacercariae are distinguishable from the preceding metacercaria (I) by a more elongated body, a longer esophagus with posterior glandular outgrowths and less developed genital glands. In spite of the posterior cuticular thickening of the body, they are not of the genus *Guschanskiana* Skrjabin, 1959, because of the simple intestines. Since details of their terminal genitalia are unknown, they are not identifiable even to

generic level. Similar unidentified metacercariae were reported by Dollfus (1960) from *S. inflata* [sic] from Villefranche-sur-mer (Alpes maritimes).

Accacoeliidae gen. sp. metacercaria III

(Fig. 2)

Host. Trunk coelom of *Sagitta crassa* f. *naikaiensis*, Suruga Bay, September 10-12, 1977.

Specimen No. NSMT-PI 2516.

Description. A single specimen with characters of the family. Metacercaria, not encysted. Body ovate, 0.65 mm long by 0.38 mm wide, with smooth cuticle, lacking ventral pit in front of ventral sucker and cuticular thickening at posterior end of body. Oral sucker subterminal, 0.11 mm long by 0.15 mm wide. Pharynx elongate-pyriform, 0.08 mm long by 0.05 mm wide, with narrow anterior extension into base of oral sucker. A cluster of (gland?) cells present on each side of pharynx. Esophagus moderately long, bifurcating dorsal to ventral sucker, without glandular outgrowths. Intestine H-shaped; anterior ceca with six lateral diverticles each; posterior ceca with many small dilatations (or short diverticles); uroproct present. Ventral sucker sessile, located at anterior third of body, 0.22 mm long by 0.19 mm wide, without flange; sucker width ratio 1 : 1.23. Genital cone small, enclosing hermaphroditic duct; genital atrium pear-shaped, small, ventral to pharynx; genital pore posteroventral to oral sucker. Other genital organs not observable. Excretory vesicle probably Y-shaped, with short stem.

Discussion. It seems likely that this metacercaria belongs to the genus *Accacladocoelium* Odhner, 1928, because it possesses branched anterior and posterior intestinal ceca, the uroproct and the genital cone enclosing the hermaphroditic duct in the genital atrium and because it lacks posterior glandular esophageal outgrowths. No species of the genus has as yet been recorded from Japanese waters.

The diplocercous cercaria, *Cercaria owreae* (Hutton, 1954) Dawes, 1959, is a larva of a member of the genus (Dawes, 1959). It parasitizes chaetognaths (Hutton, 1954; Dawes, 1959; Reimer *et al.*, 1975). A single specimen which had the appearance of *C. owreae* was found in the trunk coelom of a chaetognath taken in Suruga Bay on September 10, 1977. Unfortunately, it was lost before close observation of its morphology.

Fellodistomidae

***Tergestia* sp. metacercaria**

(Figs. 3-5)

Host. Intestine of *Sagitta crassa* f. *naikaiensis*, Tokyo Bay (35°35.0'N, 139°48.5'E), Japan, July 13-14, 1979, collected by Dr. Sachiko Nagasawa.

Fig. 7. *Parahemiurus* sp. metacercaria from a chaetognath, entire body, ventral view.

Fig. 8. Hemiuridae gen. sp. metacercaria from a chaetognath, entire body, ventral view.

(Scale bar=0.1 mm in 1-4 and 6-8; and 0.05 mm in 5.)



