ON THREE NEW SPECIES OF *COLOBOMATUS* (CYCLOPOIDA : PHILICHTHYIDAE) PARASITIC ON JAPANESE FISHES[1)]

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With Text-figures 1-30

Colobomatus is a copepod genus found parasitic in the cephalic sensory canal system of fish. Showing a pronounced sexual dimorphism, it has an almost immobile female, which keeps itself with curious assortment of processes in the narrow passage, and a mobile, much smaller male retaining much of ordinary copepod features.

Twenty-four species of this genus thus far known are the parasites of marine teleosts except *C. lamnae* which has been recorded from an elasmobranch. In this note, three additional species recently found in Japan are described, respoctively under the names, *C. pupa* n. sp., *C. exilis* n. sp., and *C. fusiformis* n. sp. The record represents the first discovery of the genus from Japanese waters and the second one from the Pacific, in which *C. embiotocae* has been obtained from several Californian species of embiotocids (Noble et al., 1969; Iverson, 1972).

Descriptions

Colobomatus pupa n. sp.

(Figs. 1-17)

Material examined: Twenty-one females and three males including one juvenile were found in the canals of pre- and suborbital bones and of preopercles of two individuals of *Pseudupeneus spilurus* (Bleeker) collected in Tanabe Bay, Wakayama Prefecture, in November, 1971, and in January, 1972. Holotypic female and ten paratypes (8 females, 2 males) will be deposited in the Seto Marine Biological Laboratory; remaining paratypes will be retained in the author's collection.

Female: Almost colorless and transparent when alive; red median eyes buried under hypodermis at the center of head. Length 1.6-3.2 mm (excluding processes and caudal furcae). Body (Figs. 1 & 2) distinct in metamerism, more or less depressed,

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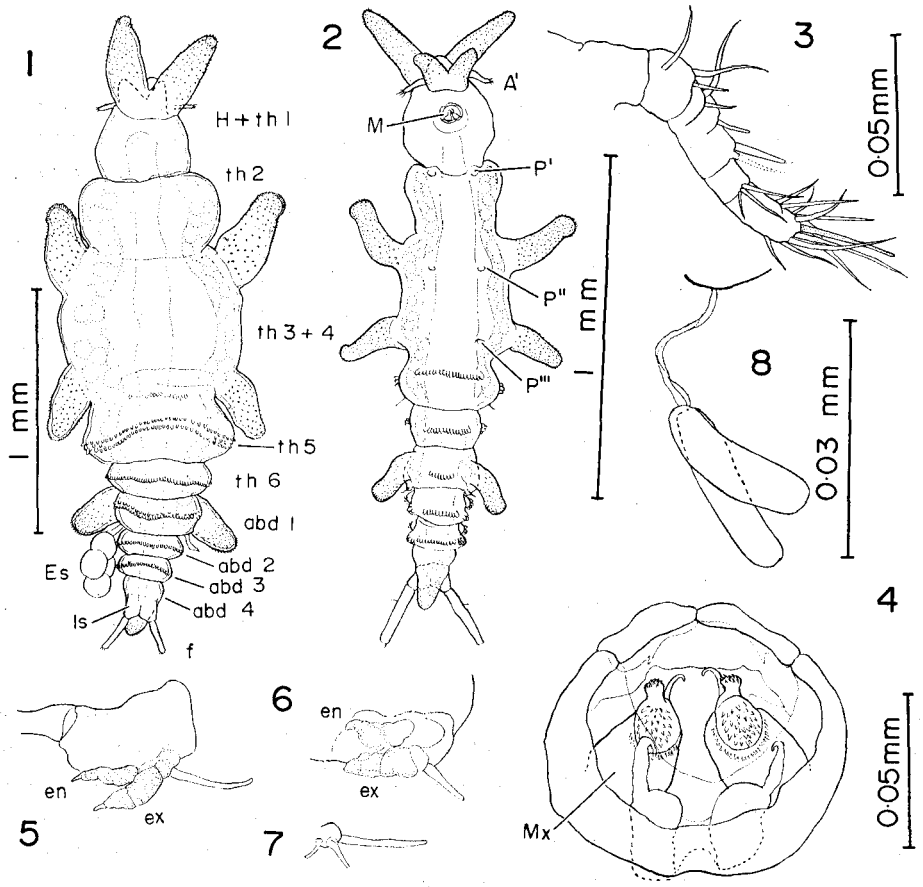
broadening about its middle in larger specimens, though slenderer in smaller ones. Alimentary tract filled with dark brown contents. Egg-filled oviducts lie on either side of body extending from second thoracic to first abdominal segments. Egg sac is made of very thin membrane. Egg ovoid, ca. 0.13 mm across longer axis. Spermatophore (Fig. 8) sausage-shaped, and attached to first abdominal segment with a thin filament.

