

Four Species of *Unicolax* Cressey and Cressey, 1980 (Copepoda: Bomolochidae) Parasitic on Marine Fishes of Taiwan

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Ching-Long Lin and Ju-shey Ho (2006) Four species of *Unicolax* Cressey and Cressey, 1980 (Copepoda: Bomolochidae) parasitic on marine fishes of Taiwan. *Zoological Studies* 45(3): 339-356. Four species of bomolochid copepods belonging to the genus *Unicolax* Cressey and Cressey, 1980 were discovered parasitic in the nasal sinuses of marine fishes of Taiwan. They are *U. ciliatus* Cressey and Cressey, 1980 on *Scomberomorus commerson* (Lacepède); *U. collateralis* Cressey and Cressey, 1980 on *Euthynnus affinus* Cantor; *U. longispinus* sp. nov. on *Psenopsis anomala* (Temminck and Schlegel); and *U. quadrispinulus* sp. nov. on *Sillago sihama* (Forsskål). The distinguishing feature of *U. longispinus* is the transformation of the 4th element on the antennule in the female into a long spine, and that of *U. quadrispinulus* is the possession of 4 (instead of 3) small outer spines on the terminal segment of the leg 1 exopod in the female. This is the first record of the occurrence of *Unicolax* on the marine fishes of Taiwan. *Unicolax chrysophryenus* Roubal, Armitage and Rohde, 1983 is proposed for transfer to *Naricolax* Ho, Do and Kasahara, 1983 and a key to the 7 species of *Unicolax* is provided. <http://zoolstud.sinica.edu.tw/Journals/45.3/339.pdf>

Key words: *Unicolax*, Bomolochidae, Copepoda, Taiwan, Marine fish.

The nasal sinuses of marine fishes are known to be exploited by members of 4 families of parasitic Copepoda, namely, the Bomolochidae, Chondracanthidae, Lernaeopodidae, and Shiinoidae. Among them, members of the 1st family seem to be the dominant dweller in this microhabitat of fish, with all of the constituent species of 2 genera - *Naricolax* Ho, Do and Kasahara, 1983 and *Unicolax* Cressey and Cressey, 1980 - found in this exclusive habitat.

In the past 7 yrs, we have been surveying parasitic copepods of marine fishes of Taiwan, and have found 21 species of bomolochids parasitic on 24 species of commercial fishes landed at fishing ports in Chiayi County, Tainan County, and Kaohsiung County. More than 1/3 (8 of 21) of the bomolochids that we found from Taiwan were parasitic in the host's nasal sinuses, with four of them belonging to *Naricolax* and the other 4 to *Unicolax*.

In this paper we report the 4 species of the latter genus, raising the number of *Unicolax* species to 7. Since a key to the species of *Unicolax* has never been constructed, we provide one in this paper after describing the 4 species found from Taiwan.

MATERIALS AND METHODS

Fish caught and landed at fishing ports in west-central and southern Taiwan were purchased and transferred in an icebox to National Chiayi University where the laboratory examination of the copepod parasites was carried out. Copepod parasites removed from the fish hosts were preserved in 70% ethanol. They were later cleared in 85% lactic acid for 1-2 h before dissection in a drop of lactic acid on a wooden slide (Humes and

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Gooding 1964). The removed parts and appendages were examined under a compound microscope with a series of magnifications up to 1500x. All drawings were made with the aid of a camera lucida and measurements were taken after soaking the specimens in lactic acid.

In the case of new species, the type materials

deposited in the Smithsonian Institution, Washington, DC, were selected from the largest collection in our possession. To confirm our identification of *Unicolax ciliatus* Cressey and Cressey, 1980 and *Unicolax collateralis* Cressey and Cressey, 1980, we requested a loan of the paratypes from the Smithsonian Institution and

