TWO NEW SPECIES OF *COLOBOMATUS* (COPEPODA, PHYLICHTHYIDAE) PARASITIC ON COASTAL FISHES IN CHILEAN WATERS

BY

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ABSTRACT

The authors describe two new species of *Colobomatus* Hesse, 1873. The first, *Colobomatus tenuis* n. sp. is parasitic on *Scartichthys viridis* in waters off Antofagasta and Valparaíso and on *Scartichthys gigas* and *Auchenionchus variolosus* from Antofagasta. *C. tenuis* lives in the preopercular canals of its fish host. This new species has three simple cephalic processes, a characteristic shared with only three of its congeners (*C. mylionus*, *C. sewelli*, and *C. sciaenae*). However, *C. tenuis* can be differentiated from these other species by the shape of the head and of the trunk processes, especially the bifid thoracic posterior processes that are simple in the other species. The male can be easily differentiated from all species of the genus based on the shape and size of the uropods, which in the other species are longer than the last abdominal somite.

Some females were observed with a pair of egg masses attached to the genital pore and another pair free in the preopercular canal with nauplii inside, implying that the oldest egg masses are released before the nauplii hatch from the eggs.

The second new species, *Colobomatus miniprocessus* n. sp., inhabits the mandibular canals of *Anisotremus scapularis*. *C. miniprocessus* is characterized by a combination of characters, such as the abdominal processes that are large and blunt, the reduced bifid cephalic process, and the length of the thoracic anterior processes, all of which differentiate it from its closest congener, *Colobomatus quadrifarius*, which has been reported off the coast of Perú on the same host. The present report raises the known number of species of *Colobomatus* to 63.

RESUMEN

Se describen dos nuevas species de *Colobomatus* Hesse, 1873. La primera *Colobomatus tenuis* n. sp. parasita a *Scartichthys viridis* en aguas de Antofagasta y Valparaíso, y a *Scartichthys gigas* y *Auchenionchus variolosus* en Antofagasta. *C. tenuis* vive en los canales preoperculares de su pez hospedador. Esta nueva especie tiene tres procesos cefálicos simples, una característica compartida sólo con tres de sus congéneres (*C. mylionus*, *C. sewelli*, and *C. sciaenae*); sin embargo *C. tenuis* se

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diferencia de éstas tres, especialmente por cuanto sus procesos torácicos posteriores son bífidos, los cuales son simples en las otras tres especie. El macho puede ser fácilmente diferenciado de todas las especies del género basándose en la forma y talla de los urópodos, los cuales en las otras especies son más largos que el último segmento abdominal.

Algunas hembras fueron observadas con un par de masas de huevos adheridas al poro genital y otro par suelto en el canal preopercular, con nauplius en su interior. Esto implica que las masas de huevos más antiguas son liberadas antes de que los nauplius eclosionen.

La segunda especie *Colobomatus miniprocessus* n. sp. habita los canales mandibulares de *Anisotremus scapularis*. *C. miniprocessus* se caracteriza por una combinación de caracteres, tales como los procesos abdominales que son grandes y romos, los procesos cefálicos reducidos, y la longitud de los procesos torácicos anteriores, lo anterior la diferencia de su más cercano congénere *Colobomatus quadrifarius*, el cual ha sido reportado desde la costa de Perú, parasitando el mismo hospedador. El presente reporte eleva el número de especies de *Colobomatus* a 63.

INTRODUCTION

The family Philichthyidae Vogt, 1877 (Copepoda, Poecilostomatoida) comprises copepods that live in the pores of the lateral lines and mucous canals of the mandibular and/or preopercular bones and cephalic canal system of their fish hosts. At these sites in the host, larval copepods penetrate their host, and females remain at the site of penetration for the rest of their lives. Males can probably enter the site or go out when necessary, and are rarely found in the canal with the female. While in the host, the female undergoes a metamorphosis, characterized by the development of processes on some of the body segments and a shrinkage of appendages, the thoracic legs in particular becoming diminutive. In some specimens, the buccal area develops the general appearance of the Philichtyidae, i.e., an open buccal area (with buccal appendages exposed), whereas in other specimens the buccal area appears more like a siphon, enclosing the mouthparts. Philichthyidae include nine genera (Boxshall & Montú, 1997; Boxshall & Halsey, 2004), namely *Philichthys* Steenstrup, 1862; *Leposphilus* Hesse, 1866; *Sarcotaces* Olsson, 1872; *Colobomatus* Hesse, 1873; *Sphaerifer* Richiardi, 1876; *Lernaeascus* Claus, 1886; *Ichthyotaces* Shiino, 1932; *Colobomatoides* Essafi & Raibaut, 1980; and *Procolobomatus* Castro Romero & Baeza-Kuroki, 1994.

Species of *Colobomatus* live in the mucous canals of the mandibular and preopercular areas or in the cephalic canal system adjacent to the nasal cavity of host fishes. To survive in those microhabitats, the copepod has a highly adapted body morphology, usually with cephalic processes that are variable in size and number, a trunk with processes (simple or bifid), genital processes, abdominal processes, and elongated uropods. The buccal area appears as a siphon-like structure (labrum plus labium) that, in all species of this genus, encloses the buccal appendages (i.e., mandible, maxillule, maxilla, and maxilliped, although some species lack some of these appendages). The buccal area is covered anteriorly by the second antenna.

For the thoracic appendages, the first two pairs are biramous, and the third pair is uniramous and diminutive.