Head pyriform, provided with two pairs of dorso-ventrally arranged processes at the fore end. Both pairs projecting forwards in the form of a V; ventral pair shorter



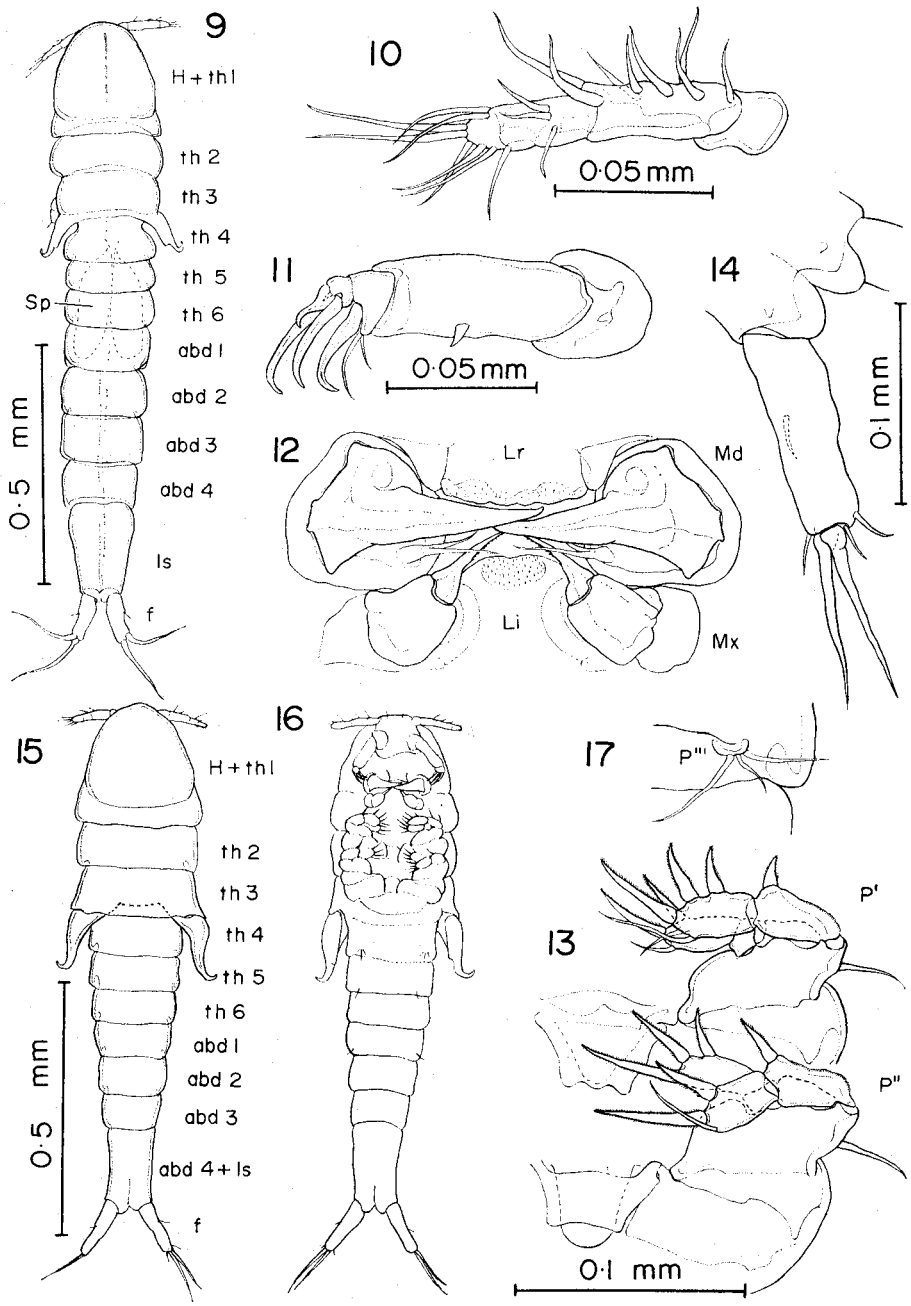
Figs. 1–8. *Colobomatus pupa* n. sp. Female: 1. total view, dorsal. 2. total view of another female, ventral. 3. first antenna, ventral view. 4. oral shield and mouth parts in situ, ventral view. 5–7. first–third legs, ventral view, magnification same as in Fig. 3. Male: 8. spermatophores attached to the female. Abbreviations: A=first antenna, abd=abdominal segment, en=endopodite, f=caudal furca, H=head, Li=labium, Lr=labrum, ls=last segment, M=mouth, Mx=maxilla, P'=first leg, P"=second leg, P'''=third leg, Sp=seminal vesicle, th=thoracic segment.

