Notes on Three Helminth Parasites of *Sagitta bedoti* (Chaetognatha) from West Bengal, India

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From the chaetognath *Sagitta bedoti* of West Bengal, India, are described and figured unencysted metacercariae and adults of *Aphanurus* sp. (Trematoda: Bunocotylidae), an unencysted metacercaria of *Derogenes* sp. (?) (Trematoda: Derogenidae), and a fourth-stage larva of *Goezia* sp. (Nematoda: Anisakidae). Their systematic positions and life cycles are briefly discussed.

Key words: trematodes, a nematode, parasites, *Sagitta bedoti*, West Bengal

Chaetognaths, marine planktonic invertebrates, are known to serve as hosts for many species of parasites (Théodoridès, 1989). This paper reports two digenetic trematodes and a nematode found in a chaetognath from West Bengal, India.

Materials and Methods

Dr. S. K. Sarkar sent me several small samples of *Sagitta bedoti* (Chaetognatha) harboring helminth parasites for identification. The samples were taken by him in the Hooghly Estuary (lat. 21°37′ and 21°52′ N; long. 88°03′ and 88°11′E), West Bengal, India, on June 10, 1990. The parasites were digenetic trematodes and a nematode. After dissected out of the hosts preserved in 4% buffered formalin, the trematodes were stained with Delafield's hematoxylin and mounted in Canada balsam. and the nematode was cleared and mounted in glycerin.

All measurements (length by width) are given in millimeters unless stated otherwise. The parasite specimens are deposited in the collection of the National Science Museum, Tokyo (NSMT).

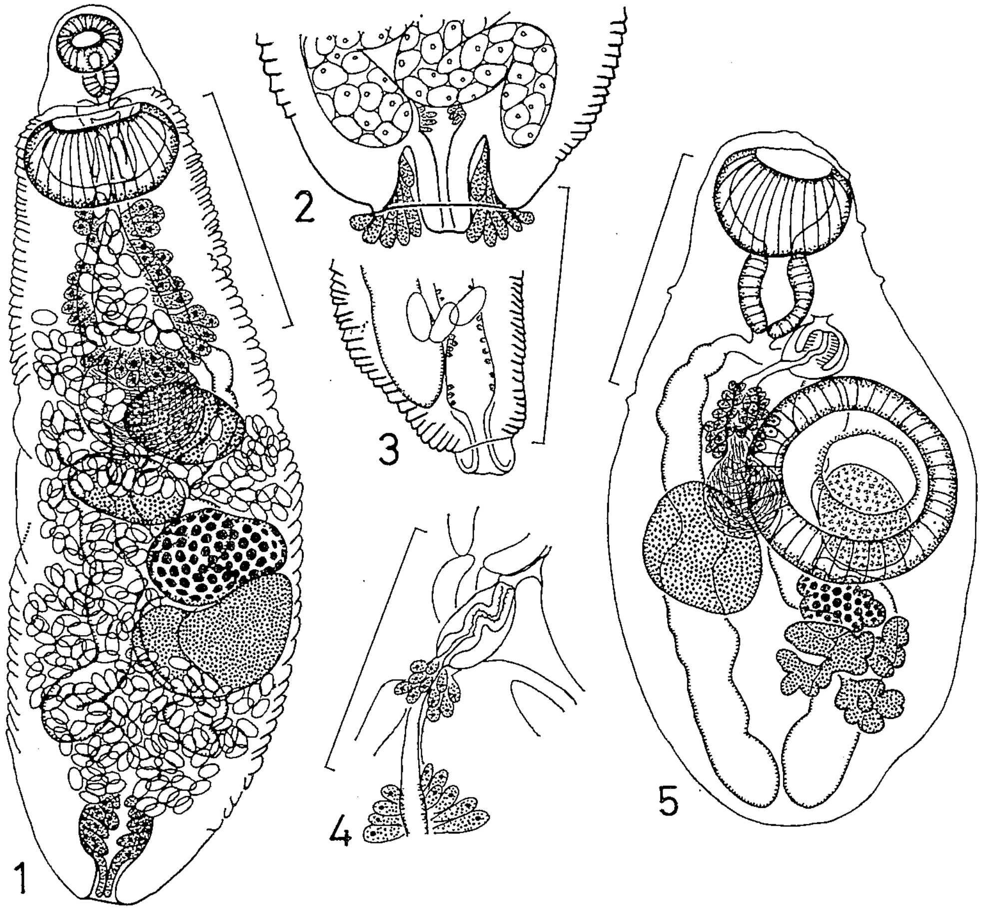
Metacercaria and Adult of *Aphanurus* sp.