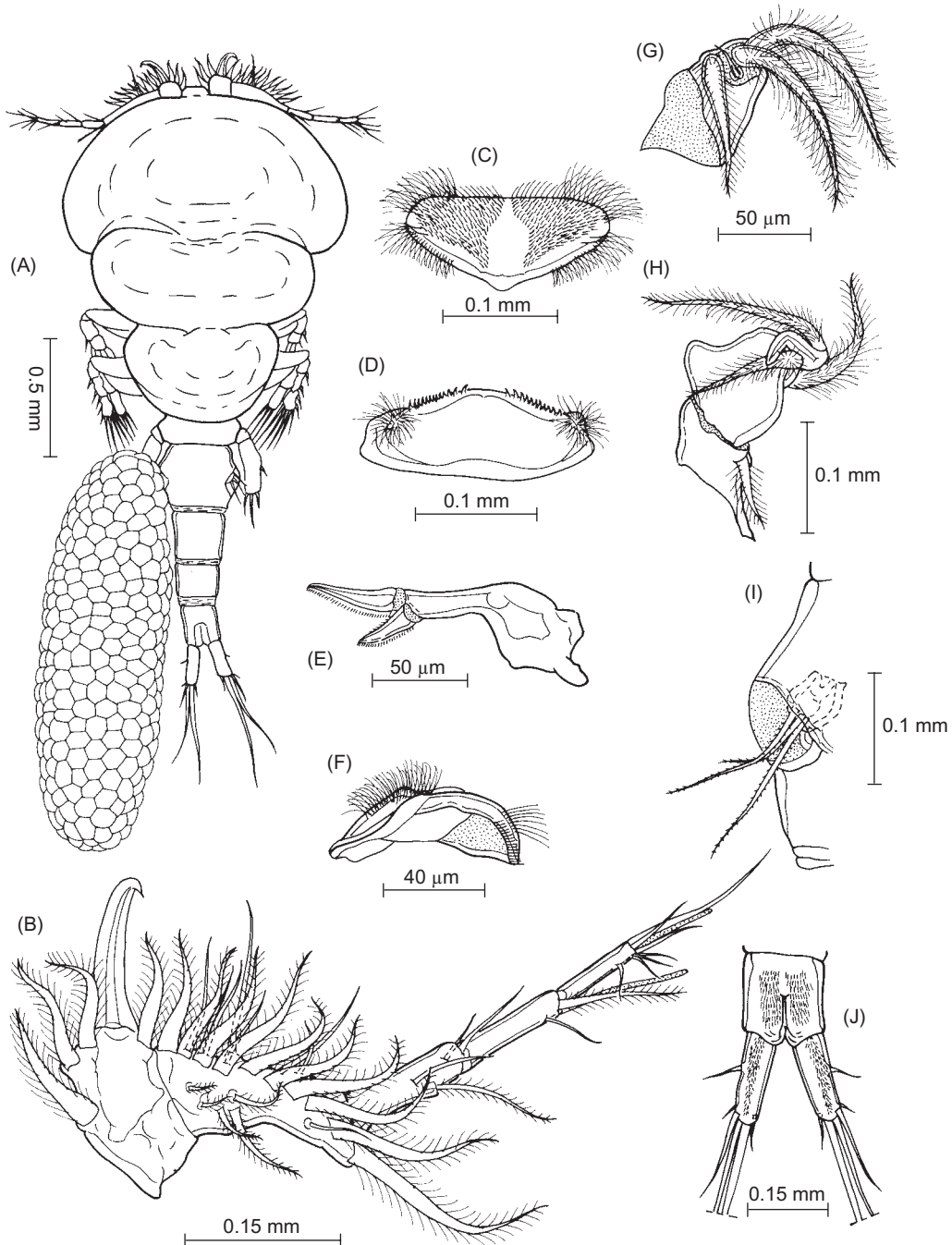


Fig. 1. *Unicolax ciliatus* Cressey and Cressey, 1980, Female. (A) Habitus, dorsal view; (B) antennule, ventral view; (C) labrum, ventral view; (D) postoral plate, ventral view; (E) mandible; (F) paragnath; (G) maxillule; (H) maxilliped; (I) egg sac attachment area, showing leg 6, dorsal view; (J) anal somite and caudal rami, ventral view.

examined them in lactic acid.

RESULTS

Order Poecilostomatoida Thorell, 1859

Family Bomolochidae Sumpf, 1870

Unicolax ciliatus Cressey and Cressey, 1980

(Figs. 1-3)

Unicolax ciliatus Cressey and Cressey 1980: 15; Cressey 1983: 264; Collete and Russo 1985: 150; Balaraman, 1983: 33.

Material examined: 1 ♀ recovered from nasal cavity of a narrow-barred Spanish mackerel, *Scomberomorus commerson* (Lacepède), landed at Mi-Tuo Fishing Port on 28 Feb. 2003 and 1 paratype ♀ (USNM 172255) from nasal sinus of *Scomberomorus plurilineatus* Faurmanoir caught in the Zanzibar Channel on 6 Oct. 1965.

Female: Body (Fig. 1A) 2.42 mm long, excluding setae on caudal rami. Cephalothorax wider than long, 0.70 x 1.16 mm, with rounded posterolateral corners. Third pediger covering 4th pediger. Urosome shorter than prosome. Genital complex (Fig. 1A) wider than long, 0.28 x 0.32 mm, area of egg sac attachment protruding laterally

(Fig. 1I). Abdomen (Fig. 1A) 3-segmented; ventral surface of anal somite with 2 large patches of spinules (Fig. 1J). Caudal ramus (Fig. 1J) about 3 times longer than wide, 154 x 57 µm, and armed with 4 short and 2 long setae. Egg sac (Fig. 1A) large, longer than urosome, and containing numerous rows of eggs.