than a half of dorsal pair. First antennae located just in front of ventral processes, and oral shield at the center of ventral face of head. Second thoracic and succeeding three segments almost entirely fused together issuing two pairs of lateral processes, one from third segment and the other from fourth segment. Each of second to fourth segments with a pair of rudimentary legs. First abdominal segment carrying a pair of lateral processes similar to those on thorax. Fourth abdominal segment elongated posteriorly into a medio-dorsal process, extending a little beyond fifth segment. Last segment distinct from fourth, carrying rod-shaped caudal furcae. All paired processes rather thick, blunt at the tip, and covered with fine tubercles. All the paired ones except ventral cephalic pair, they are subequal and moderate in length. Fifth thoracic and succeeding four segments circumscribed around the middle of each segment by one or two rows of chitinous denticles.

First antenna (Fig. 3) slender, five-segmented, bearing about two dozen of setae. Second antenna unknown. Mouth parts are enclosed within oral shield (Fig. 4), which is a short tube terminally fringed with a membraneous flange. Mandible unknown. Only mouth parts, a pair of conspicuous, two-segmented appendages may probably represent the maxilla. First segment of them broad, with a ring of spinules along the distal border; second segment stout, constricted in the middle, spatulate at the tip, and armed with surface spinules and a narrow, forwardly projecting spine, which seemingly arises from the base of the segment on anterior side. It is uncertain whether paired limb-like structures just behind maxillae may represent true appendages or reinforcement of oral shield. First two legs (Figs. 5 & 6) biramous, composed of protopodite carrying an outer seta and two unsclerotized rudimentary rami. Third leg (Fig. 7) reduced to a tiny tubercle tipped by three setae.

Male: Length 1.2-1.3 mm (excluding caudal furcae). Body (Fig. 9) almost colorless, transparent, slender, only slightly narrowing backward, and consisting of cephalothorax and ten free segments. Cephalothorax distinct, with two pairs of antennae at the fore end and two pairs of oral appendages in the middle. Second and third thoracic segments with legs. Third segment has a pair of backwardly projecting, corneous processes at the postero-lateral angles on dorsal level. Last segment evenly narrowed backward. Caudal furca elongate, slender, and armed with a single seta about the middle of its length and with five terminal setae, of which two are much longer and stouter than others.

First antenna (Fig. 10) slender, indistinctly five-segmented, and setose. Second antenna (Fig. 11) four-segmented; first segment short, with a small process; second segment elongated, with a stout process about the middle; third segment short, with a claw and two setae; fourth segment again shorter and smaller, with a tiny seta and three unequal claws. Labrum and labium relatively small, interposed between the bases of paired oral appendages (Fig. 12). Labrum quadrangular, thickened on the distal margin. Mandible two-segmented; first segment broad, almost entirely fused with body surface, and bearing a tubercle tipped by two setae; second segment transformed into