(Trematoda: Bunocotylidae)

(Figs. 1-4)

A total of 30 unencysted worms (NSMT-Pl 3664-3666) were obtained from the trunk coelom of the chaetognath. Nineteen of them were immaure or metacercariae, and the rest were ovigerous or mature adults. Four better-prepared, larger whole-mounts were measured.

Description. Body spindle-shaped, plicate, 0.48-0.73 by 0.12-0.25; forebody 0.12 long, 17-26% of total body length. A large



Figs. 1-5. Metacercariae and adults found in *Sagitta bedoti* from West Bengal, India.
Figs. 1-4. Unencysted metacercariae and adults of *Aphanurus* sp. 1: Entire worm, adult, ventral view. The tubular protrusion in the terminal body cavity is indistict. 2: Posterior end of body, metacercaria, ventral view. 3: Posterior end of body, adult, lateral view. The lining of the terminal body cavity is lacking, and a small, protruding ecsoma is present (see text). 4: Terminal genitalia, metacercaria, lateral view.
Fig. 5. An unencysted metacercaria of *Derogenes* sp. (?), entire worm, ventral view. (Scale bars: 0.2 mm in Fig. 1; 0.1 mm in Figs. 2-5.)

eversible cavity present at posterior end of body, usually lined with a thick, villous, hematoxylin-positive, nucleated, possibly cellular layer; a small, thin tubular protrusion of body rising from bottom of cavity, with a smooth tegument. Oral sucker 0.04-0.05 by 0.04-0.06; pharynx 0.03 by 0.02-0.03; esophagus short; intestinal ceca undulating, each making a loop dorsally to ventral sucker, sometimes lined with large unstained cells in their posterior halves, terminating blindly near posterior end of body. Ventral sucker large, 0.07-0.09 by 0.09-0.11; sucker width ratio 1: 2.1-2.2. Testes diagonal, elliptical, about equatorial, 0.03-0.09 by 0.05-0.08. Seminal vesicle globular, thin-walled, pretesticular, large, 0.06-0.11 in diameter. Pars prostatica long, reaching ventral sucker, 0.11-0.17 long; prostatic cells large; ejaculatory duct fairly long, surrounded by small gland cells just before entering sinus sac; ejaculatory vesicle not seen. Sinus sac oblong, thick-walled, in front of ventral sucker; hermaphroditic duct within an amuscular temporary sinus organ, slender, warty on its anterior half, slightly protrusible. Genital atrium fairly deep; genital pore median, ventral to oral sucker. Ovary posttesticular, 0.05–0.07 by 0.05–0.12. Ootype complex not worked out. Uterus occupying most available parts of hindbody; uterine seminal receptacle present; sphincter not seen just before sinus sac. Eggs 19–24 by 8–13 μm. Vitellarium a single oval mass, large, postovarian, 0.05–0.07 by 0.06–0.14. Main excretory duct or excretory vesicle dividing about testicular level, running through protrusion in terminal body cavity to open on its tip; collecting ducts fusing dorsally to pharynx.

Discussion. This trematode belongs to the genus *Aphanurus* Looss, 1907, in the family Bunocotylidae Dollfus, 1950, *sensu* Gibson and Bray (1979). Possibly, it is *A. monolecithus* (Srivastava, 1941) Manter, 1947 (=*Sterrhurus monolecithus* Srivastava, 1941), because it is similar in general morphology and especially in egg size to, though smaller on the whole than, the latter (Srivastava, 1941). The adult stage of the latter is common in the stomach of the fish *Clupea illisha* [sic] in the Bay of Bengal, the Ganges and Jumna rivers at Allahabad, and the Arabian Sea (Srivastava, 1941). Chauhan (1954) synonymized this species with *A. stossichi* (Monticelli, 1891) Looss, 1907, the type species of the genus. It is uncertain whether chaetognaths acquire infection by parasites by feeding on the second intermediate host, probably copepods, harboring metacercariae or adults as a transport (paratenic) host or by swallowing cercariae directly as a second intermediate host or by both [for discussion, see Køie (1979, 1990)].