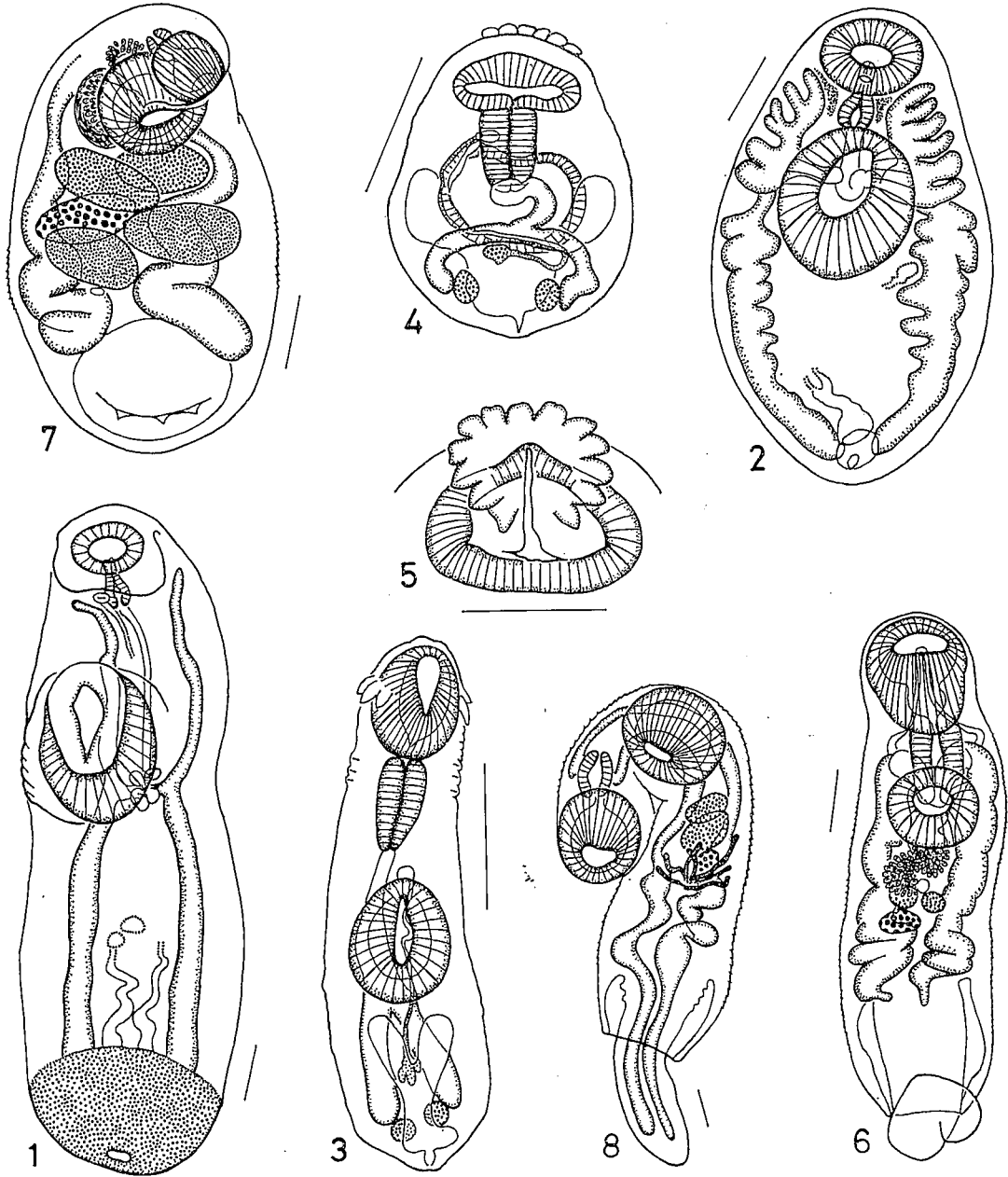


Fig. 1. Accacoeiliidae gen. sp. metacercaria II from *Sagitta crassa* f. *naikaiensis*, entire body, ventral view.

Fig. 2. Accacoeiliidae gen. sp. metacercaria III from *S. crassa* f. *naikaiensis*, entire body, ventral view.

Figs. 3-5. *Tergestia* sp. metacercariae from *S. crassa* f. *naikaiensis*. 3: Extended specimen, entire body, ventral view. 4: Contracted specimen, entire body, dorsal view. 5: Anterior part of another contracted specimen, ventral view.

Fig. 6. *Lecithocladium* sp. metacercaria from *S. enflata*, entire body, ventral view.

Specimens No. NSMT-P1 2509.

Description. A total of 386 specimens were obtained, one to three each from one host.

Measurements based on 10 relatively well-extended worms. With characters of the genus. Metacercariae, not encysted. Body elongate-oval to pyriform, 0.22-0.36 mm long by 0.09-0.11 mm wide, with a ventrally-interrupted semicircle of 13 muscular lobes around oral sucker. Transverse folds of body wall on each side of neck region not yet fully differentiated. Oral sucker subterminal, 0.05-0.08 mm wide. Prepharynx absent. Pharynx elongate, 0.06-0.07 mm long by 0.02-0.03 mm wide. Esophagus fairly long. Intestine inverted Y-shaped, bifurcating posterodorsal to or just behind ventral sucker, ending blindly some distance from posterior extremity of body. Ventral sucker almost equatorial, 0.06-0.09 mm long by 0.06-0.07 mm wide, usually larger than oral sucker; sucker width ratio 1 : 0.83-1.40. Testes opposite, behind or near cecal ends, about 0.02 mm in diameter. Ovary median, pretesticular, about 0.02 mm in diameter. Ovarian complex, uterus and terminal genitalia poorly developed. Genital pore sinistrally submedian, just in front of ventral sucker. Vitelline follicles not seen. Excretory vesicle Y-shaped; arms not reaching to ventral sucker in extended specimens; pore terminal.

Discussion. These metacercariae are likely to be of *T. acanthogobii* Yamaguti, 1938, which was described by Yamaguti (1938) from the small intestine of *Acanthogobius flavimanus* caught in Lake Hamana, Shizuoka Prefecture. In general morphology, they resemble Yamaguti's description and type-series (adult specimens) (MPM Coll. Nos. SY61-88-90) borrowed from the Meguro Parasitological Museum, Tokyo. Bray and Gibson (1980) synonymized *T. acanthogobii* with *T. laticollis* (Rudolphi, 1819) Stossich, 1899. Under the name of *T. laticollis*, some adult worms also were recorded from Japanese waters: from *Scomber japonicus* taken in Toyama Bay (Yamaguti, 1934); from *Trachurus trachurus* caught at Miasaka, Shizuoka Prefecture (Yamaguti, 1938); from *Apogon lineatus* (locality not given) (Yamaguti, 1940); and from *Caranx equula* taken at Hamazima, Mie Prefecture (Yamaguti, 1951). A review on known species and cercarial and metacercarial stages of the genus is available in Bray and Gibson (1980).

Hemiuridae

Lecithocladium sp. metacercaria

(Fig. 6)

Hosts. Tail coelom of *Sagitta enflata*, East China Sea (34°39.8'N, 122°23.0'E) (date unknown), collected by Dr. Sachiko Nagasawa; trunk and tail coeloms of *S. nagae*, East China Sea (32°00'N, 124°00'E; and 32°01'N, 124°47'E), July 14, 1975, collected by Dr. Masao Matsuzaki; and tail coelom of *S. enflata*(?), Suruga Bay, September 10-12, 1977.

Specimens Nos. NSMT-P1 2512-2514.

Description. Four specimens were obtained, one each from one host.