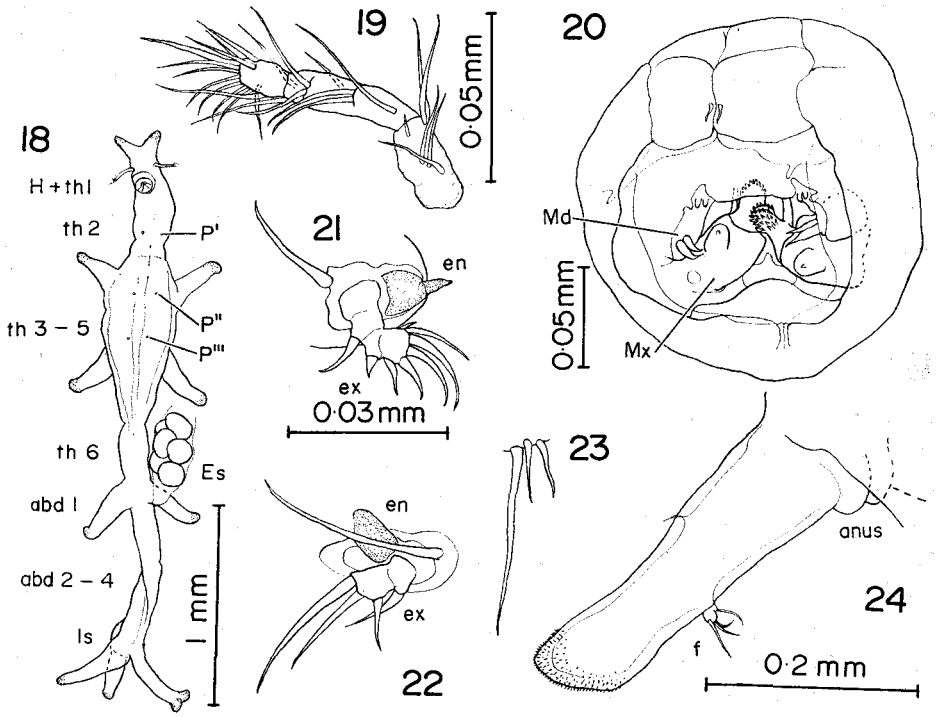


Figs. 9–17. *Colobomatus pupa* n. sp. Male: 9. total view, dorsal. 10. first antenna, ventral view. 11. second antenna, ventral view. 12. mouth parts in situ, ventral view, magnification same as in Fig. 10. 13. first and second legs folded forwards in situ, ventral view. 14. caudal furca, vorsal view. Juvenile male: 15. total view, dorsal. 16. same, ventral, same magnification. 17. third leg in situ, ventral view, magnification same as in Fig. 13.

a powerful claw having a broad base. Maxilla two-segmented ; first segment stout, quadrangular ; second segment lanceolate, and finely pectinated on the inner border. Labium broader distally, spinulated in a small marginal area on the median. First two legs (Fig. 13) biramous, resembling each other in shape and structure. Each leg consists of two-segmented protopodite, which has a seta on the outer side of second segment, and two-segmented rami reinforced by spine and setae. Numbers of spines and setae present on the legs are indicated in the following formula (Roman numeral representing number of spines and Arabic one that of setae) :

	Exopodite		Endopodite	
	lst. seg.	2nd. seg.	lst. seg.	2nd. seg.
First leg	I + 0	III + 2	0 + 0	II + 1
Second leg	I + 0	II + 1	0 + 0	III + 0

Third leg rudimentary, represented by one or two setae present on fourth thoracic segment on the ventral side near each postero-lateral angle.



Figs. 18–24. *Colobomatus exilis* n. sp., female. 18. total view, ventral. 19. first antenna, ventral view. 20. oral shield and mouth parts in situ, ventral view. 21. first leg, ventral view. 22. second leg, ventral view, magnification same as in Fig. 21. 23. third leg, ventral view, magnification same as in Fig. 21. 24. caudal furca, ventral view.

Juvenile male: Length 1.0 mm (excluding caudal furcae). Body (Figs. 15 & 16) almost similar to that of adult, differing only in having nine free segments instead of ten.

Colobomatus exilis n. sp.

(Figs. 18–24)

Material examined: Five females were discovered in the canals of pre- and suborbital bones and of preopercles of *Caprodon schlegeli* (Günther) taken in Tanabe Bay, Wakayama Pref., in January, 1972. Holotypic female and four paratypic females will be deposited in the Seto Marine Biological Laboratory.

