

A NEW BOMOLOCHID COPEPOD PARASITIC ON MARINE FISHES OF  
TAIWAN, WITH REASSIGNMENT OF SPECIES OF  
*HOLOBOMOLOCHUS* VERVOORT, 1969

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ABSTRACT

Two new genera, *Cresseyus* and *Hamaticolax*, are proposed to accommodate the 16 'orphan species' of bomolochid copepods hitherto placed in *Holobomolochus* Vervoort, 1969 but bereft of recent copepod literature. The new genera differ from *Holobomolochus* chiefly in the basal part of the antennule where the anterior margins of the first two segments are not at right angles to each other. *Hamaticolax* differs further from both *Holobomolochus* and *Cresseyus* in bearing a pair of rostral hooks. A new species, *Cresseyus nudulus*, is described from specimens found parasitic in the nasal and gill cavities of the Jarbua terapon, *Terapon jarbua* (Forsskål), caught in the Strait of Taiwan. The new species differs from its five congeners in the structure of the claw of the maxilliped and the armature of the endopod of leg 4.

RÉSUMÉ

Deux nouveaux genres, *Cresseyus* et *Hamaticolax*, sont proposés pour accommoder les 16 espèces 'orphelines' de copépodes Bomolochidae jusqu'ici placées dans le genre *Holobomolochus* Vervoort, 1969 mais absentes de la littérature récente sur les copépodes. Les nouveaux genres diffèrent de *Holobomolochus* principalement par la partie basale de l'antennule dont les bords antérieurs des deux premiers segments ne sont pas à angle droit l'un par rapport à l'autre. *Hamaticolax* diffère davantage, à la fois de *Holobomolochus* et de *Cresseyus*, par la présence d'une paire de crochets rostraux. Une nouvelle espèce, *Cresseyus nudulus* est décrite à partir de spécimens trouvés parasitant les cavités nasales et branchiales de *Terapon jarbua* (Forsskål), pêché dans le détroit de Taiwan. La nouvelle espèce diffère de ses cinq congénères par la structure du crochet du maxillipède et l'armature de l'endopodite de la quatrième paire de pattes.

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## INTRODUCTION

In 1969, Vervoort created a new genus, *Holobomolochus*, to accommodate eight species of *Bomolochus* that are characteristic in lacking modified setae in the basal region of the antennule and carrying two inner setae on the second segment of the endopod of leg 3 (table I). In 1979, the number of species of this genus was raised to 13 by Kabata (1979) with inclusion of five species that were published after Vervoort's (1969) proposal of the genus (table I). Two species, *H. embiotocae* Hanan, 1976 and *H. nemipteri* Pillai, 1973, were inadvertently left out by Kabata (1979). Thus, at the end of the 1970's there were 15 species of bomolochids known in the genus *Holobomolochus*. Then, in the 1980's, Cressey (1981, 1983), Cressey & Cressey (1980, 1985), and Byrnes (1986) together added 12 more species of bomolochids to the genus *Holobomolochus* and Oldewage (1994) topped it off with one more in the last decade of the 20<sup>th</sup> century (see table I). Therefore, in total, 28 species of bomolochids have been attributed to *Holobomolochus* since its creation in 1969 (table I). However, in their recently published book on the diversity of Copepoda, Boxshall & Halsey (2004: 451) listed only five species for the genus *Holobomolochus*. Apparently, they have followed the amendment to the genus proposed by Cressey & Cressey (1985).

Cressey & Cressey (1985) redefined the genus *Holobomolochus* and suggested to keep in this genus only those species carrying the following character states: (1) rostrum without ventral hooks, (2) antennule without modified seta in basal region, (3) anterior margins of first two segments of antennule at right angles to each other, (4) claw on maxilliped bearing prominent accessory process, (5) mid-endopodal segment of legs 2 and 3 with two inner setae, and (6) mid-endopodal segment of leg 4 with one or no seta. With this amendment, only five species (listed with bold face in table I) were qualified to be kept in *Holobomolochus*. As shown in the "Notes" of table I, seven of the remaining 23 species have been either reassigned to other bomolochid genera or relegated to a junior synonym of a bomolochid species; but, no attribution of the 16 remaining ones has been proposed. Cressey (1983, 1984) had expressed the necessity of splitting the group; but, regrettably, he was stricken by Alzheimer's disease before completion of his attempt.