With characters of the genus. Metacercariae, not encysted. Body elongate, serrate, 0.32-0.81 mm long by 0.10-0.24 mm wide, with short ecsoma. Oral sucker funnel-shaped, 0.08-0.19 mm long by 0.08-0.16 mm wide, with internal isthmus of its lumen. No prepharynx

present. Pharynx cylindrical, 0.07-0.12 mm long by 0.03-0.07 mm wide. Esophagus very short. Intestinal ceca undulating in hindbody, barely entering ecsoma. Ventral sucker 0.09-0.12 mm long by 0.09-0.15 mm wide, at about anterior third of body; sucker width ratio 1 : 0.92-1.13. Testes symmetrical, about equatorial, intercecal, 0.01-0.03 mm in diameter. Seminal vesicle pretesticular, median, 27 μ m in diameter in the figured specimen. Pars prostatica winding between testes and pharynx; prostatic cells free in parenchyma. Ovary posttesticular, 0.02-0.03 mm long by 0.06 mm wide. Other genital organs not observable; vitellaria not yet differentiated. Excretory arms uniting dorsal to oral sucker.

Discussion. Their funnel-shaped oral sucker, elongated pharynx and intestinal ceca hardly entering the ecsoma suggest that these metacercariae are larvae of *L. excisum* (Rudolphi, 1819) Lühe, 1901. Similar metacercariae identified as *L. excisum* were reported from the ctenophore, *Pleurobrachia pileus*, from New Zealand (Boyle, 1966) and from six species of chaetognaths, two species of crustaceans and three species of coelenterates, all collected in the Northeast Atlantic Ocean off Northwest Africa (Reimer *et al.*, 1975). In Japanese waters, the adult stage of *L. excisum* was recorded from *Scomber japonicus* (Yamaguti, 1934; Machida *et al.*, 1970) and *Stromateoides argenteus* (Yamaguti, unpublished data). By the way, I examined Yamaguti's specimens (described in 1934 and undescribed) of *L. excisum* (MPM Coll. Nos. SY1-8 and SY4-52-53 from *S. japonicus*; and SY1-3, 6 and 9 from *S. argenteus*) and of *L. excisiforme* Cohn, 1903 (SY1-2, 4 and 5 from *S. argenteus*), but I failed to distinguish them. These two species are considered conspecific, as pointed out by Looss (1907).

Parahemiurus sp. metacercaria

(Fig. 7)

Host. Trunk coelom of a chaetognath (damaged), Suruga Bay, September 10-12, 1977.

Specimen No. NSMT-P1 2517.

Description. A single specimen was obtained.

Metacercaria, not encysted, progenetic. Body oval, serrated, 0.50 mm long by 0.35 mm wide, with its anterior extremity bending ventrally; ecsoma very short, invaginated. Oral sucker globular, 0.07 mm in diameter. No prepharynx. Pharynx spherical, 0.03 mm in diameter. Esophagus very short. Intestinal ceca thick, sinuous, not entering ecsoma. Ventral sucker close to oral sucker, 0.14 mm long by 0.17 mm wide; sucker width ratio 1 : 2.33. Testes symmetrical, behind ventral sucker, 0.07 mm long by 0.13-0.15 mm wide. Seminal vesicle oval, thin-walled, pretesticular, posterodorsal to ventral sucker, 0.12 mm long by 0.08 mm wide. Pars prostatica long, winding dorsal to ventral sucker; prostatic cells free in parenchyma. Terminal genitalia not discernible. Ovary on right side of median line, posttesticular, 0.07 mm long by 0.13 mm wide. Vitellaria in two compact masses, postovarian, 0.07-0.09 mm long by 0.13-0.16 mm wide. A single egg seen behind right vitellarium, not filamented, 22 by 12 μ m. Excretory system not studied.

Discussion. This metacercaria is referred tentatively to the genus *Parahemiurus* Vaz et

Pereira, 1930, because of its plicated body and thin-walled saccular seminal vesicle. It is characterized by thick sinuous intestines which do not enter a very short ecsoma and the progenetic development in the metacercarial stage. Dollfus (1960) has reviewed previous records of appendiculate hemiurid metacercariae from chaetognaths.

Hemiuridae gen. sp. metacercaria

(Fig. 8)

Hosts. Trunk and tail coeloms of *Sagitta enflata*(?), *Heterokrohnia* sp. and chaetognaths (damaged), South China Sea (2°03'N, 110°21'E; 2°24'N, 109°52'E; and 2°33'N, 109°50'E), July 20, 23 and 25, 1970.

Specimens Nos. NSMT-P1 2532-2534.

Description. Four specimens were obtained, one each from one host.

With characters of the family. Metacercariae, not encysted. Body elongate, serrate, 0.97-1.50 mm long by 0.23-0.40 mm wide; ecsoma present, 0.55 mm long in the figured specimen. Oral sucker globular, 0.17-0.27 mm long by 0.18-0.25 mm wide. Prepharynx absent. Pharynx ovoid, 0.08-0.13 mm long by 0.06-0.12 mm wide. Esophagus very short. Intestinal ceca extending into ecsoma, ending blindly near its end. Ventral sucker pre-equatorial, 0.21-0.27 mm long by 0.22-0.30 mm wide; sucker width ratio 1 : 1.20-1.22. Testes posterior to ventral sucker, 0.04-0.10 mm long by 0.09-0.16 mm wide. Ovary 0.03-0.06 mm long by 0.07-0.10 mm wide. Vitellaria consisting of seven tubules. Genital pore ventral to oral sucker. Other genitalia and excretory system not observable.

Discussion. It is impossible to identify these metacercariae even to generic level, because little is known about detailed anatomical structure of their terminal genitalia. They bear some resemblance to the subfamily Dinurinae Looss, 1907, in having the serrate body, the ecsoma and the digitate vitellaria. Reimer *et al.* (1975) assigned a closely similar metacercaria found in *S. friderici* from the Northeast Atlantic Ocean off Northwest Africa to the genus *Dimurus* Looss, 1907.