Colobomatus comprised 61 species to date. These species have a narrow host specificity according to Grabda & Linkowski (1978), but Hayward (1996) reported that many or most of the species are specific to host families or genera rather than to single host species: e.g., two species of *Colobomatus* utilize three genera of host fish (*C. quadrifarius* Cressey & Schotte, 1983 is found on *Anisotremus* Gill, 1861, *Haemulon* Cuvier, 1829, and *Orthopristis* Girard, 1858, whereas *C. deltotus* West, 1985 is found on *Mugil* Linnaeus, 1758, *Liza* Jordan & Swain, 1884, and *Myxus* Günther, 1861).

Three species of Phylichthyidae have been reported in the South Pacific region: *Colobomatus quadrifarius* is parasitic on *Anisotremus scapularis* Tschudi, 1846, from Peruvian waters (Luque & Farfán, 1990), *Procolobomatus hemilutjani* Castro, 1994 is parasitic on *Hemilutjanus macrophthalmus* (Tschudi, 1846), and *Sarcotaces* sp. is parasitic on *Antimora rostrata* (Günther, 1878) (R. Castro, unpubl. data); the latter two fishes live in Chilean waters.

After examining the preopercular mucous canals of *Scartichthys viridis* (Valenciennes, 1836) from the north and central coasts of Chile, as well as of *Scartichthys gigas* (Steindachner, 1876) and *Auchenionchus variolosus* (Valenciennes, 1836) from northern Chilean waters, and also the mandibular canals of *Anisotremus scapularis* (Tschudi, 1846) from northern Chile, we identified two new species of *Colobomatus*, which we describe herein.

MATERIAL AND METHODS

Fish were examined to detect the presence of parasitic copepods in the preopercular and mandibular canals: *Scartichthys viridis*, collected from El Tabo, Valparaíso, Chile (33°27′S), *Scartichthys gigas* and *Auchenionchus variolosus* from Antofagasta (23°39′S), and *Anisotremus scapularis*, also from Antofagasta. To collect the parasites from their fish hosts, the skin and musculature of freshly caught fish had to be removed to access the bones. This allowed us to observe the parasites inside the canals using transmitted light under a dissecting microscope. Some copepods were fixed in 70% ethanol, whereas others were fixed in 2.5% glutaraldehyde for later observation under a scanning electron microscope (SEM). The copepods prepared for SEM were dehydrated, coated with gold-palladium, and observed by SEM at an acceleration voltage of 12 kV (Castro & Baeza, 1989).

Some copepod specimens were treated with lactic acid to clear parts of the body, enabling us to observe details of the appendages. Drawings of the antennule and buccal appendages were made with the aid of a camera lucida. The specimens were measured with the aid of reticulated eye piece. The terminology for the buccal appendages follows that of West (1992).

RESULTS

Colobomatus tenuis n. sp. (figs. 1-16)

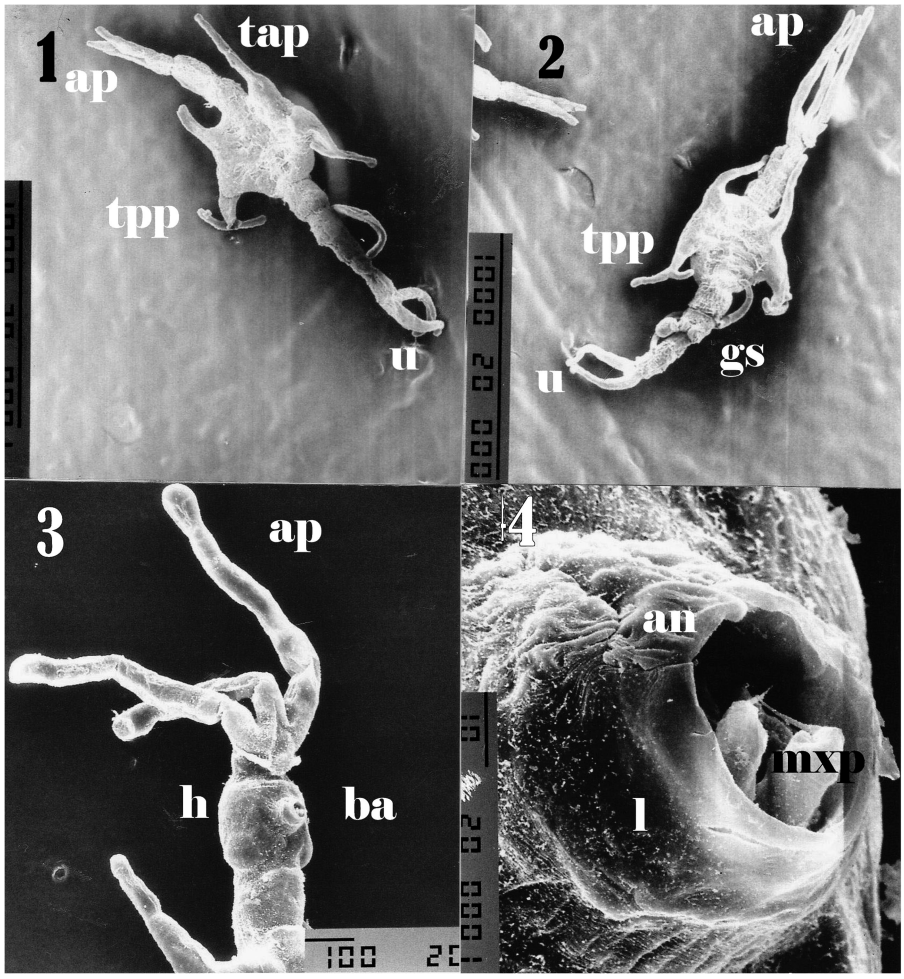
Material examined. — From Valparaíso we collected 17 specimens parasitic on *Scartichthys viridis*; from Antofagasta we examined 40 specimens from *S. viridis*, 5 specimens from *Scartichthys gigas*, and 2 specimens from *Auchenionchus variolosus*. Type material: specimens were deposited in the Museo Nacional de Historia Natural, Chile (MNHNCL), with holotype number MNHNCL: CP-N° 15104, and paratypes (5 spms.) number MNHNCL CP-N° 15105. The specimens were living in the mucous canals of the preopercular bones. The prevalence of parasite infestation of *S. viridis* was 65% for Valparaíso specimens, and 100% for Antofagasta specimens. Measurements: total length (including uropods) based on 21 specimens was 3720 μm (range 5717-2564 μm). Mean egg mass, 32 eggs (range 20-45) (n = 5). Mean egg dimensions, 105 μm (91-112 μm) by 87 μm (71-102 μm).