In our survey of the parasitic Copepoda of Taiwan, we found a new species of bomolochid attributable to the above-mentioned group of "orphan species." Thus, in this paper we shall propose a solution to reassign those "orphan species" in addition to describing that new species.

TABLE I

Species of bomolochids reported under or transferred into the genus *Holobomolochus* Vervoort, 1969; the five species in **bold face** are the ones proposed to be kept in this genus by Cressey & Cressey (1985)

Species of <i>Holobomolochus</i>	Remarks
<i>H. acutus</i> (Gnanamuthu, 1948)	Recognized by Vervoort (1969), Kabata (1979)
<i>H. albidus</i> (Wilson, 1932)	Recognized by Vervoort (1969), Kabata (1979)
<i>H. ardeolae</i> (Krøyer, 1864) <sup>1</sup>	Recognized by Vervoort (1969), Kabata (1979)
<i>H. asperatus</i> Cressey & Cressey, 1980 <sup>2</sup>	
<i>H. attenuatus</i> (Wilson, 1913)	Recognized by Vervoort (1969), Kabata (1979)
<i>H. australiensis</i> Byrnes, 1986	
<i>H. centropristis</i> Cressey, 1981	
<b><i>H. chilensis</i></b> Cressey & Cressey, 1985	
<i>H. confusus</i> (Stock, 1953)	Recognized by Vervoort (1969), Kabata (1979)
<i>H. crevallens</i> Cressey, 1981 <sup>2</sup>	
<b><i>H. dawsoni</i></b> Cressey & Cressey, 1985	
<i>H. divaricatus</i> Cressey Cressey, 1980 <sup>2</sup>	
<i>H. embiotocae</i> Hanan, 1976	
<b><i>H. glyphisodontis</i></b> (Krøyer, 1863)	
<i>H. longicaudus</i> (Cressey, 1969)	Recognized by Kabata (1979)
<i>H. maleus</i> Oldewage, 1994	
<i>H. nemipteri</i> Pillai, 1973 <sup>3</sup>	
<i>H. nothrus</i> (Wilson, 1913) <sup>4</sup>	Recognized by Vervoort (1969), Kabata (1979)
<i>H. nudiusculus</i> Cressey & Cressey, 1980 <sup>2</sup>	
<i>H. occultus</i> Kabata, 1971	Recognized by Kabata (1979)
<i>H. pallescens</i> (Wilson, 1913)	Recognized by Vervoort (1969), Kabata (1979)
<i>H. prolixus</i> (Cressey, 1969)	Recognized by Kabata (1979)
<i>H. scutigerulus</i> (Wilson, 1936)	Recognized by Vervoort (1969), Kabata (1979)
<i>H. serratus</i> Cressey, 1981	
<i>H. spinulus</i> (Cressey, 1969)	Recognized by Kabata (1979)
<i>H. venustus</i> Kabata, 1971	Recognized by Kabata (1979)
<b><i>H. vervoorti</i></b> Cressey, 1983	
<b><i>H. wilsoni</i></b> Cressey & Cressey, 1985	

## Notes:

<sup>1</sup> Cressey (1981: 3) synonymized this species with *Bomolochus bellones* after restudying the type specimen of *Bomolochus ardeolae* deposited in the Universitetets Zoologiske Museum in Copenhagen.

<sup>2</sup> These four species were transferred to *Acantholochus* by Cressey (1984).

<sup>3</sup> This species was transferred to *Holocolax* by Cressey (1982).

<sup>4</sup> This species was synonymized with *Holobomolochus glyphisodontis* by Cressey (1981).

## MATERIALS AND METHODS

Fish landed at fishing ports in the central and southern part of Taiwan were purchased, kept in an icebox, and transported to the Fish Pathology Laboratory located on the campus of the National Chiayi University. Examination of the fish

for parasitic copepods was carried out in the laboratory while the fish were still fresh. The copepod parasites removed from the fish host were preserved in 70% ethanol. They were later cleared in 85% lactic acid for a couple of hours before making dissection in a drop of lactic acid. The hanging drop method devised by Humes & Gooding (1964) was employed in dissection of the appendages under a dissection microscope and examination of the dissected parts and appendages was done under a compound microscope. All drawings were made with the aid of a camera lucida. Measurements of the body and body parts were taken after the specimen was cleared in lactic acid.