Opecoelidae

Pseudopecoelus japonicus metacercaria*

Host. Lateral thoracico-abdominal muscle of *Euphausia similis* (Euphausiacea), Suruga Bay, May 25-June 3, 1971 and September 10-12, 1977.

Specimens Nos. NSMT-P1 2197-2199 and 2501-2508.

Results. In 1971, a total of 32,221 *E. similis* collected in the bay were examined, and 134 or 0.42% out of them were found infected with *P. japonicus* metacercariae: 9 or 0.08% out of 11,655 juveniles, 62 or 1.28% out of 4,859 males, and 63 or 0.4% out of 15,707 females were positive. The incidence of infection was significantly higher in the males than in the females (χ^2 -test, $P < 0.001$). As for this difference, no explanation can be

* On the parasitic organisms in a krill, *Euphausia similis*, from Suruga Bay, III. Parts I and II of this series are the papers by Komaki (1970) and Shimazu (1971), respectively.

forwarded at present. All but one of the krill infected harbored one parasite each; the exception, two. Data in 1977 were not recorded because krill examined were not many.

Metacercariae were detected exclusively in a body muscle, located usually side by side with the heart, of the krill. Most presumably, the muscle is equivalent to the muscle that Daniel (1929) referred to as the lateral thoracico-abdominal muscle in the euphausiid, *Meganyctiphanes norvegica*. The muscle infected with the metacercaria was found to become reduced to a thin wall around the parasite accompanying parasite growth. In the muscle infected with a very young metacercaria, a hemocytic infiltration was seen surrounding the parasite and narrowly stretching out from there to its posterior end, which is just underneath the soft membranous connective between the carapace and the tergum of the first abdominal segment of the krill.

Ellipsoidal cysts of 158 formalin-fixed metacercariae obtained in 1971 measured 0.27 to 1.84 by 0.20 to 1.70 mm. In the youngest one of them, 0.27 by 0.20 mm in cyst size, the oral and the ventral sucker, digestive organs, two tandem testes, the ovary and a thick-walled epithelial excretory vesicle were recognized. The seminal vesicle and terminal genitalia were weakly differentiated. The stylet was not seen. As the metacercaria developed, follicular vitelline glands appeared, and then the seminal vesicle and terminal genitalia became fully differentiated. The spermatogenesis began, and the seminal vesicle came to be filled with sperms. After some further development, when attaining its cyst size of about 1.10 by 1.00 mm, the worm matured progenetically to begin to produce eggs. It continued growing, and eventually it began to lay eggs into its cyst.

The morphology of progenetic metacercariae has already been described in some detail by Shimazu (1971). The following are further observations to be added. (1) The metacercarial cyst proper was single-layered and transparent; the outer one of the two layers described by Shimazu proved to be the host's transformed muscle tissue joined fast with the cyst proper. (2) The ootype was surrounded by larger basophilic Mehlis' gland cells, which expanded widely forming a layer outer to that of smaller eosinophilic gland cells opening into the ovo-vitelline duct. (3) No sperms were stored in the uterine seminal receptacle even in egg-laying metacercariae, whereas sperms were always seen in the seminal vesicle in them. (4) Laurer's canal was present. (5) The excretory vesicle was thick-walled and lined internally with a layer of large, usually multinuclear epithelial (or glandular?) cells in sexually immature metacercarial stages, but it became thin-walled about the time when the worm attained sexual maturity: The epithelial cells came off. (6) The flame-cell formula was $2[(2+2)+(2+2)]=16$.

Discussion. Komaki (1970) and Shimazu (1971) have already reported that the metacercaria of *P. japonicus* (Yamaguti, 1938) von Wicklen, 1946*, develops progenetically to sexual maturity to produce eggs while still encysting in *E. similis* in Suruga Bay.

The egg-bearing progenetic metacercariae had sperms in the seminal vesicle but not in the uterine seminal receptacle. On the contrary, nearly all the adult worms of *P. japonicus* (NSMT-P1 2193 and 2194) obtained from the intestine of *Chlorophthalmus albatrossis* taken

* Komaki and Shimazu included the trematode in the family Allocreadiidae.

in Kumano-nada and Tosa Bay (Shimazu, 1971) contained sperms in both the organs. It seems that the self-insemination does not take place in encysted metacercariae and that consequently eggs produced progenetically by them are unfertile. If this is true, a fish final host is essential for the trematode to complete its life cycle, that is, a three-host one, as will be discussed later. Really fertile eggs would be formed after insemination (self- or cross- or both) with prior excystation of the metacercaria in the upper intestine of the fish host. Biological significance of the progenesis in this fluke remains to be further investigated.

In Suruga Bay, Yamaguti (1938) recorded the adult *P. japonicus* (= *Cymbophallus japonicus*) from ten species of fishes. Sh. Kamegai (pers. comm.) found adult *Pseudopicoelus* worms, which were closely similar to, if not identical with, *P. japonicus*, from a variety of deep-sea fishes. So far as is known, only *E. similis* serves as the second intermediate host for *P. japonicus*. Yamaguti (1938) claimed to obtain encysted forms of this trematode from the peribuccal connective tissue of *Trachurus trachurus* caught in the bay. However, he must have had before him the metacercariae that had just been freed in the buccal cavity from their host krill recently ingested into the fish, because the fish is a well-known predator of *E. similis*. The first intermediate host of *P. japonicus* is as yet unknown. Cable (1963) regarded a ctylomicrocercous cercaria, *Cercaria caribbea* LX Cable, 1963, developing in a sporocyst in *Columbella mercatoria*, as the larva of a small unidentified *Pseudopicoelus* trematode parasitizing the pygmy wrasse in Curaçao. He was able to infect experimentally an amphipod with the cercaria.