Rostral area protruding anteriorly but no rostral hooks (Fig. 1A). Antennule (Fig. 1B) 5-segmented, with indistinctly separated but heavily sclerotized 2nd segment making appendage appear to be 6-segmented. Armature on proximal segment consisting of 4 plumose setae and 1 stout spine, that on 2nd segment comprising 15 plumose and 8 naked setae. Formula of armature for cylindrical distal 3 segments: 4, 2+1 aesthete, and 7+1 aesthete. Antenna (Fig. 2A) 4-segmented; proximal segment (coxobasis) bearing single basal seta; 1st endopodal segment small, bearing spiniform, outer seta; 2nd endopodal segment long and protruding distally into a process, carrying rows of denticles on ventral surface and armed terminally with 1 claw and 1 pectinate process; 3rd endopodal segment smallest, armed with 3 claws and 3 naked setae distally (Fig. 2B). Labrum (Fig. 1C) covered with patch of spinules and long setules on both sides. Mandible (Fig. 1E) tipped

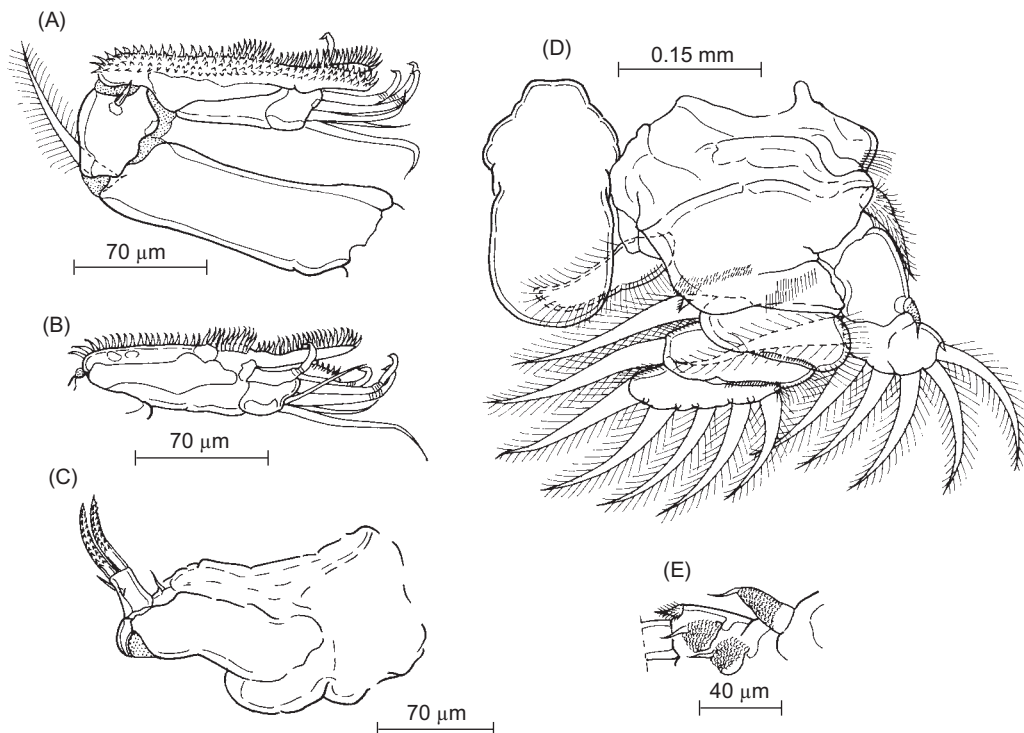


Fig. 2. *Unicolax ciliatus* Cressey and Cressey, 1980, female. (A) Antenna, anterior view; (B) distal 1/2 of antenna, posterior view; (C) maxilla; (D) leg 1 and intercoxal plate, anterior view; (E) outer spines on exopod of leg 1, posterior view.

with 2 subequal blades bearing marginal serrations along posterior margin; additional spinules on anterior margin of subterminal blade. Paragnath (Fig. 1F) with folded sclerites and long setules. Area immediately behind mouth and between paragnaths armed with plate bearing cluster of long setules and row of teeth on both sides (Fig. 1D). Maxillule (Fig. 1G) a lobe tipped with 3 large, pilose setae and 1 tiny, naked seta. Maxilla (Fig. 2C) 2-segmented; proximal segment large, carrying 1 short seta; distal segment small, tipped with 2 long, sharp, denticulated spines in addition to subterminal, naked seta. Maxilliped (Fig. 1H) 3-segmented; proximal segment (syncoxa) bearing plumose, subterminal seta; middle segment (basis) broad, protruding outward in basal region, and equipped with 2 unequal, pilose setae on medial

surface; terminal (endopodal) segment a small, sigmoid claw carrying large, pilose, basal 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-I	I-0; III,6	0-1; 0-1; 5
Leg 2	0-1	1-0	I-0; I-1; III,1,5	0-1; 0-2; II,3
Leg 3	0-1	1-0	I-0; I-1; II,1,5	0-1; 0-1; II,2
Leg 4	0-0	1-0	I-0; I-1; II,1,5	0-1; 0-1; III

Intercoxal plate of leg 1 (Fig. 2D) without ornamentation; basis with 2 patches of setules on anterior surface and a small spiniform seta on medial margin. Bases of proximal 3 outer spines on exopod covered with denticles (Fig. 2E). All