Description. — Female (figs. 1-2), head with three anterior processes (figs. 1-4), one on each side and one central (69% of the length of the lateral ones). Antennules located at the base of these processes. Antennules apparently with four-segmented (figs. 3, 4, 7) basal parts with three setae, two subdistal setae, and at the other margin three setae, distally armed with six setae. Antennae displaced and cover the siphon-like buccal area.

Cephalosome (head and first thoracic somite) elongated with approximately parallel sides. Second thoracic somite a little shorter than the cephalosome. The third, fourth, and fifth thoracic somites are fused together and have a subquadrangular shape, bearing a pair of processes on the anterior margin and a pair at the posterior margin; the anterior processes are more slender than the posterior ones. The posterior processes are bifurcate distally. The sixth thoracic somite is approximately subrectangular and short. Thoracic somite VII, the genital somite (fig. 6), is subquadrangular and shorter than the previous somite, and it has a pair of processes arising from its anterior margin, while the paired genital orifices are at the distal end (fig. 6), dorsally. These genital processes are short, not reaching the end of the last abdominal somite. The second and fourth abdominal somites are of subequal length (the fourth bears a pair of uropods) and are slightly longer than half the length of the abdomen.

The buccal area, which forms a tube-like structure (figs. 3, 4, 5), is covered anteriorly by the second antennae (figs. 4, 5), and the labium covers it posteriorly; this last structure is of a simple type. Inside the tube there is a pair of one-segmented maxillules, bearing a short spine (fig. 8), and maxillae (larger) (fig. 8) with spines and a spiniform process. The maxillipeds (figs. 5, 8) have a basal segment and one distal spine. Also apparent is a process between the bases of the maxillipeds, close to the labium.

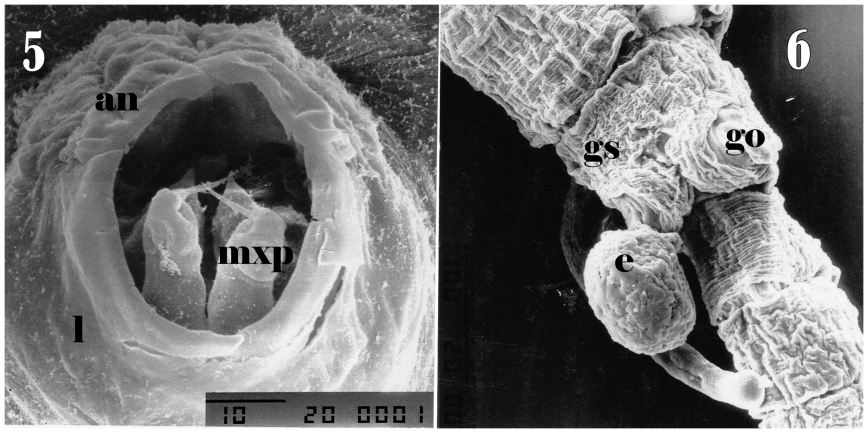
Legs: none detected.



Figs. 1-4. *Colobomatus tenuis* n. sp., female. 1, whole body, ventral view; 2, ditto, another specimen; 3, ditto, anterior part of the body with cephalic processes, antennule, and buccal area; 4, buccal area, lateral view (an, antenna; ap, anterior process; ba, buccal area; gs, genital somite; h, head; l, labium; mxp, maxilliped; tap, thoracic anterior process; tpp, thoracic posterior process; u, uropod). Scales: 1, 2 = 1000 μm; 3 = 100 μm; 4 = 10 μm.

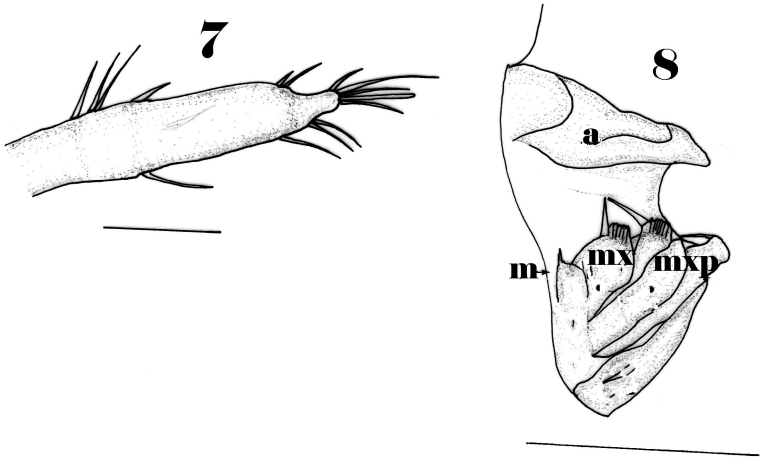
Some females were observed with the egg mass attached to the genital orifice, whereas another pair of egg masses remains free in the canal even if the nauplius stays in the egg case. Each mass contains from 33 to 64 nauplii (n = 15 specimens observed). The nauplius size range was from 154 to 172 μm (13 nauplii measured).