The cellular infiltration observed in the krill's muscle infected may indicate that the cercaria of *P. japonicus* enters the krill through the soft membraneous connective between the carapace and the tergum of the first abdominal segment, penetrates into the posterior end of either of the paired lateral thoracico-abdominal muscles, makes its way through the muscle to the site of preference which is usually situated side by side with the heart, and finally encysts there in the muscle.

Syncoeliidae

Paronatrema sp. metacercaria

(Fig. 9-10)

A single specimen was found free in a plankton haul taken in the East China Sea (32°01'N, 124°47'E) on July, 14, 1975, by Dr. Masao Matsuzaki.

Specimen No. NSMT-P1 2518.

Description. With characters of the genus, *Metacercaria*, not encysted. Body elongate, plump, non-ocellated, 2.60 mm long by 0.82 mm wide, with large gland cells scattered in parenchyma. Tail absent. Oral sucker terminal, cup-shaped, 0.40 mm long by 0.60 mm wide; accessory suckers 43 in number. Pharynx pyriform, 0.35 mm long by 0.27 mm wide. Esophagus short, running anterodorsally. Intestines undulating, probably forming uroproct (Fig. 10). Ventral sucker shortly stalked, located in middle third of body, 0.70 mm long by 0.83 mm wide; accessory suckers numbering 37; sucker width ratio 1 : 1.38.

Testes divided into a number of large follicles, occupying intercecal field, a little overlapping intestines, containing sperms; larger ones measuring up to 100 μm in diameter. Seminal vesicle tubular, coiling. Pars prostatica posterior to pharynx. Hermaphroditic duct tubular, straight, 0.35 mm long. Genital pore median, just ventral to border between oral sucker and pharynx, lying in sucker-like structure. Ovary single, globular, posttesticular, near posterior end of body, 0.10 mm long by 0.15 mm wide. Uterus or metraterm convoluted in forebody along median line. Vitellaria forming small clusters of segmented tubules, postovarian, ventral to intestines. Excretory system obscured by other internal organs.

Discussion. Large follicular testes containing sperms are characteristic of this sexually immature worm. They do not appear to form chains of follicles. Specific identification of the specimen is impossible at present on account of the state of immaturity. From the East China Sea, an unidentified *Paronatrema* metacercaria with a forked tail and 26 accessory suckers on the ventral sucker was reported by Shimazu and Kagei (1978) from the euphausiid, *Euphausia pacifica*. For information on other previous records of *Paronatrema* members, reference should be made to Shimazu and Kagei (1978).

CESTODA

Diphyllidea: Echinobothriidae

Echinobothrium sp. larva

(Figs. 11-13)

Host. Cephalothoracic hemocoel of *Leptocheila* sp. pasiphaeid (Decapoda), South China Sea (2°03'N, 110°21'E), July 20, 1970.

Specimens No. NSMT-P1 2523.

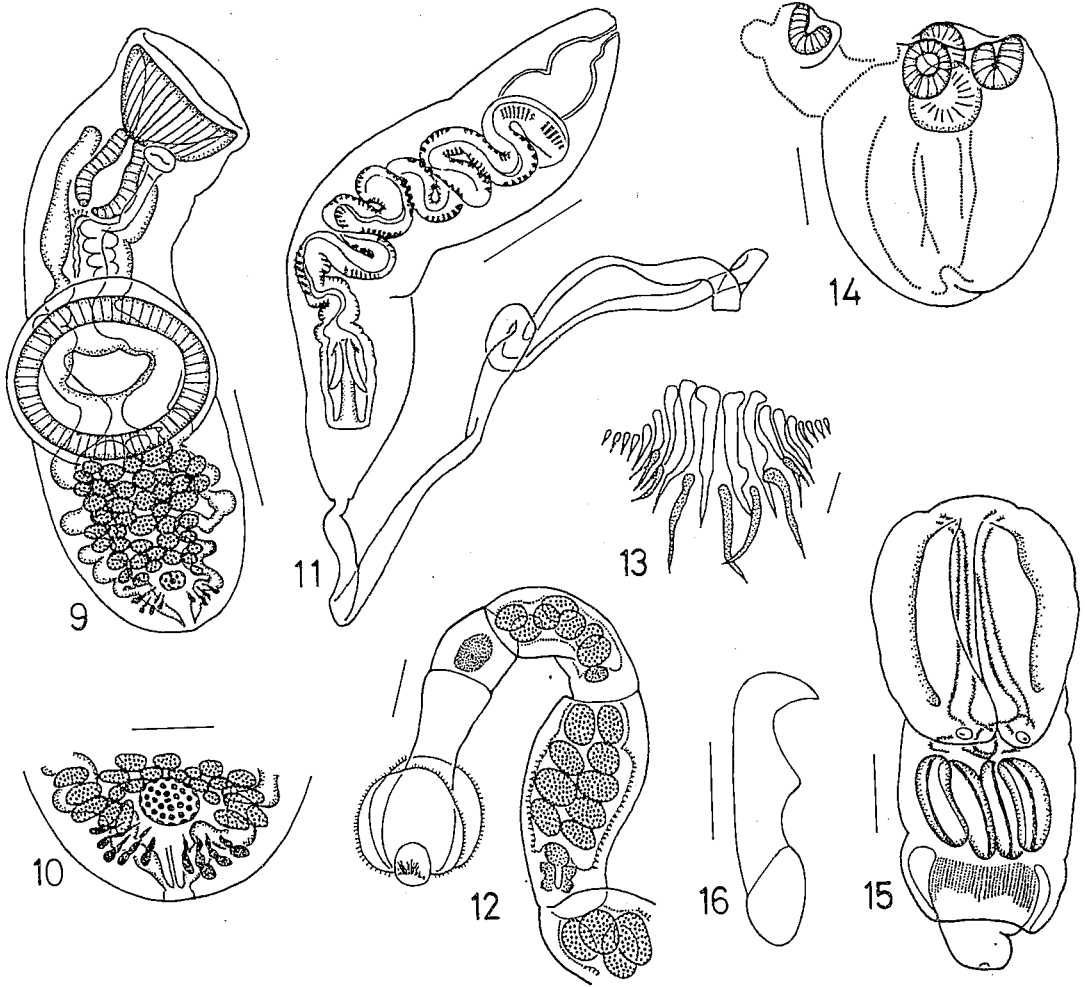
Description. A total of 24 specimens were obtained, mostly one but occasionally two to three each from one host.