#### SYSTEMATIC ACCOUNTS

##### Order POECILOSTOMATOIDA Thorell, 1859

##### Family BOMOLOCHIDAE Sumpf, 1871

##### **Cresseyus** n. gen.

Female. — Body form typical of family, with only first pedigerous somite incorporated into cephalothorax. Abdomen 3-segmented. Caudal ramus with 6 setae, 2 of which on distomedian margin much longer than others. Rostrum without ventral hooks. Antennule 6-segmented (or 5-segmented with indistinctly separated 2<sup>nd</sup> and 3<sup>rd</sup> segments); basal region without modified setae, and anterior margins of first 2 segments straight (not at right angles to each other). Antenna and oral appendages typical of family. Legs 1-4 biramous and trimerite. Middle segment of endopod of legs 2 and 3 with 2 medial setae. Leg 5 typical of family.

Male. — Abdomen 2-segmented. Antennule 6-segmented. Legs 1-4 biramous and trimerite, except for leg 4 with 2-segmented endopod.

Type species. — *Cresseyus palleucus* (Wilson, 1913) [described as *Artacolax palleucus* Wilson, 1913].

Etymology. — This new genus is named in honor of Dr. Roger F. Cressey, who created five genera in the family Bomolochidae. The gender of the new generic name is masculine.

Remarks. — Five species of bomolochids hitherto placed in the genus *Holobomolochus* are attributable to this new genus (table II). They differ from the species of *Holobomolochus* chiefly in the basal region of the antennule, where the anterior margins of the first two segments are straight (not at right angles to each other). This special morphology of the antennule is visible without dissection.

TABLE II  
Species formerly in *Holobomolochus*, now placed in *Cresseyus* n. gen. in the present paper

Species	Host	Locality
<i>C. centropristis</i> (Cressey, 1981)	<i>Centropristis striata</i> (Linnaeus, 1758)	Gulf of Mexico
<i>C. confusus</i> (Stock, 1953)	<i>Conger conger</i> (Linnaeus, 1758)	North Sea
	<i>Cyclopterus lumpus</i> Linnaeus, 1758	North Sea
	<i>Gadus morhua</i> Linnaeus, 1758	North Sea
	<i>Melanogrammus aeglefinus</i> (Linnaeus, 1758)	North Sea
	<i>Merlangius merlangus</i> (Linnaeus, 1758)	North Sea
	<i>Molva molva</i> (Linnaeus, 1758)	North Sea
	<i>Pollachius virens</i> (Linnaeus, 1758)	North Sea
	<i>Trisopterus luscus</i> (Linnaeus, 1758)	North Sea
<i>C. longicaudus</i> (Cressey, 1969)	<i>Paralabrax clathratus</i> (Girard, 1854)	South California
	<i>Paralabrax nebulifer</i> (Girard, 1854)	South California
<i>C. nudulus</i> n. sp.	<i>Therapon jarbua</i> (Forsskål, 1775)	Taiwan
<i>C. palleucus</i> (Wilson, 1913)	<i>Scorpaena plumieri</i> Bloch, 1879	Jamaica
<i>C. serratus</i> (Cressey, 1981)	<i>Scorpaena brasiliensis</i> Cuvier, 1829	Gulf of Mexico

Note: Information listed in this table was compiled from the following references: Boxshall (1974), Cressey (1969, 1981), Kabata (1979), Stock (1953), and Wilson (1913).

### ***Cresseyus nudulus* n. sp. (figs. 1-3)**

Material examined. — Sixteen ovigerous ♀♀ and 1 larva parasitic on inside operculum, gill filament, and nasal cavity of *Therapon jarbua* (Forsskål, 1775), as follows: 2 ♀♀ on a fish collected at Dong-shi Fishing Port of Chiayi County on 23 June 2000; 13 ♀♀ on 6 fishes collected at same fishing port on 14 June 2004; 1 ♀ and 1 larva on a fish collected at Mi-tuo Fishing Port of Kaoshiung County on 21 July 2004. Holotype (USNM 1079373) and 8 paratypes (USNM 1079374) deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Female. — Body (fig. 1A) 1.20 (1.02-1.38) mm, excluding setae on caudal rami. Cephalothorax (fig. 1A) wider than long, 0.29 (0.26-0.32) × 0.55 (0.48-0.62) mm, with marked dorsal sclerite in centre of cephalosome. First pediger completely fused to cephalosome, but remaining pedigers on prosome distinctly separated from each other; third pediger enlarged dorsally. Urosome shorter than prosome, measuring 518 (478-551) µm, which is less than one-half (43%) of body length. Genital double-somite distinctly wider than long, 133 (122-146) × 200 (170-227) µm. Abdomen 3-segmented; all somites distinctly wider than long; anal somite (fig. 1J) with two patches of spinules on ventral surface. Caudal ramus longer than wide, 49 (48-50) × 34 (32-41) µm, with a patch of spinules on ventral surface and armed with usual 2 long and 4 short setae. Egg sac (fig. 1A) large, containing multiseriate eggs.