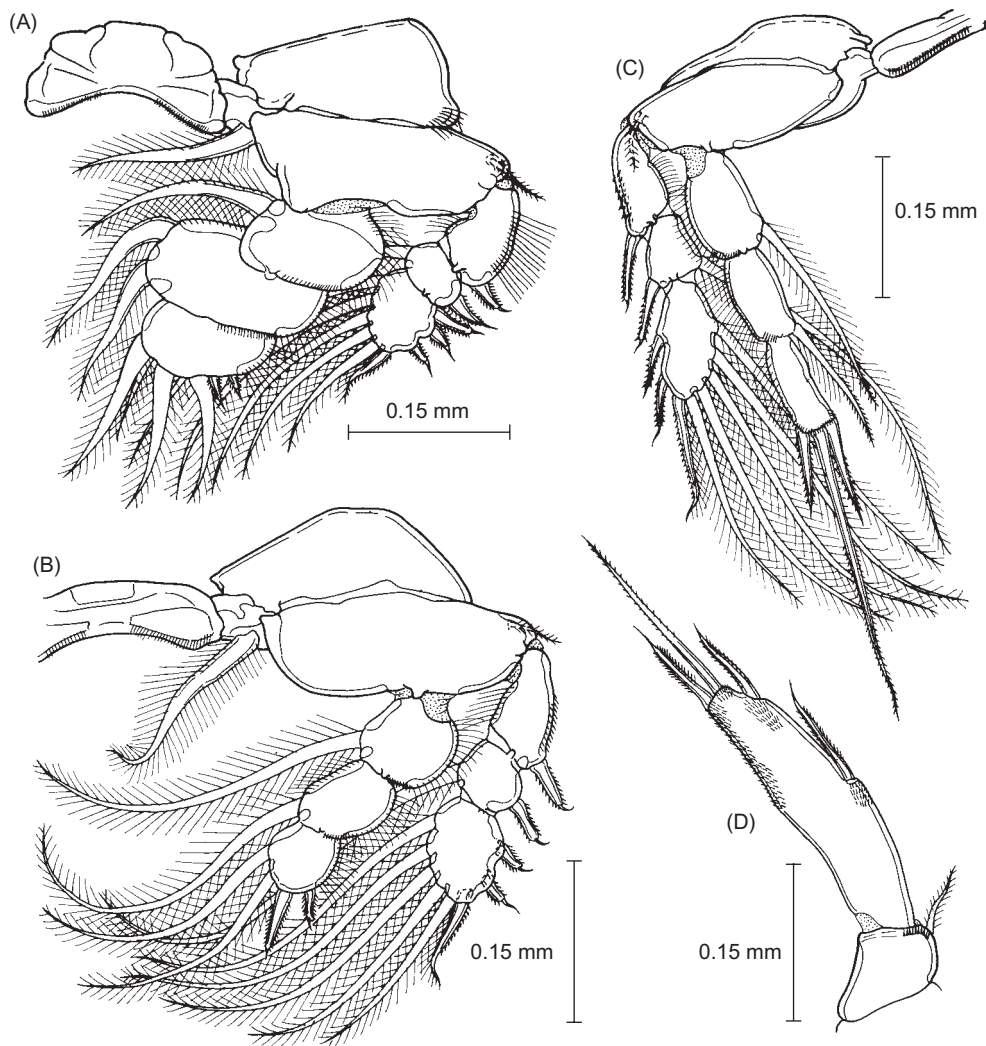


Fig. 3. *Unicolax ciliatus* Cressey and Cressey, 1980, female. (A) Leg 2 and intercoxal plate, ventral view; (B) leg 3 and intercoxal plate; (C) leg 4 and intercoxal plate; (D) leg 5, anterior view.

spines on legs 2 (Fig. 3A), 3 (Fig. 3B), and 4 (Fig. 3C) armed with spinules bilaterally and tipped with a flagellum. Leg 5 (Fig. 3D) 2-segmented; proximal segment short, armed with 1 small, plumose outer seta; distal segment 3.75 times as long as wide, ornamented with 4 patches of spinules, and armed with 3 bilaterally barbed, straight spines with terminal flagellum and 1 long, spiniform seta. Leg 6 represented by 3 long, pinnate setae on protuberance located in pit for attachment of egg sac

(Fig. 11).

Male: Not found.

Remarks: This species of *Unicolax* was first reported by Cressey and Cressey (1980) from 6 species of Spanish mackerel (*Scomberomorus*) occurring in the Indo-West Pacific and the Gulf of Guinea. It is so far the only species of *Unicolax* found on species of this genus of scombrids.

The original description of *U. ciliatus* given by Cressey and Cressey (1980) was based on speci-