With characters of the genus. Cysticeroid-like larva consisting of a larva proper and a double-walled bladder with a tail. Bladder spindle-shaped. Tail solid, like a ribbon, long; embryonic hooks not seen on it. Fairly well-developed larvae measuring 2.62-3.00 mm long by 0.62 mm wide in bladder and 4.87-5.00 mm in tail.

Larva proper showing strobilization. Scolex not invaginated, 0.20-0.45 mm long including cephalic peduncle. Rostellum inverted pear-shaped, 0.06-0.11 mm long by 0.04-0.07 mm wide. Bothridia two, oval to orbicular, 0.13-0.30 mm long by 0.10-0.17 mm wide, covered densely with minute spines. A group of hooks present anterior to each bothridium, composed probably of 10 anterior and 7 posterior larger apical hooks and 3-4 smaller lateral hooks on each side; hooks measuring 2-40 μm long, largest in center of group and descending in size from center to lateral margins of group. Cephalic peduncle short, less than 0.22 mm long, lacking any kind of spines. Strobila invaginated fully or in part, acraspedote, long, with evident segmentation; 23-25 proglottids present in well-formed larvae. Proglottids longer than wide, 0.40-0.45 mm long by 0.23-0.25 mm wide. Testes ellipsoidal, 9-11 in number per proglottid, arranged in two longitudinal rows, 0.04-0.06 mm long by 0.10-0.13

mm wide. Ovary small, posttesticular, median, near posterior end of proglottid. Vitelline follicles lateral on each side of body. Other genital organs not clearly observable.

Discussion. The number of apical hooks per group and testes per proglottid is of taxonomic



Figs. 9-10. *Paronatrema* sp. metacercaria found free in a plankton haul. 9: Entire body, ventral view. 10: Posterior part of body, ventral view.

Figs. 11-13. *Echinobothrium* sp. larvae from *Leptochela* sp. pasiphaeids. 11: Fairly well-developed larva, entire body. 12: Anterior part of a well-formed larva. 13: Rostellar armature, hooks of posterior row shaded.

Fig. 14. *Scolex pleuronectis* from *Sagitta enflata*(?), entire body.

Figs. 15-16. *Pseudonybelinia odontacantha* larvae from *Euphausia recurva*. 15: Entire body of a larva. 16: Tentacular hook, lateral view.

(Scale bar=0.5 mm in 9, 11 and 15; 0.2 mm in 10; 0.1 mm in 12; 0.05 mm in 14; and 0.01 mm in 13 and 16.)

importance in the genus *Echinobothrium* Beneden, 1849, although this feature alone is not considered sufficient to separate species. The present larvae have 17 (namely 10 anterior and 7 posterior) larger apical hooks flanked by 3 to 4 smaller lateral hooks per side in each group, and 9 to 11 testes per proglottid. These two respects would distinguish them from all the 17 hitherto known species and from some already described larvae of the genus. They do not bear any kind of spines on the cephalic peduncle. As a general rule, spines on the cephalic peduncle are regarded as adult structures in *Echinobothrium* species living in their final hosts as discussed by McVicar (1976). An exception to this is *E. reesae* Ramadevi, 1969, in which no spines occur in the adult stage as well as in the larval stage (Ramadevi, 1969; Ramadevi and Rao, 1974). At any rate, a survey of cestode parasites of elasmobranchs to obtain the adult stage of the larvae in the South China Sea needs for specific determination of them.

Tetraphyllidea

Scolex pleuronectis

(Fig. 14)

Host. Trunk coelom of *Sagitta enflata*(?), South China Sea (2°36'N, 111°01'E), July 15, 1970.

Specimen No. NSMT-P1 2522.

Description. A single specimen of *S. pleuronectis* Mueller, 1788, was obtained.

Body obovate, 0.18 mm long by 0.15 mm wide; four cup-shaped bothridia 0.04 mm in diameter; apical sucker 0.05 mm in diameter.

Discussion. It is impossible to identify this larva even to generic level, because *S. pleuronectis* larvae represent a number of tetraphyllidean species.

Phyllobothriidae gen. sp. plerocercoid

Hosts. Trunk coelom of *Eukroknia hamata* (Chaetognatha), Japanese Pacific waters (32°59'N, 135°13'E), February 23, 1976, collected by Dr. Kazunori Kuroda; and of *Sagitta crassa* f. *naikaiensis*, Tokyo Bay (35°35.0'N, 139°48.5'E), July 13-14, 1979, collected by Dr. Sachiko Nagasawa.

Specimens Nos. NSMT-P1 2510-2511.

Description. Two specimens were obtained. They were plerocercoids closely similar to those described by Shimazu (1978, pp. 113-114, Figs. 12-13). Body 1.12-1.37 mm long by 0.20-0.40 mm wide, with four orbicular bothridia; scolex invaginated or not, with possibly fairly long apex.