Female: Length 2.1–3.2 mm (excluding processes). Almost colorless and transparent when alive, setting aside the dark brown contents of alimentary canal. Body (Fig. 18) much slender, with segmental borders obliterated in any region.

Head elongate, produced in front into a pair of short processes, and with first antennae and oral shield on the ventral face a little behind. Second thoracic segment as wide as head, and carrying rudimentary first legs on the ventral side. Succeeding three segments swollen into a fusiform region and provided with two pairs of lateral processes and two pairs of rudimentary legs. Remaining segments slightly narrower than head, occupying about a half of entire length, and furnished with two pairs of lateral processes, one on first abdominal segment, and the other on last segment. An unpaired ventral process present on penultimate segment. All the paired processes simple, whereas the unpaired one bifurcate. They are covered with spinules at their blunt tips, and except the cephalic pair, moderate in length and subequal to one another.

First antenna (Fig. 19) slender, three-segmented, armed with about two dozen of setae. Second antenna absent. Oral shield (Fig. 20) as in the previous species. Mandible carries two setae, though its whole structure is indefinable. Maxilla two-segmented; first segment broad, with a tubercle on posterior side; second segment terminating in a spinulated round end and with an anteriorly directed basal spine. First two legs (Figs. 21 & 22) biramous. Protopodite of both legs almost entirely fused with sternal surface, and bearing an outer seta. Exopodite indistinctly two-segmented; that of first leg bearing a seta on first segment and seven on the second, whereas that of second leg carrying one on first segment and three on the second. Endopodite reduced into an unsclerotized fleshy knob in both legs. Third leg (Fig. 23) represented by an inconspicuous sternal swelling tipped by three setae. Caudal furca (Fig. 24) small, attached to last process midway on its posterior border, and carrying four setae.

Male: Unknown.

Colobomatus fusiformis n. sp.

(Figs. 25-30)

Material examined: Six females were found in the canals of pre- and suborbital bones and of preopercles of *Heniochus monoceros* Cuvier et Valenciennes, which had been kept in the aquarium of Seto Marine Biological Laboratory till it died in January, 1972. The host fish had originally come from Okinawa. Holotypic female and five paratypic females will be deposited in the Seto Marine Biological Laboratory.

Female: Length 2.0-2.8 mm. Colorless and transparent when alive, except for dark brown color of alimentary canal. Body (Fig. 25) relatively slender, slightly depressed in the middle portion which is fusiform. Segmentation indicated merely by shallow, lateral notches.