Rostral area without tines. Antennule (fig. 1B) 5-segmented, with indistinctly separated 2<sup>nd</sup> segment. Basal part fringed with 15 robust, plumose setae in addition to 7 naked, slender setae on dorsal side and 4 plumose plus 1 naked setae on

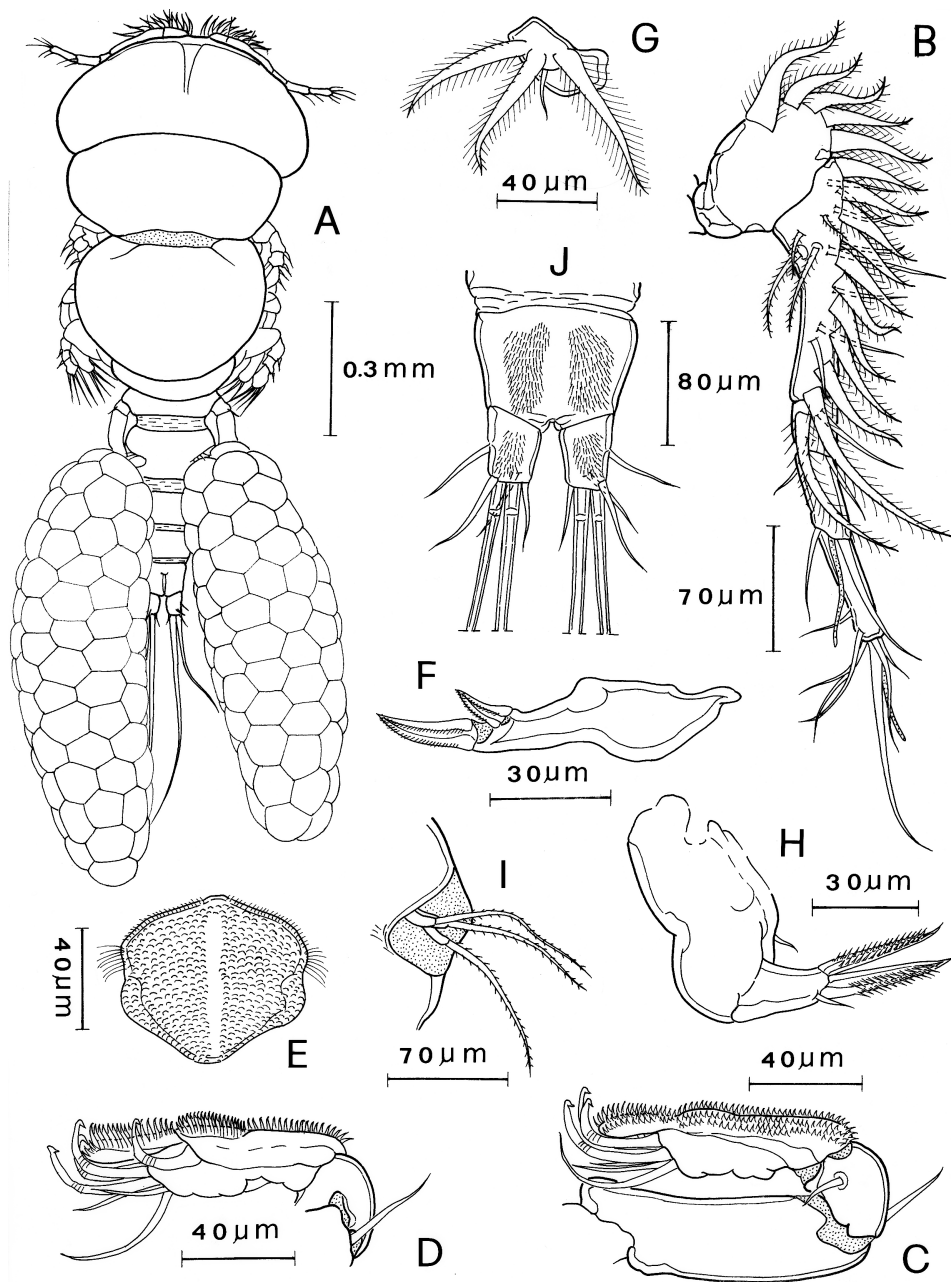


Fig. 1. *Cresseys nudulus* n. sp., female. A, habitus, dorsal; B, antennule; C, antenna, posteroventral; D, distal