Male. Total length, 1153 μm and 1011 μm (two specimens measured) (not considering the distal setae of the uropods). Body (fig. 9) comprised of 11 somites, the cephalic somites plus the thoracic somites I, II, III, IV, V, VI (genital somite), and the abdomen with 4 somites. The cephalosome widens posteriorly. The third

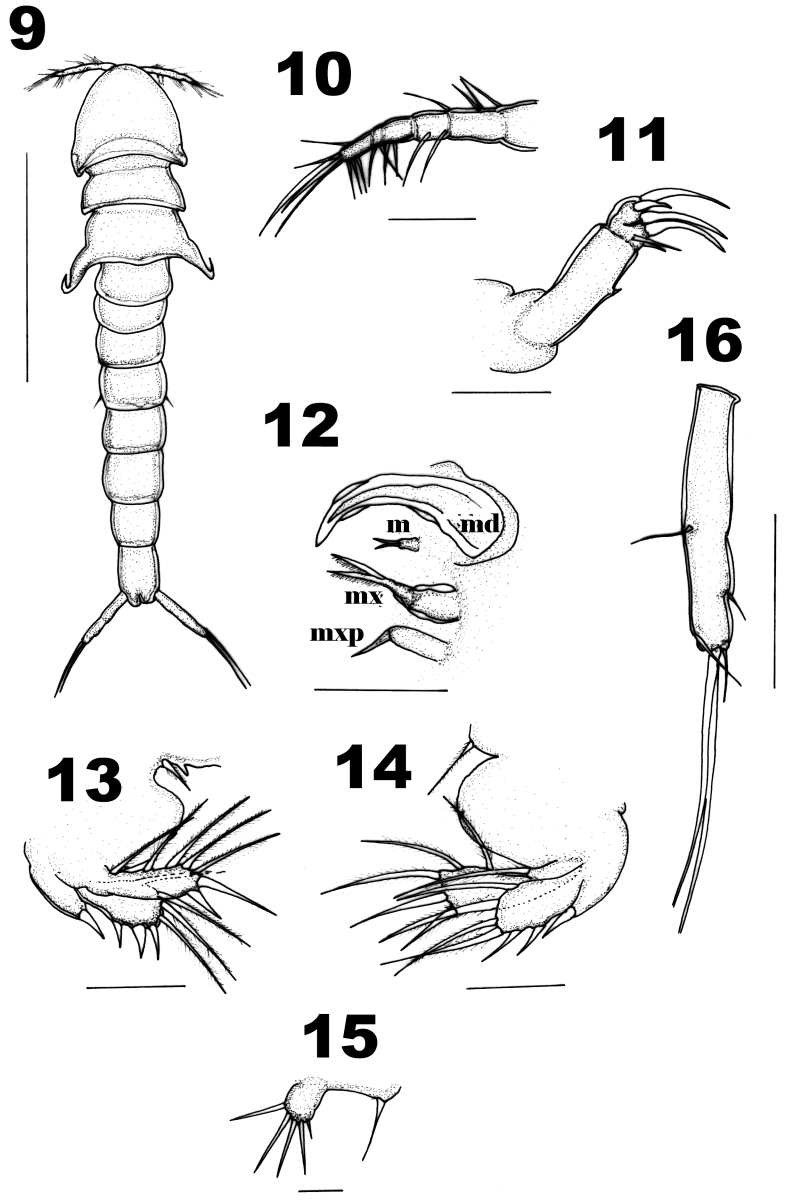


Figs. 5-6. *Colobomatus tenuis* n. sp., female. 5, buccal area in frontal view, showing the antenna and inner portion of the buccal cone (an, antenna; mxp, maxilliped; lb, labium); 6, genital somite, abdominal somites, showing the genital orifice, and one attached egg (go, genital orifice; gs, genital somite; e, egg). Scales: 5 = 10 μm; 6 = 100 μm.

thoracic somite has a dorsal spiniform process and is curved distally, longer than the second free somite. Thoracic somites II, III, and IV bear the first (fig. 13), second (fig. 14), and third (fig. 15) pairs of legs. The first and second legs are biramous, and the third leg is uniramous. The last abdominal somite is shorter than the uropods. The uropods are slender and approximately cylindrical (fig. 16), armed distally with two long setae, two other short setae at the base, and two other setae that are more subdistal and medial.



Figs. 7-8. *Colobomatus tenuis* n. sp., female. 7, antennule; 8, position of buccal appendages, lateral view (by transparency) from right side (a, antenna; l, labium; m, maxillule; mx, maxilla; mxp, maxilliped). Scales: 7, 8 = 50 μm.



Figs. 9-16. *Colobomatus tenuis* n. sp., male. 9, entire, dorsal view; 10, antennules; 11, antenna; 12, buccal appendages (md, mandible; m, maxillule; mx, maxilla; mp, maxilliped); 13, first leg; 14, second leg; 15, third leg; 16, uropod. Scales: 10 = 500 μm; 11 = 50 μm; 12 = 100 μm; 13, 14 = 50 μm; 15 = 25 μm; 16 = 100 μm.