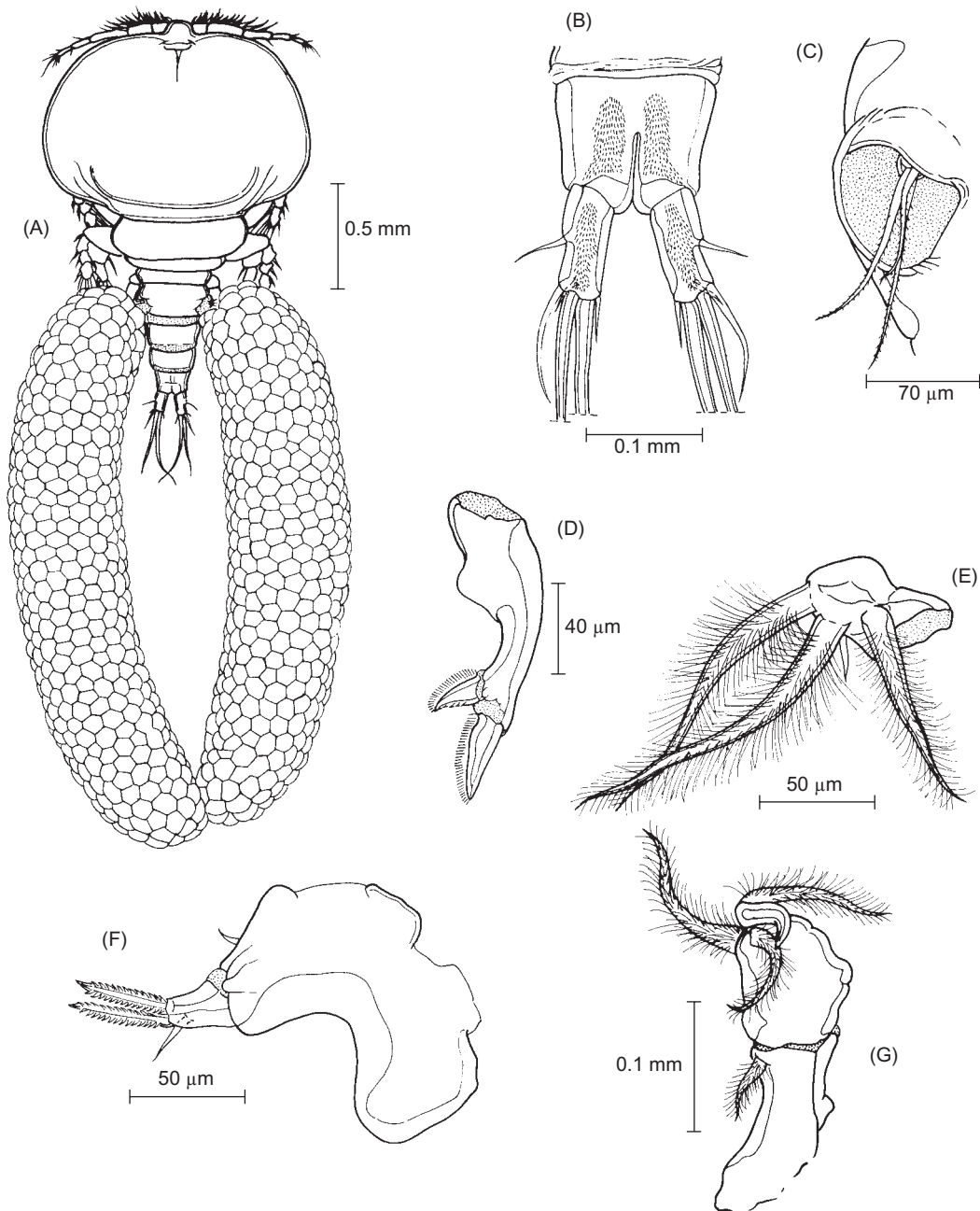


Fig. 4. *Unicolax collateralis* Cressey and Cressey, 1980, female. (A) Habitus, dorsal view; (B) anal segment and caudal rami, ventral view; (C) egg sac attachment area, dorsal view; (D) mandible; (E) maxillule; (F) maxilla; (G) maxilliped.

mens obtained from the Kanadi kingfish, *Scomberomorus plurilineatus* Fourmanoir collected in the Zanzibar Channel. The specimen that we found in the nostril of *S. commerson* from Taiwan shows some morphological differences from the original description. For instance, we found that the egg sacs of the specimen from Taiwan is

longer (vs. shorter) than the urosome and there are 3 (instead of 2) outer spines on the terminal segment of the exopod of leg 1. Examination of the paratypic female of *U. ciliatus* (USNM 172255) deposited in the Smithsonian Institution revealed that while the dissimilarity in the egg sac is likely due to the difference in the maturity of the speci-