segment of antenna, anterodorsal; E, labrum, ventral; F, mandible; G, maxillule; H, maxilla, anterior; I, egg-sac attachment area; J, anal somite and caudal rami, ventral.

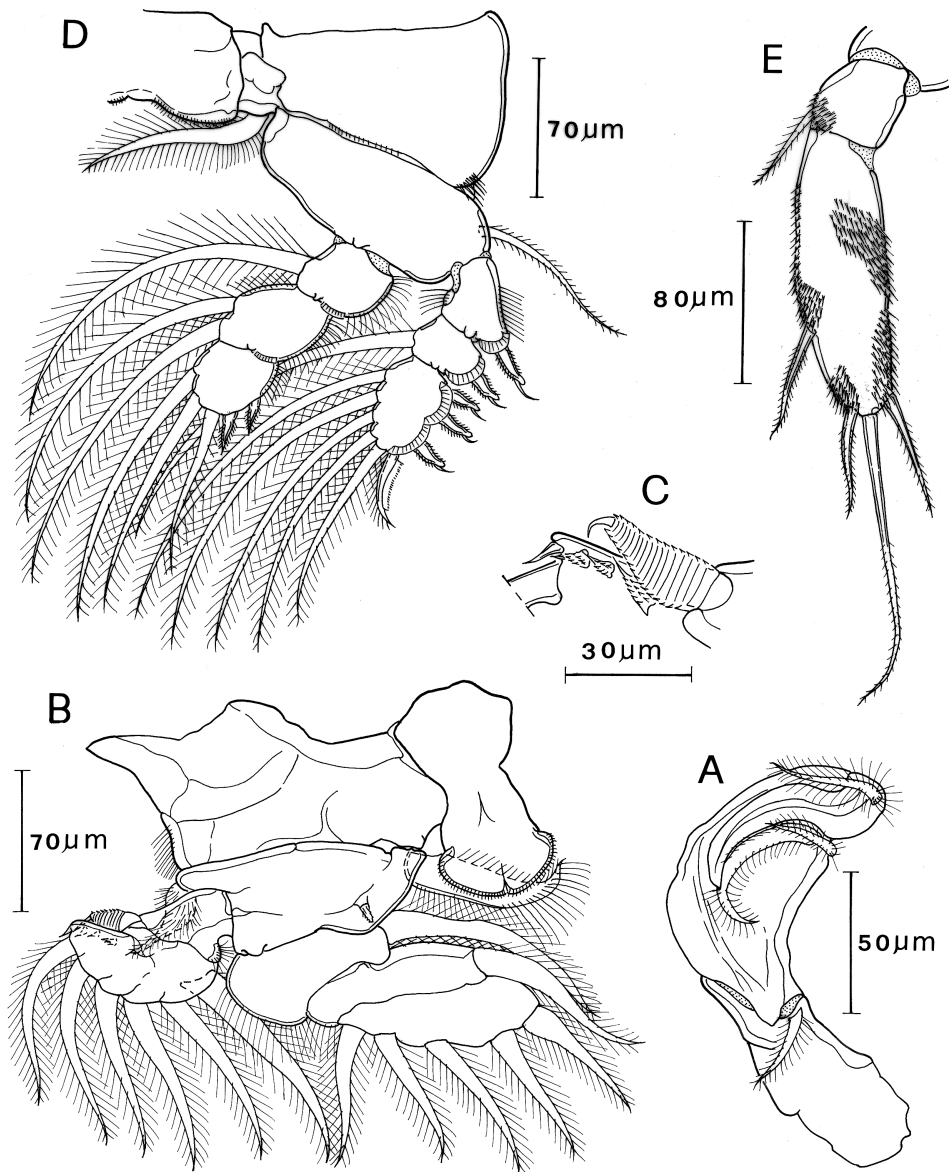


Fig. 2. *Cresseys nudulus* n. sp., female. A, maxilliped, ventral; B, leg 1, anterior; C, outer spines on leg 1 exopod, dorsal; D, leg 2, anterior; E, leg 5, anterior.