There has been considerable comment in the literature as to whether *Aphanurus* possesses or lacks an ecsoma, but this question has not yet been resolved (Gibson and Bray, 1979). Gibson and Bray (1979) said that a vestigial ecsoma may be present in the genus. Srivastava (1941) described and figured a small ecsoma in *A. monolecithus*. The present trematode has a tubular protrusion, through which the stem of the excretory vesicle runs, in a terminal body cavity. The protrusion is smooth and probably irretractile. The terminal body cavity is eversible and lined with a nucleated, possibly cellular, layer. The developmental origin of both the tubular protrusion and the terminal body cavity is unknown. Little is known of the process of formation of the ecsoma in ecsomate hemiurids. Hemiurid metacercariae with the terminal cavity lined with a thick, villous layer have also been recorded from marine planktonic invertebrates (Dollfus, 1960; Reimer *et al.*, 1975; Køie, 1990). According to Matthews and Matthews (1988), in an ecsomate hemiurid, *Lecithochirium furcolabiatum* (Jones, 1933) Dawes, 1947, the terminal body cavity is formed not as an invagination of the body but as a bulbous dilatation of the posterior section of the stem of the Y-shaped excretory vesicle; in mesocercariae [sic] in copepods, the wall of this section becomes progressively thickened into an ecsoma with a nucleated lining (or an ecsomal protegument of Matthews and Matthews, either a complete cellular or an incomplete syncytial layer); and the lining is eventually modified into an anucleate syncytial tegument of the protrusible ecsoma in metacercariae [sic] enclosed within fibrous capsules of host origin attached to the mesenteric membrane of visceral organs of small fish. [Morphologically, the mesocercaria of Matthews and Matthews is a juvenile, hence a metacercaria. To distinguish the two juveniles, it would be enough to call them early and late metacercariae, or premetacercaria and metacercaria, instead of obscuring the nature of the difference between the two stages intermediate between cercaria and adult (Pearson, personal communication).] According to Køie (1990), in another ecsomate hemiurid, *Hemiurus luehei* Odhner, 1905, a small protrusible ecsoma has a thick, villous lining in metacercariae in copepods; the lining is shed shortly after the metacercariae are freed from the copepod hemocoel [in the stomach of fish hosts?]; and the tegument below is smooth as in adults. In either *L. furcolabiatum* or *H. luehei*, the tubular protrusion as seen in the present trematode is not formed. If Matthews and Matthews (1988) and Køie (1990) are correct in their interpretation of the process of formation of the ecsoma, the process in their species may differ from that in the present species. In the latter, the lining of the terminal body cavity is rarely cast off during its development in chaetognaths (Fig. 3). The adult figured in Fig. 3 resembles that of *A. monolecithus* (Srivastava, 1941, fig. 1) in morphology of the posterior end of the body. It seems to me that in this specimen, the lining already disappeared and that the tubular protrusion thickened a little and protruded out of the soma. I consider that the tubular protrusion is a vestigial ecsoma, which however hardly develops any further because it was very small even in the mature adults.

Metacercaria of *Derogenes* sp. (?)

(Trematoda: Derogenidae)

(Fig. 5)

A single unencysted, well-developed metacercaria (NSMT-Pl 3667) was obtained from the trunk coelom of the chaetognath.

Description. Body oval, not ecsomate, smooth, 0.29 by 0.15; forebody 0.14 long, 48% of total body length. Oral sucker 0.05 by 0.06; pharynx 0.05 by 0.03; esophagus short; intestinal ceca slightly winding, terminating blindly near posterior end of body. Ventral sucker large, 0.09 in diameter; sucker width ratio 1: 1.5. Testes globular, diagonal, about midlevel of body, 0.03–0.05 by 0.04–0.06. Seminal vesicle oval, thin-walled, between testes, 0.03 in diameter. Pars prostatica dorsal to ventral sucker, surrounded by prostatic cells; ejaculatory duct short before entering sinus sac. Sinus sac rather thick-walled; permanent sinus organ present, muscular, conical. Genital atrium shallow; genital pore shifted sinistrally, ventral at pharyngeal level. Ovary indented, posttesticular, 0.03 by 0.04. Ootype complex not worked out. Uterus extending posterior to vitellarium.