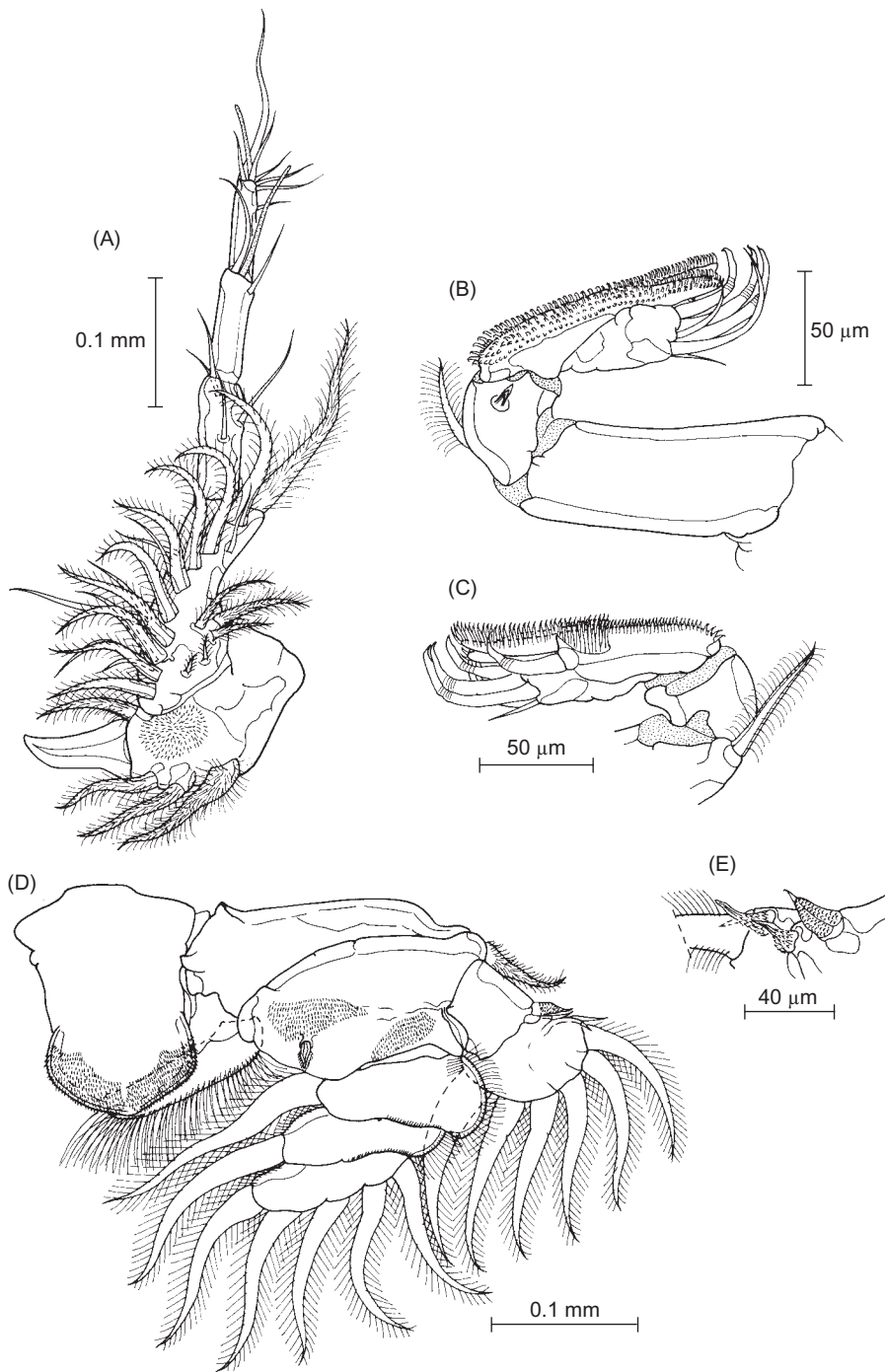


Fig. 5. *Unicolax collateralis* Cressey and Cressey, 1980, female. (A) Antennule, ventral view; (B) antenna, anterior view; (C) distal 1/2 of antenna, posterior view; (D) leg 1 and intercoxal plate, anterior view; (E) outer spines on exopod of leg 1, posterior view.

men or geographical variation, the number of outer spines on the leg 1 exopod is due to the authors' failure to examine the posterior surface of the appendage.

***Uicolax collateralis* Cressey and Cressey,
1980
(Figs. 4-6)**

Uicolax collateralis Cressey and Cressey 1980: 8; Ho et al. 1983: 6; Cressey 1986: 138; Boxshall and Montu 1996:

17.

Cephalocolax katsuwni Avdeev 1980: 334.

Material examined: In total, 7 ♀♀ recovered from nasal cavities of the kawakawa, *Euthynnus affinis* (Cantor) landed at Dong-Shih Fishing Port: 6 ♀♀ from 3 hosts caught on 3 Dec. 1999 and 1 ♀ from 1 host caught on 30 Dec. 1999. Additionally examined 34 paratypes (USNM 172258; ♀♀, ♂♂) from nasal sinus of *Euthynnus alletteratus* (Rafinesque) caught in St. George Bay, Lebanon.