The antennule (fig. 10) apparently has six segments, with the armature of setae as follows: 3, 3, 3, 1, 8. Antenna (fig. 11) with four segments, its armature comprises one spine medially on the second segment, and the third segment armed with a strong spine and two short, simple setae. The distal segment is equipped with two strong, long spines and a short spine. The mandible (fig. 12) has a slightly curved claw. The maxillule (fig. 12) is a very small segment equipped with two short setae. The maxilla (fig. 12) has two segments, with the strong basal segment being longer than the second. The second segment is armed distally with two long, plumose setae. The maxilliped (fig. 13) has one segment that is armed distally with a spiniform process. Three pairs of legs were detected, all biramous (figs. 13, 14, 15) with Arabic numerals indicating setae, and Roman numerals denoting spines:

	Exopod		Endopod	
	First segm.	Second segm.	First segm.	Second segm.
First pair	I	I, I, I, 4	1	5, I
Second pair	I	I, I, 4	1	I, 4
Third pair	5	–	1	–

Etymology. — The specific name *tenuis* refers to the slender body of the female specimens. It is an adjective agreeing in gender with the (masculine) generic name.

Remarks. — *Colobomatus tenuis* n. sp., parasitic on *Scartichthys* spp. (*S. gigas* and *S. viridis*) and *Auchenionchus variolosus*, is morphologically quite similar to its congeners (*Colobomatus mylionus* Fukui, 1965, *Colobomatus sewelli* West, 1992, and *Colobomatus sciaenae* (Richiardi, 1876)), sharing the presence of three cephalic processes (lobes) among the 61 species currently belonging to the genus *Colobomatus*. Most *Colobomatus* species have only two processes at that position, and in some species the processes are smaller than in other species.

Colobomatus tenuis n. sp. differs from *C. mylionus* in shape and length of the head, with approximately parallel sides, versus the nearly rounded head of *C. mylionus*. Also, these species differ in the fourth and fifth thoracic somite, with regard to shape and processes, especially the thoracic posterior processes, with a short bifurcation distally in *C. tenuis* but simple in *C. mylionus*. Other differences can be found in the processes on the seventh thoracic somite, which is longer in *C. mylionus*, although the uropods are longer in *C. tenuis* n. sp.

Colobomatus tenuis n. sp. can be easily distinguished from *C. sewelli* by the short abdomen, the short central anterior process, the length of the processes on the seventh thoracic somite, and the length of the uropods. The cephalic somite and length and shape of the free third thoracic somite also differ between the two species.

The new species differs from *C. sciaenae* by the well-known segmentation on the anterior part (first, second, and third thoracic somites). The shape of the

fourth and fifth thoracic somites differs between these species, i.e., nearly circular in *C. sciaenae* and subquadrangular in *Colobomatus tenuis* n. sp. The posterior processes on the fifth thoracic somite are bifid in *C. sciaenae*, while in contrast there is a short bifurcation in *C. tenuis*. Moreover, the abdomen of *C. sciaenae* is shorter than that of *C. tenuis*.

Colobomatus steenstrupi (Richiardi, 1876) and *Colobomatus mulli* Essafi, Raibaut & Boudaoud-Krissat, 1983 have three anterior processes, but both species differ from *Colobomatus tenuis* n. sp. in the antero-lateral processes, which are short and forked at the tip in the former two species. This same character was observed on the thoracic processes of *C. steenstrupi* and *C. mulli*, which are simple processes in the new species. All other species in the genus can be distinguished from *C. tenuis* by the absence of processes on the head or by the presence of only two processes.

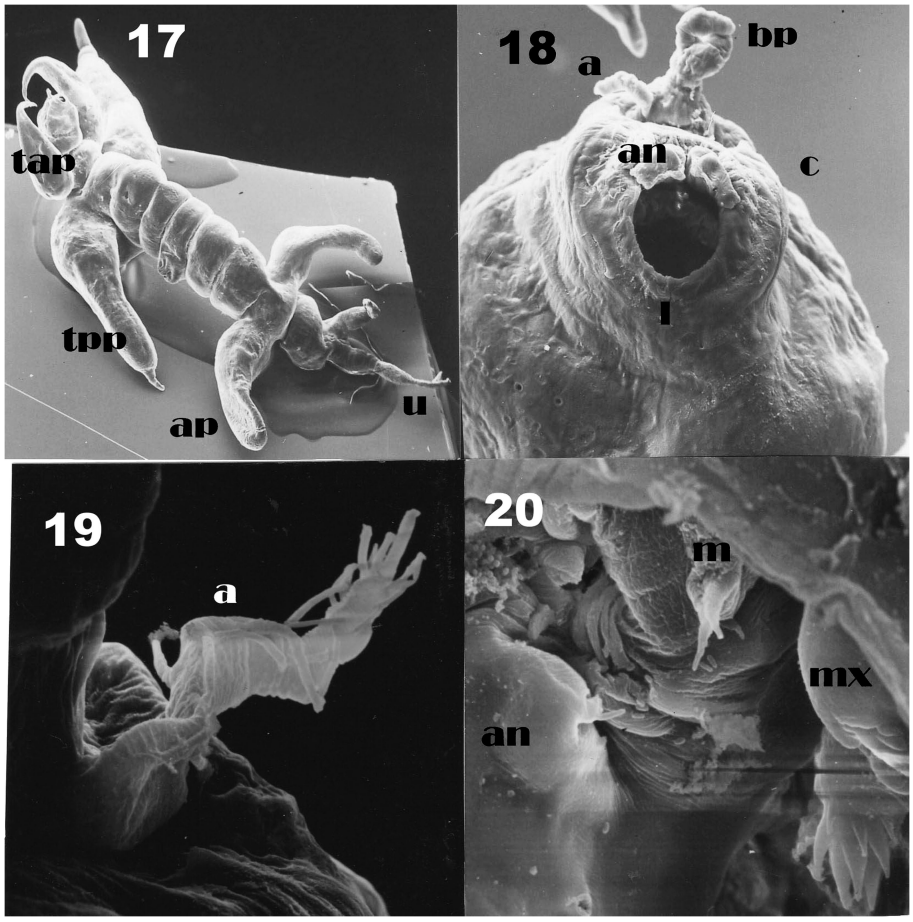
We propose a new taxon to accommodate the *Colobomatus* specimens we describe here, with the specific name *Colobomatus tenuis*, to make reference to the the slender body of the female. The male specimens examined (one collected from *Auchenionchus variolosus*, one from *Scartichthys gigas*) differ greatly from all the known males of other *Colobomatus* species. The principal difference is in the shape and size of the uropods, being slender and cylindrical in *C. tenuis* n. sp. Also, *C. tenuis* n. sp. has uropods longer than the last abdominal somite compared with all other males of *Colobomatus* spp. The shape of the *C. tenuis* n. sp. cephalic somite also differs from that of all other *Colobomatus* males. The third leg is smaller and differs from all the other species by the presence of four long setae and one short, fine seta. Males of *Colobomatus mackayi* West, 1992 are morphologically similar to *C. tenuis* n. sp. in uropod size and armature, but there are slight differences in uropod shape and margin constriction in *C. tenuis* n. sp. These differences confirm that the copepod here described is a new species.