Vitellarium composed of at least 4 lobes or branches, 0.04 by 0.06, each lobe further lobulated. Excretory system not worked out.

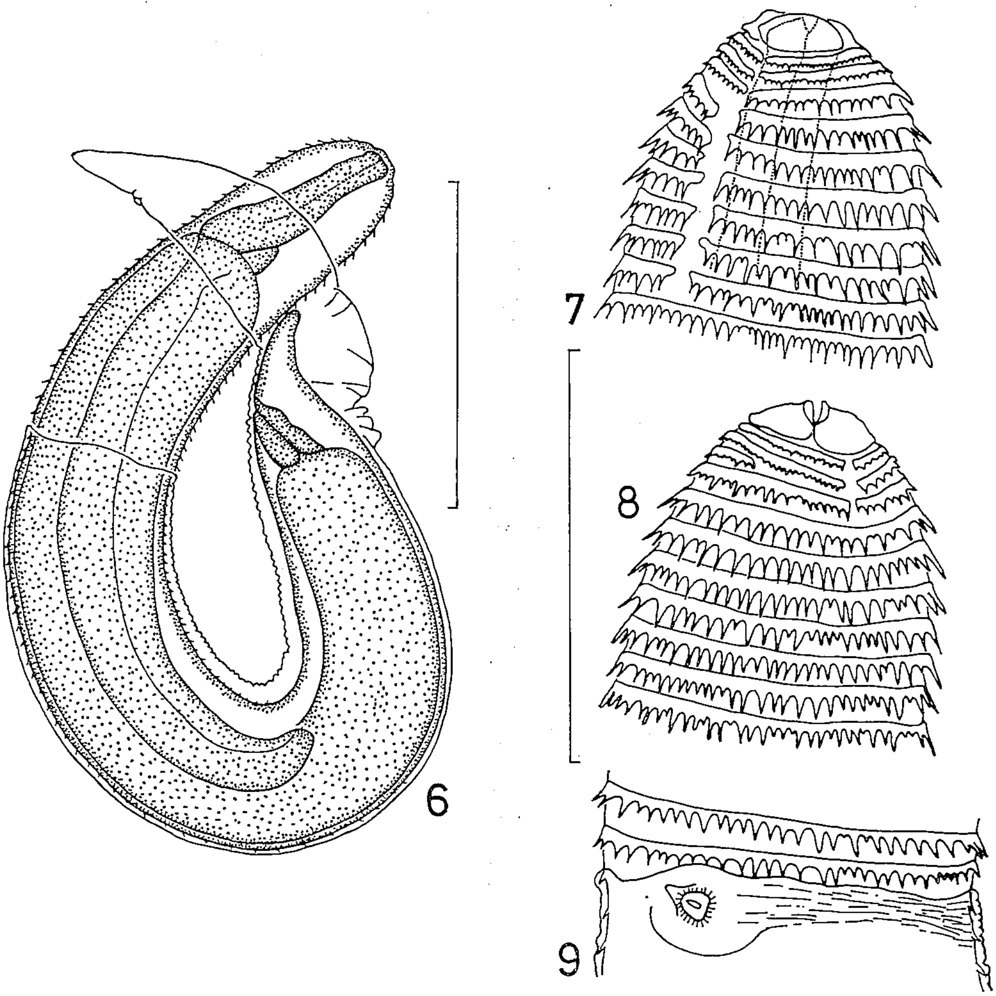
Discussion. This trematode seems to fall within the genera *Derogenes* Lühe, 1900, and *Derogenoides* Nicoll, 1913, in the family Derogenidae Nicoll, 1910, *sensu* Gibson and Bray (1979). These two differ from each other in egg shape (rounded versus pointed at the anopercular pole, respectively). The former is common, but the latter is rare. In the lobed or branched vitellarium, the trematode is similar to *Derogenes latus* Janiszewska, 1953, which parasitizes the intestine of the fish *Mullus barbatus* of the Adriatic Sea (Janiszewska, 1953), but it has a larger seminal vesicle. It remains to be identified. It is uncertain whether chaetognaths acquire infection by parasites by feeding on the second intermediate host, probably copepods, harboring metacercariae or adults as a transport (paratenic) host or swallowing cercariae directly as a second intermediate host or by both. Køie (1979) hypothesized the first route of infection for *D. varicus* (Müller, 1784) Looss, 1901, metacercariae and adults of which have often been recorded from chaetognaths of various species in various waters (Théodoridès, 1989).