ventral side. Formula of armature for cylindrical distal part: 4, 2 + 1 aesthete, and 7 + 1 aesthete. Antenna (fig. 1C) 3-segmented; proximal segment largest, carrying long, naked outer seta at tip; middle segment smallest, bearing short, medial seta; terminal segment carrying rows of denticles on ventral surface and protruded distally into large, blunt, cylindrical process with rows of longer denticles; also

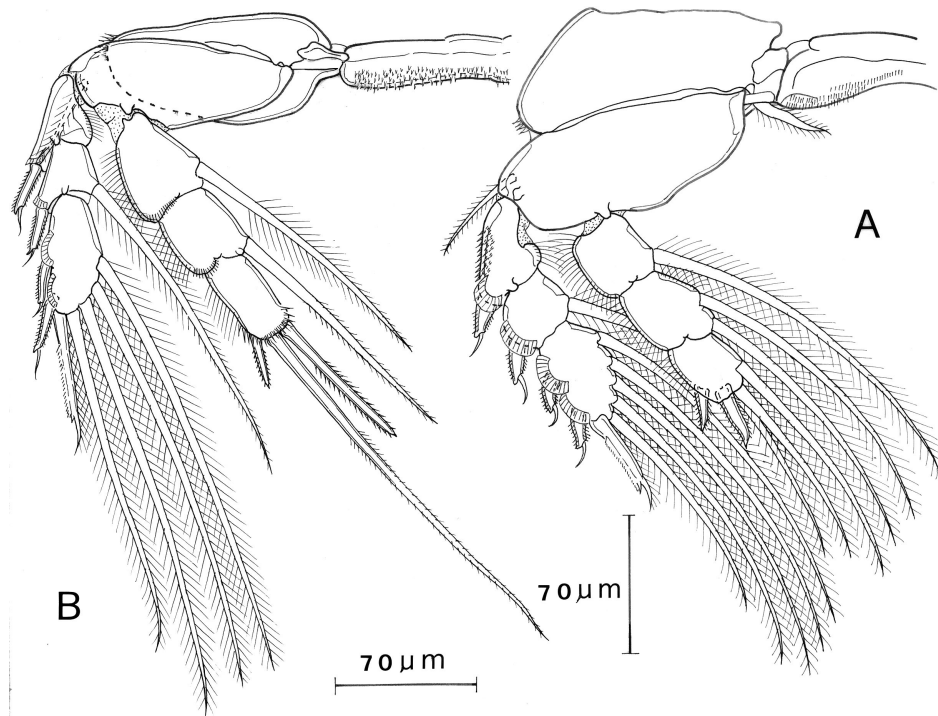


Fig. 3. *Cresseyus nudulus* n. sp., female. A, leg 3, anterior; B, leg 4, anterior.

armed distally with 4 unequal, curved, long claws, and 3 naked setae (fig. 1D). Ventral surface of labrum (fig. 1E) covered with 2 large patches of sculpturations, a row of short setules along posterior margin, and a tuft of longer setules on both posterolateral corners. Mandible (fig. 1F) tipped with 2 unequal blades bearing rows of spinules. Maxillule (fig. 1G) with 1 small, naked and 3 large, plumose setae. Maxilla (fig. 1H) 2-segmented; proximal segment large, with a small, subterminal seta on medial margin; distal segment small and armed with 1 tiny, naked seta and 2 large, spinulose, spiniform setae. Maxilliped (fig. 2A) 3-segmented; proximal segment with subterminal, plumose seta on medial margin; middle segment largest, with 1 robust and another slender, pilose setae on medial margin; terminal segment a sigmoid claw without auxiliary hook (or tine), its proximal region carrying a large, pilose seta.