The *C. tenuis* n. sp. female produces about 33-64 eggs per egg mass. No information exists in the literature on the reproductive aspects of *Colobomatus* or other Philichthyidae, especially with regard to the number of eggs per egg mass produced by the female and to the mechanisms by which these are delivered. Several females of *Colobomatus tenuis* n. sp. had a pair of egg masses attached to the genital pore, whereas the other pair stayed in the mucous canal. Each egg-enclosed nauplius was about ready to hatch, demonstrated by the fact that some nauplii started to hatch immediately after the egg masses were transferred to a Petri dish containing sea water. Generally, copepods (both free-living and parasites) produce egg sacs and carry their brood attached to the genital opening until the offspring hatch (Holger, 2004), i.e., to protect them. In this case, the egg masses obviously detach prior to nauplius hatching; it is possible, however, that the eggs, like here, usually stay inside the mucous canal, where they are protected from the outside environment.

Colobomatus miniprocessus n. sp. (figs. 17-26)

Material examined. — Eighteen specimens were obtained from *Anisotremus scapularis* off Antofagasta, collected from the mandibular canals. Specimens were deposited in MNHNCL; holotype female number MNHNCL CP N° 15106, and paratype females (00 spms.) number MNHNCl CP N° 15107. Measurements (based on 10 specimens): total length 4779 μm (range 4238-7974 μm), including the uropods. Egg mass of 75 eggs (we counted only one mass).

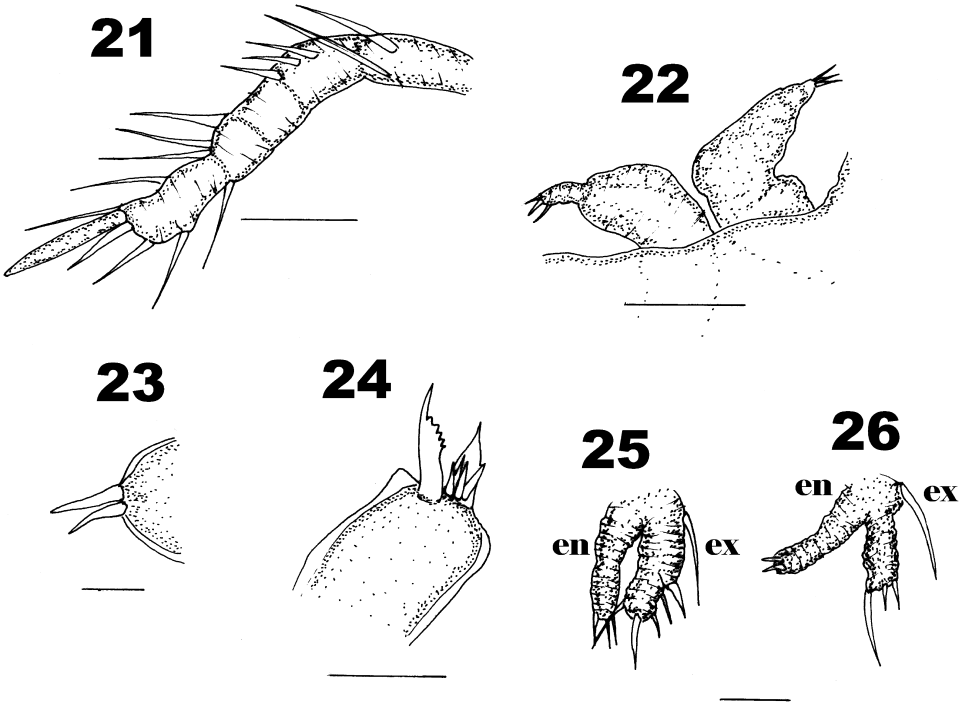
Description. — Female (fig. 17) with cephalosome (head plus the first thoracic somite) bearing on its anterior margin a reduced, bifid process only 60 μm in length, with at its base the first pair of antennae. The process (fig. 17) is a little