Discussion. It is impossible to identify them even to genus.

Trypanorhyncha: Tentaculariidae
Pseudonybelinia odontacantha larva
(Figs. 15-16)

Host. Cephalothoracic hemocoel of *Euphausia recurva*, East China Sea (position not recorded, but near Kyushu, Japan), July 7, 1970; and Suruga Bay, September 10-12, 1977.

Specimens Nos. NSMT-P1 2524-2525.

Description. Three specimens were obtained, one each from one host.

Plerocercoid-like larva, without blastocyst. Scolex craspedote, 2.25-2.62 mm long (including velum 0.50-0.75 mm long), 1.25 mm wide in pars bothridialis, 1.00-1.12 mm wide in pars bulbosa. Bothridia divided distinctly into four, rather contiguous, sessile, not prominent, covered densely with minute hair-like spines, 1.25-1.50 mm long by 0.50-0.55 mm wide; an internally-ciliated sensory pit present near posterior end of each bothrium, orbicular to elliptical, 37-70 μm long by 42-62 μm wide. Tentacles invaginating, shorter than internal sheaths, each located near anterior extremity of each bothridium; retractor muscles attached to bottoms of bulbs. Tentacular hooks solid, alike in shape and size throughout tentacles, feebly curved, with a claw-like tip, a small tooth-like protuberance at midlevel on ventral arc and a simple and slightly swollen base, 35-37 μm in total length; their arrangement not determined. Internal sheaths not corkscrewlike, longer than bothridia. Bulbs banana-shaped, posterior to bothridia, 0.70-0.75 mm long by 0.22-0.30 mm wide. Appendix short, about 0.70 mm long, not showing strobilization.

Discussion. Dollfus (1966) created *P. odontacantha* as the type and only species of the new genus *Pseudonybelinia* from his larval trypanorhynchs found in a plankton haul taken off the Cape Verde Islands, Northeast Atlantic Ocean. He (1966, 1967) briefly described and figured them without giving the systematic position of the genus. The present specimens agree well with his descriptions except that the number of bothridia is four instead of two and that the tentacular hooks are slightly longer (35 to 37 μm vs. about 32 μm), although their arrangement is left undetermined in the former. He described the number of bothridia as two in his specimens, but his figure (1967, p. 168, Fig. 23) seems to indicate that on each side of scolex are two bothridia which are divided completely at least in the posterior part and completely but weakly or incompletely in the remaining anterior parts. The bothridia are probably four in number in the genus.

Shimazu (1975b, c) described the larval stage of *Nybelinia surmenicola* Okada in Dollfus (1929) (Tentaculariidae) from euphausiids and the adult stage of this species from the shark, *Lamna ditropis*, both from the northern North Pacific Ocean. Dollfus' and the present *Pseudonybelinia* larvae resemble Shimazu's *N. surmenicola* larvae in many morphological and biological features, but differ in the presence of sensory pits, the shape of tentacular hooks and the degree of strobilization of the appendix. It seems unlikely that this difference separates families to which the two genera belong. The internal anatomy of gravid segments and the life cycle of *P. odontacantha* are unknown. They will probably prove to be similar to those of *N. surmenicola* (Shimazu, 1975b, c). From the above,

I prefer placing the genus *Pseudonybelinia*, along with the genus *Nybelinia* Poche, 1926, in the family Tentaculariidae Poche, 1926. Schmidt (1970) assigned the genus *Pseudonybelinia* to the new family Paranybeliniidae, which however is not adopted here. The following is a diagnosis of the genus with an emendation of that given by him.

Genus *Pseudonybelinia* Dollfus, 1966, emend.

Generic diagnosis. Of the family Tentaculariidae. Scolex craspedote. Bothridia four, sessile, not prominent, each possessing a ciliated sensory pit at near its posterior end. Tentacles shorter than internal sheaths, located near anterior extremities of bothridia. Tentacular hooks solid, homeoacanthous, arranged in continuous spiral rows, each slightly arcuate, with a claw-like tip, a small ventral tooth-like projection and a slightly swollen base. Internal sheaths longer than bothridia. Bulbs banana-shaped, about three times longer than wide. Retractor muscles reaching to bottoms of bulbs. Adult unknown. Larva without blastocyst; appendix showing very weak strobilization or not at all; in euphausiid crustaceans (and accidentally free in plankton hauls).

Type and only species. *P. odontacantha* Dollfus, 1966.

NEMATODA

Ascaridoidea: Anisakidae

Anisakis sp. larva

Host. Cephalothoracic hemocoel of *Euphausia nana*, East China Sea (32°01'N, 124°47'E), July 14, 1975, collected by Dr. Masao Matsuzaki.

Specimen No. NSMT-As 1512.

Description. A single specimen was obtained.

Body 2.70 mm long by 0.09 mm wide. Boring tooth present; nerve ring 0.14 mm from anterior end of body. Ventriculus oblong, 0.15 mm long by 0.05 mm wide, 0.47 mm from anterior end of body. Excretory pore located between subventral lips; renette cell expanding posterior to ventriculus. Genital organs not observable. Rectum 0.05 mm long. Tail 0.05 mm long; mucron 10 μ m long.

Discussion. This larva belongs to *Anisakis* sp. larva (I) of Berland (1961). Kagei (1974) also found larvae of this type in *E. pacifica* from the East China Sea. For information on previous records of *Anisakis* larvae from euphausiids, readers are referred to Kagei (1979).

Thynnascaris spp. larvae

The present larvae with characters of the genus *Thynnascaris* Dollfus, 1933, are classified into five types based mainly on the presence or absence of the mucron and the ratio of the ventricular appendix length to the intestinal cecum length. Each of the five types possibly represents a species, but it remains unidentified because of its larval form.