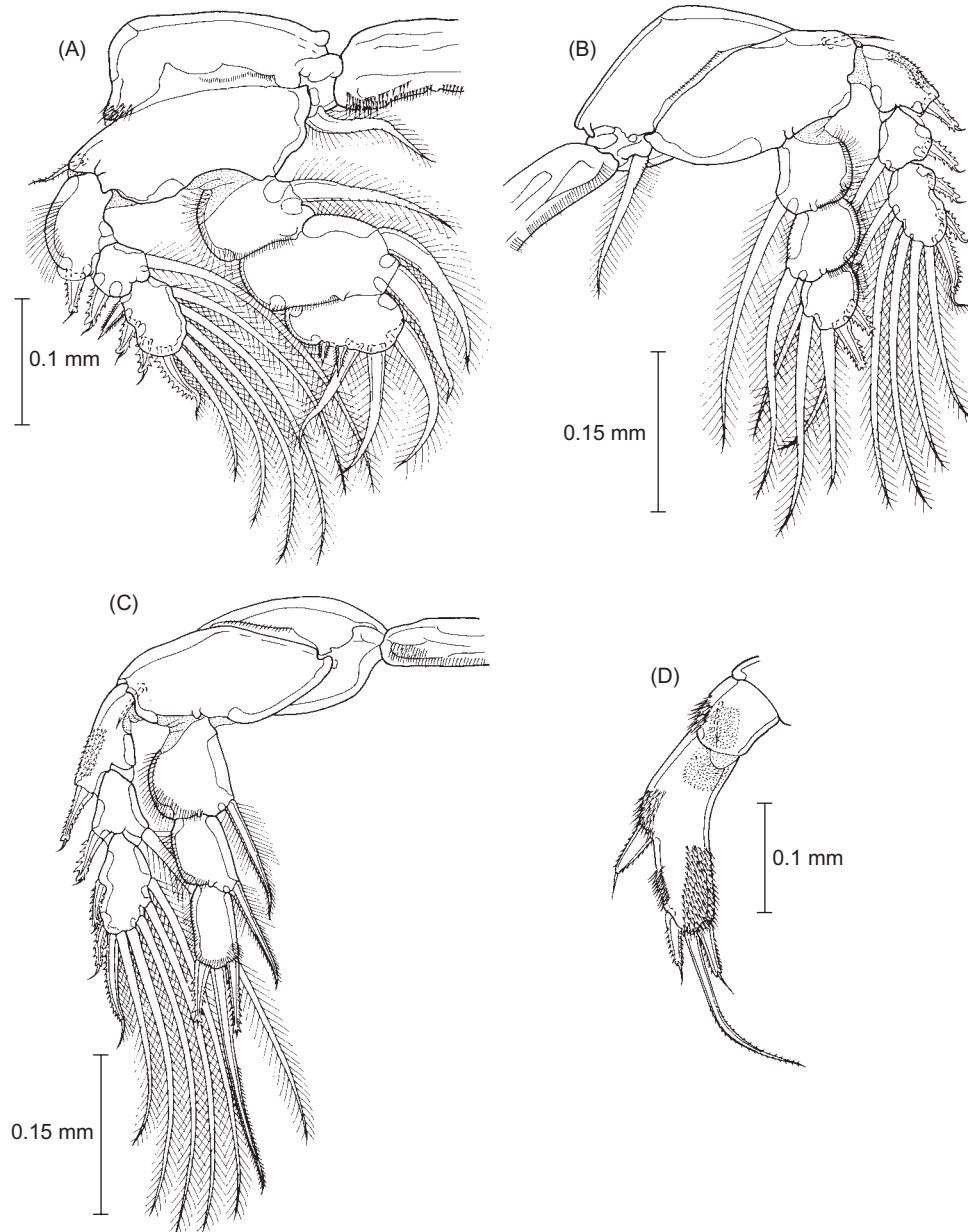


Fig. 6. *Uicolax collateralis* Cressey and Cressey, 1980, female. (A) Leg 2 and intercoxal plate, ventral view; (B) leg 3 and intercoxal plate, ventral view; (C) leg 4 and intercoxal plate, ventral view; (D) leg 5, anterior view.

Female: Body (Fig. 4A) 1.72 (1.40-2.14) mm long, excluding setae on caudal rami. Cephalothorax wider than long, 0.75 (0.71-0.79) x 1.10 (1.00-1.18) mm, with large posterodorsal protrusion concealing dorsally large portion of 2nd pediger. Third pediger also covering large portion of 4th pediger. Urosome shorter than prosome. Genital complex (Fig. 4A) wider than long, 0.18 (0.16-0.20) x 0.30 (0.28-0.32) mm, with area of egg sac attachment protruding laterally. Abdomen 3-segmented, all somites wider than long, ventral surface of anal somite with 2 large patches of spinules (Fig. 4B). Caudal ramus (Fig. 4B) longer than wide, 96 (89-105) x 47 (41-49) μm , armed with 4 short and 2 long setae. Egg sac large, sausage-shaped, longer than body, and containing numerous rows of eggs.

Rostral area (Fig. 4A), mandible (Fig. 4D), maxillule (Fig. 4E), maxilla (Fig. 4G), and maxilliped (Fig. 4G) generally as those in *U. ciliatus*; but antennule (Fig. 5A) differing in having stouter spine and a patch of spinules on 1st segment and antenna (Fig. 5B, C) with indistinguishably fused last 2 segments of endopod.

Formula of armature on rami of legs 1-4 as in *U. ciliatus*. Leg 1 ornamented with 2 patches of denticles on posteroventral surface of intercoxal plate and another 2 patches of denticles on anterior surface of basis where there is a stout spine (Fig. 5D). Outer spines on exopod covered basally with denticles (Fig. 5E). Leg 2 with rows of long spinules on posterior edge of intercoxal plate and outer-distal area of coxa (Fig. 6A). Outer spines on exopod of leg 2 bilaterally serrated, except for proximal spine on terminal segment which is spinulated instead. All spines on legs 3 (Fig. 6B) and 4 (Fig. 6C) bilaterally serrate and also tipped with a flagellum. Leg 5 (Fig. 6D) curved inward at base of distal segment and appearing stouter and more heavily ornamented than *U. ciliatus*. Leg 6 (Fig. 4C) as in previous species.