Figs. 17-20. *Colobomatus miniprocessus* n. sp., female (SEM). 17, entire latero-ventral view (ap, abdominal process; tap, trunk anterior process; tpp, trunk posterior process; u, uropod); 18, cephalosome, anterior disto-ventral part, showing the buccal area, antennule, and bifid process (a, antennule; an, antenna; c, buccal area-like siphon); 19, detail of antennule; 20, buccal area, inner view (m, maxillule; mx, maxilla; a, antenna inferior view). Magnifications: 17 = 13×; 18 = 160×; 19 = 640×; 20 = 1600×.

longer than the antennule. The second thoracic somite, bearing the second pair of legs and producing a pair of anterior processes, reaches beyond the cephalosome area (about twice the length of the head). The third and fourth thoracic somites are partially fused; ventrally, the boundary of the original somites can be seen (fig. 17). These somites are armed with a pair of processes, very long and wide, the left acute, the right blunt. The processes are longer on one side, but, apparently indifferently, either those on the left or the right side can be the longest. The fifth, sixth, and seventh thoracic somites are free. The seventh thoracic somite (genital somite) has genital pores located dorsally. The abdomen comprises four somites of near-equivalent length and width. The third abdominal somite bears a pair of processes that are wide and of uniform diameter along their length, and are blunt distally. The fourth abdominal somite is rounded, bearing a pair of terminal uropods that are long and acute distally. Some females have an egg mass attached to the genital pore.

Appendages. Each antennule (figs. 8, 19, 21) apparently has five segments, armed with 3, 4, 4, 2, and 3 elements, plus one aesthete element, respectively, on each segment. The antennae (figs. 18, 20, 22) are displaced posteriorly and cover



Figs. 21-26. *Colobomatus miniprocessus* n. sp., female. 21, antennule; 22, antenna; 23, maxillule; 24, maxilla; 25, first leg (en, endopod; ex, exopod); 26, second leg (en, endopod; ex, exopod). Scales: 21 = 15 μm; 22 = 50 μm; 23 = 10 μm; 24 = 25 μm; 25 and 26 = 100 μm.

the siphon-like structure; they are wide, very close to each other, apparently have two segments, and are distally armed with three elements.

The buccal area is siphon-like (figs. 8, 20) and quite large. The rim of the labrum, apparently simple and narrow, is covered by the antenna. The maxillule (fig. 23) has only one segment, armed with two setae distally. The maxilla (figs. 20, 24) has one segment, almost subquadrate, armed with one spiniform process beset with several short spines, and laterally there is a spiniform process with spinules on its inner margin. Neither a mandible nor a maxilliped were detected.

Two pairs of thoracic legs are present, but a third pair was not detected. The first pair is biramous (fig. 25), and the endopod is unisegmented and probably armed with one seta. The exopod is bisegmented, and the first segment has one long seta, whereas the second segment bears five setae distally (note: setae not detectable on specimens processed for SEM). The base of the exopod has a simple, long seta. There is a second, biramous leg (fig. 26), with the endopod is unisegmented and distally equipped with one seta; the exopod is bisegmented, the basal segment is armed with one long seta, and the distal segment is armed with four setae (the central one is the longest); the exopod base has one long seta.

Etymology. — The specific name *miniprocessus* is a combination of "mini" (small) and "processus", making reference to the reduced size of the bifid cephalic process. The name is an adjective agreeing in gender with the (masculine) generic name.

Remarks. — The *Colobomatus* specimens parasitic on *Anisotremus scapularis* are not conspecific with species lacking abdominal processes (58 species), and must therefore be compared with those described by Cressey & Schotte (1983) that have abdominal processes (*Colobomatus caribbei* Cressey & Schotte, 1983, *Colobomatus quadrifarius* Cressey & Schotte, 1983, and *Colobomatus belizensis* Cressey & Schote, 1983). *C. miniprocessus* can be distinguished from *C. caribbei* by the size of the anterior processes, the type of lobulate processes on the third and fourth thoracic somites, and the type of abdominal processes. *C. belizensis* can be distinguished because of its simple anterior processes, which is bifid and comparatively much smaller in the specimens we here analysed. These two species also differ with respect to the type of abdominal processes.

C. quadrifarius, seemingly the closest congener of *C. miniprocessus*, can be differentiated by the size of the anterior processes, which are long in *C. quadrifarius* and minute in *C. miniprocessus*. The first pair of thoracic processes on the second thoracic somite differs from that of *C. miniprocessus* by the position on the respective somite in *C. miniprocessus*, the base occupying the entire length of the somite. Further, the somite itself is quite different from that of *C. quadrifarius* by the pronounced constriction between the second and third thoracic

somite, which does not occur in *C. quadrifarius*. The second pair of thoracic processes of *C. miniprocessus* is wider and longer than that of *C. quadrifarius*. The abdominal processes also differ, especially in diameter, which in *C. miniprocessus* is essentially constant for all processes along their length, and the processes are distally blunt; by contrast, the diameter varies in *C. quadrifarius*, and the processes are terminally acute. The terminal somite, bearing the uropods, is rounded in *C. miniprocessus* but subrectangular and shorter in *C. quadrifarius*. Even if *C. quadrifarius* parasitizes *Anisotremus* species (*A. davidsoni* (Steindachner, 1876), *A. dovii* (Günther, 1864), *A. interruptus* (Gill, 1862), and *A. pacifici* (Günther, 1864), this species is not conspecific with our *C. miniprocessus*, and the same is true for *C. caribbei*, which parasitizes *Anisotremus surinamensis* (Bloch, 1791). Consequently, it was considered necessary to create a taxon to accommodate the *Colobomatus* species that parasitize *Anisotremus scapularis* from Antofagasta on the Chilean coast; the specific name *Colobomatus miniprocessus* refers to the relatively small bifid anterior processes. This species is probably the same as that reported by Luque & Farfán (1990) as *C. quadrifarius* from *A. scapularis* from Peruvian waters.