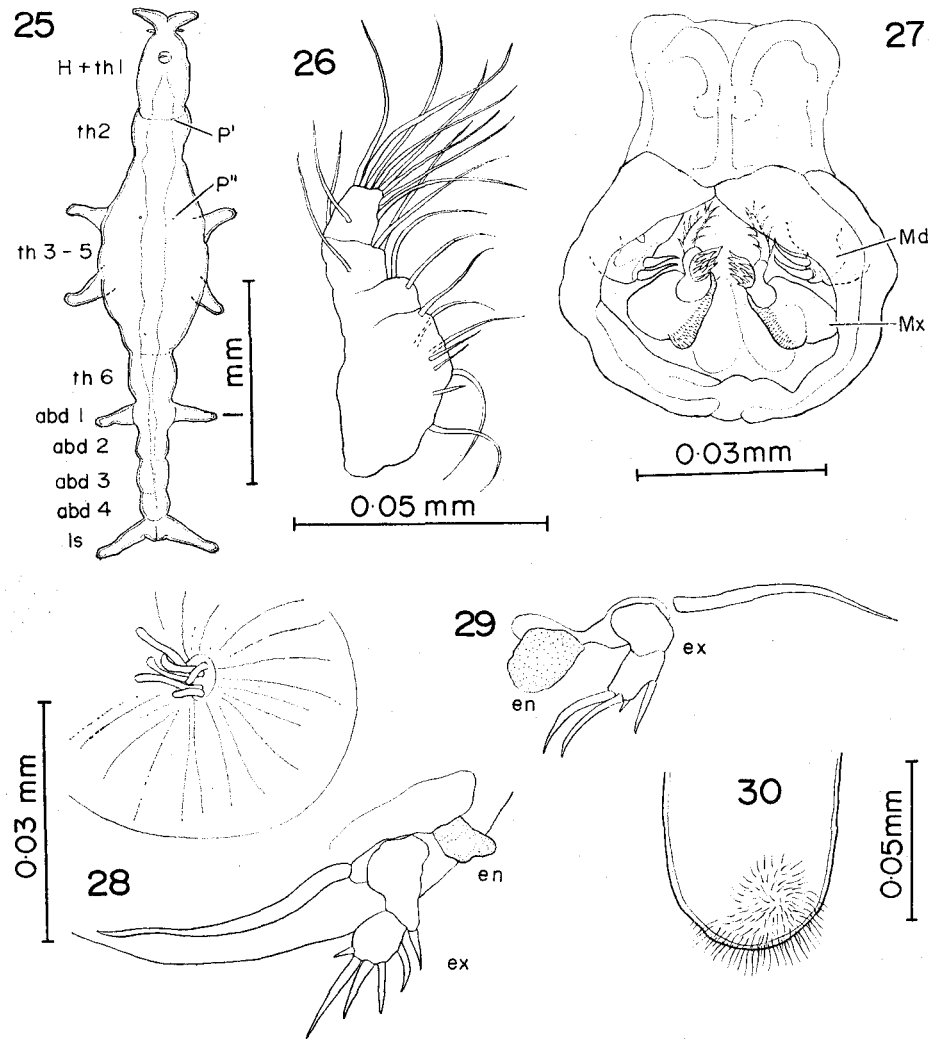
Head oblong oval, with a pair of anterior processes. First antennae located just behind and ventrally to these processes. Oral shield at anterior one third of head. Second thoracic segment round on sides, about half as long as and slightly wider than head, and carrying rudimentary first legs near the fore end. Succeeding three thoracic segments fused into a fusiform portion, produced laterally into two pairs of processes, and bearing a pair of rudimentary legs. The remainder of body as long as the fusiform portion, as wide as head at the anterior end, gradually diminishing in width posteriorly. A pair of lateral processes present on first and last abdominal segments respectively. All the lateral processes simple, moderate in length and subequal except somewhat shorter cephalic ones. Their tips blunt and covered with spinules. No unpaired process.

First antenna (Fig. 26) indistinctly two-segmented, broader basally, narrower apically, and with about two dozen of setae. Second antenna absent. Oral shield and mouth parts (Fig. 27) more or less as in the previous species. Mandible provided with two setae, though its whole structure is indefinable. Maxilla two-segmented; first segment broad, covered with spinules on the inner surface, second segment with an anteriorly directed, doubly serrated process and an ovoid, disc-like, spinulated process. Two pairs of legs (Figs. 28 & 29) biramous. Protopodite almost entirely fused with body surface in both pairs, and carrying a long, thick outer terminal spine. Endopodite reduced into an unscrelotized fleshy mass in both pairs. In first leg, exopodite has a spine on first segment and five on the second whereas in second leg it has four only on second segment. First leg accompanies a sensory pad just in front of its base.

Remarks

The three species of *Colobomatus* described above are distinguishable from one another and also from all the known species of the genus, except *C. richiardii* (Valle), 1880, by the character of the female. *C. richardii* which was based on a single female

found in a preopercular canal of *Box salpa* Cuv. from the Adriatic has never been rediscovered. Although it is regrettable that the original description of this species is inaccessible to the author, neither adequate diagnosis nor illustration seems to have been given by Valle, according to Delamare-Deboutteville (1962). Considering from the remoteness of localities and the difference in host species, it seems improbable that



Figs. 25–30. *Colobomatus fusiformis* n. sp., female. 25. total view, ventral. 26. first antenna, ventral view. 27. oral shield and mouth parts in situ, ventral view. 28. first leg and sensory pad in situ, ventral view. 29. second leg, ventral view, magnification same as in Fig. 28. 30. tip of last process, ventral view.

any of the Japanese species may be synonymous with *richiardii*.

Noble et al. (1969) found three pairs of mouth parts (mandible and two maxillae) in both the sexes of *C. embiotocae*. In the species here dealt with, the second maxilla has not been discovered.

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