Armature on rami of legs 1-4 as follows (Roman numerals indicating spines and Arabic numerals, setae):

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-1	I-0; IV, 6	0-1; 0-1; 5
Leg 2	0-1	1-0	I-0; I-1; III, I, 5	0-1; 0-2; II, 3
Leg 3	0-1	1-0	I-0; I-1; II, I, 5	0-1; 0-2; II, 2
Leg 4	0-0	1-0	I-0; I-1; II, I, 4	0-1; 0-1; I, 1, 1



Outer-distal margin of coxa of leg 1 (fig. 2B), leg 2 (fig. 2D) armed with row of setules, but same area of leg 3 (fig. 3A) and leg 4 (fig. 3B) setules replaced by spinules. Outer spine on proximal segment of leg 1 exopod robust, striated, and serrated on both sides; next 3 outer spines spinulate, but distalmost spine naked (fig. 2C). Exopod of legs 2-4 (figs. 2D, 3A, B) fringed with narrow hyaline membrane in basal regions of outer spines. All outer spines on legs 2-4 tipped with a flagellum. Leg 5 (fig. 2E) 2-segmented; proximal segment short, armed with 1 sparsely plumose outer seta and cluster of setules in outer-distal corner; distal segment about 3 times as long as wide, carrying 4 pinnate, setiform elements and ornamented with a row of fine spinules along proximal outer edge and 4 patches of stronger spinules on anterior surface. Leg 6 (fig. 1I) represented by 3 long setae on genital operculum located in a pit for attachment of egg sac.

Male. — Unknown.

Etymology. — The species name *nudulus* is a diminutive form of *nudus*. It means bare in Latin. The name is referring to the possession of a sigmoid claw on the maxilliped without the usual auxiliary tine on the outer margin. It is an adjective agreeing in gender with the (masculine) generic name.

Remarks. — As inferred by the species name, the new species is characteristic in having a bare terminal claw on the maxilliped. This claw carries a large auxiliary tine in *Cresseyus centropristis* (Cressey, 1981), *C. pallescens* (Wilson, 1913), and *C. serratus* (Cressey, 1981). In *C. confusus* (Stock, 1985) and *C. longicaudus* (Cressey, 1969), the auxiliary tine is there, but small. Another distinguishing characteristic of the new species is the armature of the terminal segment on the leg 4 exopod. While the armature of this segment is II,I,5 in the five known species of *Cresseyus*, it is II,I,4 in the new species.

This is the only species of the genus *Cresseyus* not recorded from a fish so far caught only in the waters off North America and Europe.

#### **Hamaticolax** n. gen.

Female. — Body form typical of family, with only first pedigerous somite incorporated into cephalothorax. Abdomen 3-segmented. Caudal ramus with 6 setae, 2 of which on mid-distal margin much longer than others. Rostrum with a pair of ventral hooks. Antennule 5-, 6- or 7-segmented; basal region without modified setae, and anterior margins of first 2 segments not at right angles to each other. Antenna and oral appendages typical of family. Legs 1-4 biramous and trimerite. Middle segment of endopod of legs 2 and 3 with 2 medial setae. Leg 5 typical of family.

Male. — Abdomen 2-segmented. Antennule 6-segmented. Legs 1-4 biramous and trimerite, except for leg 4 with 2-segmented endopod.

TABLE III

Species formerly in *Holobomolochus*, now placed in *Hamaticolax* n. gen. in the present paper