In the present specimens of *C. miniprocessus* n. sp., the posterior thoracic processes vary with respect to whether the right-side or left-side process is longest. Luque & Farfán (1990) reported a similar variation for *C. quadrifarius*. No variation was observed among specimens of *C. miniprocessus* n. sp. with respect to the bifid cephalic process, the anterior thoracic processes, or the abdominal processes.

DISCUSSION

The buccal cone in *Colobomatus*

In *Colobomatus*, the buccal cone (also referred to as the siphon-like structure) is a modification of the normal, albeit relatively primitive, buccal area of Philichtyidae that is generally open, i.e., the labrum is not fused with the labium. Huys & Boxshall (1991) established that the ancestral state of the labrum typically is an undivided lobe, overlying the mouth opening, and that in Philichthyidae the original state is retained that is, the labrum is free and not fused with the labium and it also is simple, leaving all the buccal appendages free and exposed as in *Colobomatus*. However, the buccal cone could be formed by the combined structure of the labrum and labium, even if not fused. Notably, West (1992) mentioned that the plate covering the buccal cone represents a modified second antenna (here identified for *Colobomatus* n. sp. extracted from *Anisotremus scapularis*, after dissection of the plates). Castro (1994) described the genus *Procolobomatus* Castro

Romero & Baeza-Kuroki, 1994 with the species *Procolobomatus hemilutjani* Castro Romero, 1994, in which the real labrum (not divided) is in a normal position over the buccal appendages and not fused with the labium in that genus. For another species of the same genus, *P. kyphosus* (Sekerak, 1970), West (1992) showed that the labrum is a subtriangular process that could only be a projection, on the ventral surface of the labrum.

The real labrum in *Colobomatus* appears to be a smaller rim (both in width and in length), which remains concealed under the second antenna. Boxshall & Halsey (2004) found that the labrum is enclosed within the buccal capsule formed by the antennae and a posterior cuticular fold. The antennae in several species are very close to each other and have a tendency to be fused as shown by West (1992) for *Colobomatus nanus* West, 1992. This latter morphological aspect may reflect the findings of Huys & Boxshall (1991) for the majority of poecilostomatoids with both a bilobed labrum and a marked median incision.

Some investigators have demonstrated the labium in *Colobomatus* to be like a short projection between the bases of the maxillipeds (West, 1992), but this position appears to be incorrect if compared with the situation in other parasitic copepods (like pennellids or caligids) in which the fusion of the labium with the labrum forms the buccal cone and tube. We thus propose that the projection located between the maxillipeds may correspond to a projection from the labium surface, as occurs with the intrabuccal armature in pennellids (Siphonostomatoida).

Colobomatus species vary with regard to the absence or presence of buccal appendages located inside the siphon-like tube (Raibaut et al., 1978). West (1992) used SEM images and drawings to invoke the presence of a mandible, maxillule, maxilla, and maxilliped (the latter located inside the buccal tube). Not all *Colobomatus* species, however, have been described as having a maxilliped; for example, Essafi et al. (1983) reported that *Colobomatus steenstrupi* and *C. mulli* lack a maxilliped. Moreover, in other studies there may have been confusion as to the presence and identity of the maxilliped as a consequence of the reduced size of this area, and the likewise minute size of the individual appendages. Essafi et al. (1983) claimed that *Colobomatus* species have a mandible, but this actually corresponds to the first maxilla (as has been shown for other species). Further, Byrnes & Cressey (1986) reported the existence of a maxillule, but this appendage corresponds to the maxilla; moreover, these investigators mentioned the existence of a maxilla that actually represents the maxilliped. Thus, the buccal area and related appendages must be re-investigated in Philichthyidae in regard to their possible absence, presence, size, and potentially altered position in this highly modified group of copepods.

In *Colobomatus tenuis* n. sp., the buccal cone encloses the maxillule, maxilla, and maxilliped, and between the bases of the latter pair is a single projection,

probably arising from the buccal cavity wall, similar to the intrabuccal armature of pennellids (Castro & Baeza, 1989). This structure was also drawn by Byrnes & Cressey (1986) when describing *Colobomatus mylionus*.

The two new species we describe in our present report show egg masses attached to the genital pore, which is not covered by a membrane, implying that the eggs can easily separate from the female when she moves. This seems to be a common feature of *Colobomatus* species, as evidenced by illustrations of some species (e.g., Delamare Debouteville, 1962; Cressey & Schotte, 1983; etc.). Although certain *Colobomatus* species have been described as carrying egg sacs (West, 1983, 1995), this condition if favoured by the parasite habit in which the eggs are protected from the outside environment and from predators. In Philichthyidae, the females of *Leposphilus* bear defined egg sacs (Delamare Debouteville, 1962), whereas *Sarcotaces* females have a body filled with liquid and eggs and *Sphaerifer leydigi* Richiardi, 1877 has an egg mass. Huys & Boxshall (1991) proposed that egg sacs are typical of copepods; however, many orders lack them, although species of Poecilostomatoida indeed have egg sacs.

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