1) Larva I. Two specimens (NSMT-As 1513) were found in the trunk coelom of *Sagitta crassa* f. *naikaiensis* taken in the Inland Sea of Japan (34°28.6'N, 133°44.6'E) on June

18, 1973, by Dr. Kazunori Kuroda.

Body 4.30-4.80 mm long by 0.08-0.09 mm wide; boring tooth present; nerve ring (or excretory pore) about 0.22 mm from anterior end of body; globular ventriculus 0.65-0.70 mm from anterior end of body; ventricular appendix 0.55-0.57 mm long; intestinal cecum 0.32-0.42 mm long; ratio 1 : 1.35-1.69; rectum 0.05-0.07 mm long; tail 0.07-0.08 mm long, with bluntly pointed tip; mucron absent; genital organs not developed.

2) Larva II. Four specimens (NSMT-As 1514) were found in the trunk coelom of *S. nagae* taken in the East China Sea (32°00'N, 124°00'E) on July 14, 1975, by Dr. Masao Matsuzaki.

Body 3.10-5.30 mm long by 0.08-0.14 mm wide; boring tooth present; nerve ring 0.16-0.21 mm from anterior end of body; globular ventriculus 0.50-0.69 mm from anterior end of body; ventricular appendix 0.55-1.07 mm; intestinal cecum 0.12-0.21 mm long; ratio 1 : 4.01-5.83; rectum 0.05-0.07 mm long; tail 0.06-0.07 mm long, with mucron; genital organs not developed.

3) Larva III. One specimen (NSMT-As 1515) was found in the trunk coelom of *S. nagae* taken in the East China Sea (31°40'N, 124°00'E) on July 14, 1975, by Dr. Masao Matsuzaki.

Body 3.40 mm long by 0.09 mm wide; boring tooth present; nerve ring 0.17 mm from anterior end of body; ventriculus 0.50 mm from anterior end of body; ventricular appendix 0.60 mm long; intestinal cecum 0.12 mm long; ratio 1 : 4.8; rectum 0.07 mm long; tail 0.07 mm long, with mucron; spinous tail of the next developmental stage seen under tail cuticle; genital organs not developed.

4) Larva IV. One specimen (NSMT-As 1516) was found in the trunk coelom of *S. nagae* taken in the East China Sea (31°40'N, 124°00'E) on July 14, 1975, by Dr. Matsuzaki.

Body 4.60 mm long by 0.11 mm wide; nerve ring 0.15 mm from anterior end of body; globular ventriculus 0.46 mm from anterior end of body; ventricular appendix 0.90 mm long; intestinal cecum 0.14 mm long; ratio 1 : 6.57; rectum 0.06 mm long; tail 0.09 mm long, with bluntly pointed tip; mucron absent; genital organs not developed.

5) Larva V. One specimen (NSMT-As 1517) was found in *Calanus sinicus* (Copepoda) taken in the East China Sea (32°00'N, 124°00'E) on July 14, 1975, by Dr. Matsuzaki. It is somewhat similar to those of the Larva II.

Body 4.70 mm long by 0.12 mm wide; boring tooth present, not prominent; nerve ring 0.20 mm from anterior end of body; globular ventriculus 0.55 mm from anterior end of body; ventricular appendix 0.90 mm long; intestinal cecum 0.16 mm long; ratio 1 : 5.55; rectum 0.07 mm long; tail 0.06 mm long; mucron very small; genital organs not developed.

Other helminth or metazoan parasites

1) Encysted metacercariae. Two encysted lepecreadiid or opecoelid metacercariae (NSMT-Pl 2521) were found free in a formalin-fixed plankton haul taken in Suruga Bay on September 10, 1977. They were globose (0.27 mm in diameter) or ellipsoidal (0.39 by 0.42 mm) in cyst. In having the smooth cuticle and the genital pore located dorsomarginal at the level of the ventral sucker on the left side of the body, they appear to be related to *Neonotoporus trachuri* (Yamaguti, 1938) Srivastava, 1942 (Lepocreadiidae), the metacercaria

of which was reported by Shimazu (1981) from *Euphausia similis* from the same bay.

2) *Monilicaecum* and *Torticaecum* metacercariae (Didymozoidae). Small unencysted metacercariae of the two groups (NSMT-PI 2519-2520) similar to those described by Shimazu (1978, pp. 110-113, Figs. 7-11) were often found in chaetognaths from the areas studied.

3) Trypanorhynchan cestode larvae. Live larvae of the two species which were described by Shimazu (1975a) as Eutetrarhynchidae gen. sp. (pp. 123-125, Figs. 4-7) and *Tetrarhynchobothrium* sp. (pp. 125, Figs. 8-11) were obtained from *E. similis* collected in Suruga Bay on September 10, 1977. They will be described elsewhere.

4) Unclassified parasite. The same specimens (NSMT-PI 2526-2530) as Shimazu (1978, pp. 114-115, Figs. 14-17) described were found in the trunk coelom of *Sagitta enflata* taken off the Japanese Pacific coast (34°01'N, 137°29'E) on August 10, 1971, by Dr. Kazunori Kuroda, and in Suruga Bay on September 26, 1975, by Dr. Sachiko Nagasawa; in the trunk coelom of *Pterosagitta draco* taken off the Japanese Pacific coast (32°00'N, 135°15'E) on February 15, 1975, by Dr. Kuroda; in the trunk coelom of a chaetognath (damaged) taken in the South China Sea (2°33'N, 109°50'E) on July 25, 1970; in the intestine of *S. enflata* (?) and a chaetognath (damaged) taken in Suruga Bay on September 10 to 12, 1977. Their systematic position is still quite unknown.

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