Species	Host	Locality
<i>H. albidus</i> (Wilson, 1932)	<i>Lophius piscatorius</i> Linnaeus, 1785	Massachusetts
<i>H. attenuatus</i> (Wilson, 1913)	<i>Scorpaena plumieri</i> Bloch, 1789	Jamaica
<i>H. australiensis</i> (Byrnes, 1986)	<i>Acanthopagrus australis</i> (Günther, 1859)	Queensland, Australia
	<i>Acanthopagrus berda</i> (Forsskål, 1775)	Queensland, Australia
<i>H. embiotocae</i> (Hanan, 1976)	<i>Cymatogaster aggregate</i> Gibbson, 1854	Southern California
	<i>Rhacochilus vacca</i> (Girard, 1855)	Southern California
	<i>Zalembius rosaceus</i> (Jordan & Gilbert, 1880)	Southern California
<i>H. maleus</i> (Oldewage, 1994)	<i>Malacocephalus laevis</i> (Lowe, 1843)	South Africa
<i>H. occultus</i> (Kabata, 1971)	<i>Hippoglossoides elassodon</i> Jordan & Gilbert, 1880	British Columbia
	<i>Lyopsetta exillis</i> (Jordan & Gilbert, 1880)	British Columbia
<i>H. prolixus</i> (Cressey, 1969)	<i>Chitonotus pugetensis</i> (Steindachner, 1876)	Southern California
	<i>Citharichthys sordidus</i> (Girard, 1854)	Southern California
	<i>Citharichthys stigmaeus</i> Jordan & Gilbert, 1882	Southern California
	<i>Genyonemus lineatus</i> (Ayres, 1855)	Southern California
	<i>Hippoglossina stomata</i> Eigenmann & Eigenmann, 1890	Southern California
	<i>Icelinus quadriseriatus</i> (Lockington, 1880)	Southern California
	<i>Microstomus pacificus</i> (Lockington, 1879)	Southern California
	<i>Paralichthys californicus</i> (Ayres, 1859)	Southern California
	<i>Parophrys vetulus</i> Girard, 1854	Southern California
	<i>Pleuronichthys coenosus</i> Girard, 1854	Southern California
	<i>Pleuronichthys verticalis</i> Jordan & Gilbert, 1880	Southern California
	<i>Porichthys notatus</i> Girard, 1854	Southern California
	<i>Symphurus atricaudus</i> (Jordan & Gilbert, 1880)	Southern California
	<i>Zalembius rosaceus</i> (Eigenmann & Eigenmann, 1889)	Southern California
	<i>Zaniolepis frenata</i> (Eigenmann & Eigenmann, 1889)	Southern California
	<i>Zaniolepis latipinnis</i> Girard, 1858	Southern California

TABLE III  
(Continued)

Species	Host	Locality
<i>H. scutigerulus</i> (Wilson, 1935)	<i>Pseudupeneus maculatus</i> (Bloch, 1793)	West Indies
<i>H. spinulus</i> (Cressey, 1969)	<i>Scorpaena guttata</i> Girard, 1854	Southern California
	<i>Sebastes dallii</i> (Eigenmann & Eigenmann, 1890)	Southern California
	<i>Sebastes mystinus</i> (Jordan & Gilbert, 1881)	Southern California
	<i>Sebastes serranoides</i> (Eigenmann & Eigenmann, 1881)	Southern California
<i>H. venustus</i> (Kabata, 1971)	<i>Zaniolepis latipinnis</i> Girard, 1854	Southern California
	<i>Scorpaenichthys marmoratus</i> Girard, 1854	British Columbia
	<i>Sebastes caurinus</i> Richardson, 1844	British Columbia

Note: Information listed in this table was compiled from the following references: Byrnes (1986), Cressey (1969, 1983), Dojiri (1977), Ho (1972), Kabata (1971), Oldewage (1994), Pillai (1967), Stock (1953), and Vervoort (1969).

Type species. — *Hamaticolax attenuatus* (Wilson, 1913) [described as *Bomolochus attenuatus* Wilson, 1913].

Etymology. — The generic name is a combination of “hamatus”, a Latin word meaning “with hooks”, and “colax”, a common suffix of seven bomolochid genera, derived from Latin “-cola”, which refers to “inhabitant” (= incola).

Remarks. — Ten species of bomolochids hitherto placed in the genus *Holobomolochus* are attributable to this new genus (table III). They differ from the species of *Holobomolochus* and *Cresseyus* chiefly in the possession of a pair of ventral hooks in the rostral region. Having the anterior margins of the first two segments in the basal region of the antennule lined in a straight fashion, the species of *Hamaticolax* appears to be closer to *Cresseyus* than to *Holobomolochus*.

Due to the inadequate original description and concomitant with the lack of subsequent work, one ‘orphan species,’ “*Bomolochus acuta* Gnanamuthu, 1948”, cannot be assigned to either one of the two new genera. The species was reported by Gnanamuthu (1948: 18) based on “a single mature female specimen” found on the gill filament of a rainbow sardine, *Dussumieria acuta* Valenciennes, 1847, collected at Madras, India. It was alleged to have a 3-segmented leg 5, which is unusual for the bomolochids. Besides, the middle segment of the endopod of leg 3 has only one seta, an armature unknown for *Cresseyus*, *Hamaticolax*, or *Holobomolochus*. The species was not included in Pillai’s (1985) book on the parasitic copepods of India either. Therefore, “*Bomolochus acuta* Gnanamuthu,

1948" should be placed as incertae sedis in the Bomolochidae until further information is available.

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