Fourth-Stage Larva of *Goezia* sp. (Nematoda: Anisakidae) (Figs. 6–9)

A single specimen (NSMT-As 2117) was found in the trunk coelom of the chaetognath. It was a larva in the middle of the molt: The posterior two-thirds of the body was still left in the cuticle of the preceding larval stage. The shed cuticle was finely transversely striated with a small conical boring tooth by the mouth on its anterior tip and a short bluntly-pointed tail but with no other armatures.

Description. Body stout, 0.81 by 0.10; tail blunt, short, 0.05 long. Cuticular rings denser near anterior end of body, incomplete in anteriormost several but complete in others; posterior spines of each ring unequal in length, becoming smaller and sparser in more posterior parts of body but somewhat larger and denser again around level of rectum. Lips 3, flattened; esophagus claviform, 0.12 long; ventriculus indistinct; ventricular appendage long, possibly bicylindrical, 0.41 long; intestine thick, 0.59 long; intestinal cecum small, 0.02 long; rectum 0.05 long. Nerve ring, excretory organs and genital organs not worked out.

Discussion. This nematode belongs to the genus *Goezia* Zeder, 1800, adults of which parasitize the stomach or intestine of fishes and reptiles in freshwater, estuarine and marine habitats. Adult males, especially their caudal papillae, are necessary to identify most species (Deardorff and Overstreet, 1980). Ecologically and morphologically, the nematode seems to be ralated to *G. gavialidis* Maplestone, 1930. This species was described from a single female specimen found in the stomach of the Indian gavial *Gavialis gangeticus* in the Calcutta Zoological Gardens (Maplestone, 1930). Two other known Indian species, *G. chitali* Zaidi and Khan, 1975 (=*Goezia* sp. of Rai,



Figs. 6-9. A fourth-stage larva of *Goezia* sp. found in *Sagitta bedoti* from West Bengal, India. 6: Entire worm, almost lateral view. 7: Anterior end of body, showing one half side as in Fig. 6. 8: Anterior end of body, showing the other half side. 9: Anterior end of the shed cuticle of the preceding third-stage larva, showing a boring tooth by the mouth. (Scale bars: 0.2 mm in Fig. 6; 0.1 mm in Figs. 7-9.)

1967) (freshwater), and *G. aspinulosa* Arya, 1978 (marine), have no cuticular spines (Zaidi and Khan, 1975; Rai, 1967; Arya, 1978). This larva remains unidentified.

The life cycle of *G. ascaroides* (Goeze, 1782) Railliet and Henry, 1915 (freshwater), was experimentally elucidated by Mozgovoĭ *et al.* (1971). The intermediate host for this nematode is the copepod *Diaptomus castor* in which the nematode develops to an infective third-stage larva; the third-stage larva has a finely transversely striated cuticle devoid of spines, a boring tooth, a ventricular appendage, an intestinal cecum and a genital primordium; the third-stage larva, when ingested into the final host, a catfish, molts twice into the fourth and then the fifth or adult stage of development; and the fourth-stage larva has cuticular spines and three lips but no boring tooth. It seems likely from this and the above description that the present nematode is a fourth-stage larva in the middle of the third molt and that the chaetognath serves as a reservoir host, which acquires infection by the third-stage larva by feeding upon an unknown true intermediate host, most presumably a copepod, harboring it. Deardorff and Overstreet (1980) obtained a larva with cuticular spines of *G. sinamora* Deardorff and Overstreet, 1980, from the fish *Tilapia aurea* and determined it as a third-stage larva. However, it may have been a fourth-stage larva.

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