Male: Not found.

Remarks: This is the most widely distributed species of *Unicolax*. Cressey and Cressey (1980) found it inside the nasal cavities of 8 species of scombrids, including *Euthynnus affinis*, from various waters in the tropical and subtropical zones throughout the world. Therefore our finding of *N. collateralis* on *E. affinis* caught in the waters of Taiwan is not surprising.

The most characteristic feature of the present species is the possession of a pair of unusually large egg sacs in the female. Each is nearly twice as wide as the genital double somite (the widest

level of the urosome) and 3.9 times as long as the urosome.

A close comparison of our specimens with the work of Cressey and Cressey (1980) revealed that there is a discrepancy in the number of outer spines on the terminal segment of the exopod of leg 1. It was described as having "2 short, outer flagellate spines" but we found 3 in all of our specimens (see Fig. 5E). Examination of the 29 (7 ovigerous ♀♀, 16 ♂♂, 5 juvenile ♀♀ and 1 copepodid) paratypes of *U. collateralis* (USNM 172258) deposited in the Smithsonian Institution revealed that one of the 3 outer spines was overlooked by Cressey and Cressey (1980).

***Unicolax longispinus* sp. nov.**

(Figs. 7-11)

Material examined: In total, 342 ♀♀ and 6 ♂♂ recovered in nasal sinuses of melon seed, *Psenopsis anomala* (Temminck and Schlegel): 122 ♀♀ and 2 ♂♂ on 28 (of 60) hosts landed at Hsing-Dah Fishing Port on 24 Dec. 1997; 148 ♀♀ on 47 (of 83) hosts landed at Hsing-Dah Fishing Port on 14 Jan. 1999; and 72 ♀♀ and 4 ♂♂ on 19 (of 24) hosts landed at Dong-Shih Fishing Port on 10 Nov. 2000. Holotype female (USNM 1072187), allotype male (USNM 1072188), 30 paratype females (USNM 1072189) and 1 paratype male (USNM 1072190) have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC.

Female: Body (Fig. 7A) 1.11 (0.75-1.44) mm long, excluding setae on caudal rami. Cephalothorax wider than long, 338 (235-470) x 527 (348-680) μm . First pediger completely fused to cephalosome, but pedigers on prosome distinctly separated from each other and becoming smaller posteriorly. Urosome (Fig. 7B) slender, about 45.3% of body length. Genital complex (Fig. 4B) wider than long, 140 (113-178) x 154 (97-259) μm , with area of egg sac attachment protruding laterally. Abdomen (Fig. 7B) 3-segmented, ventral surface of anal somite with 2 large patches of spinules (Fig. 7C). Caudal ramus (Fig. 7C) also with large patch of spinules; ramus longer than wide, 50 (32-65) x 28 (16-41) μm , and armed with 4 short, 1 medially long, and 1 long setae. Egg sac large, containing numerous rows of eggs.

Rostral area (Fig. 7A), labrum (Fig. 7E), mandible (Fig. 7D), maxillule (Fig. 8D), maxilla (Fig. 7H), and maxilliped (Fig. 8E) generally as those in previous 2 species. Antennule (Fig. 8A) bearing long, straight spine on proximal segment,

otherwise as in previous 2 species. Antenna (Fig. 8B) 3-segmented as in *U. collateralis*; but differing from it in having fewer rows of, but larger, denticles. Labrum (Fig. 7E) spinulose. Paragnath (Fig. 7G) more spinulose than in previous 2 species.

Formula of armature on rami of legs 1-4 as in previous 2 species, except leg 2 with only 1 medial seta on middle segment of leg 2. Ornamentation on leg 1 also as in *U. collateralis* except for larger patch of spinules on 1st 2 segments of endopod (Fig. 9A) and stouter outer spines on distal segment of exopod (Fig. 9B). Spines on legs 2 (Fig. 9C), 3 (Fig. 9D), and 4 (Fig. 8F) more slender than those on *U. collateralis* and armed with fine spin-

ules instead of teeth. Leg 5 (Fig. 9E) straight as in *U. ciliatus* but more heavily ornamented. Leg 6 (Fig. 7B) as in previous 2 species.

Male: Body (Fig. 10A) 620 (577-665) μm long, excluding setae on caudal rami. Cephalothorax wider than long, 203 (179-203) \times 240 (211-271) μm , with rostral region protruding anteriorly. First pediger completely fused to cephalosome, but remaining pedigers on prosome distinctly separated from each other and becoming narrower posteriorly. Urosome shorter than prosome, occupying 45.4% of body length. Genital somite longer than wide, 122 (115-127) \times 81 (80-84) μm , with posterolateral protrusion. Abdomen 2-segmented, with 1

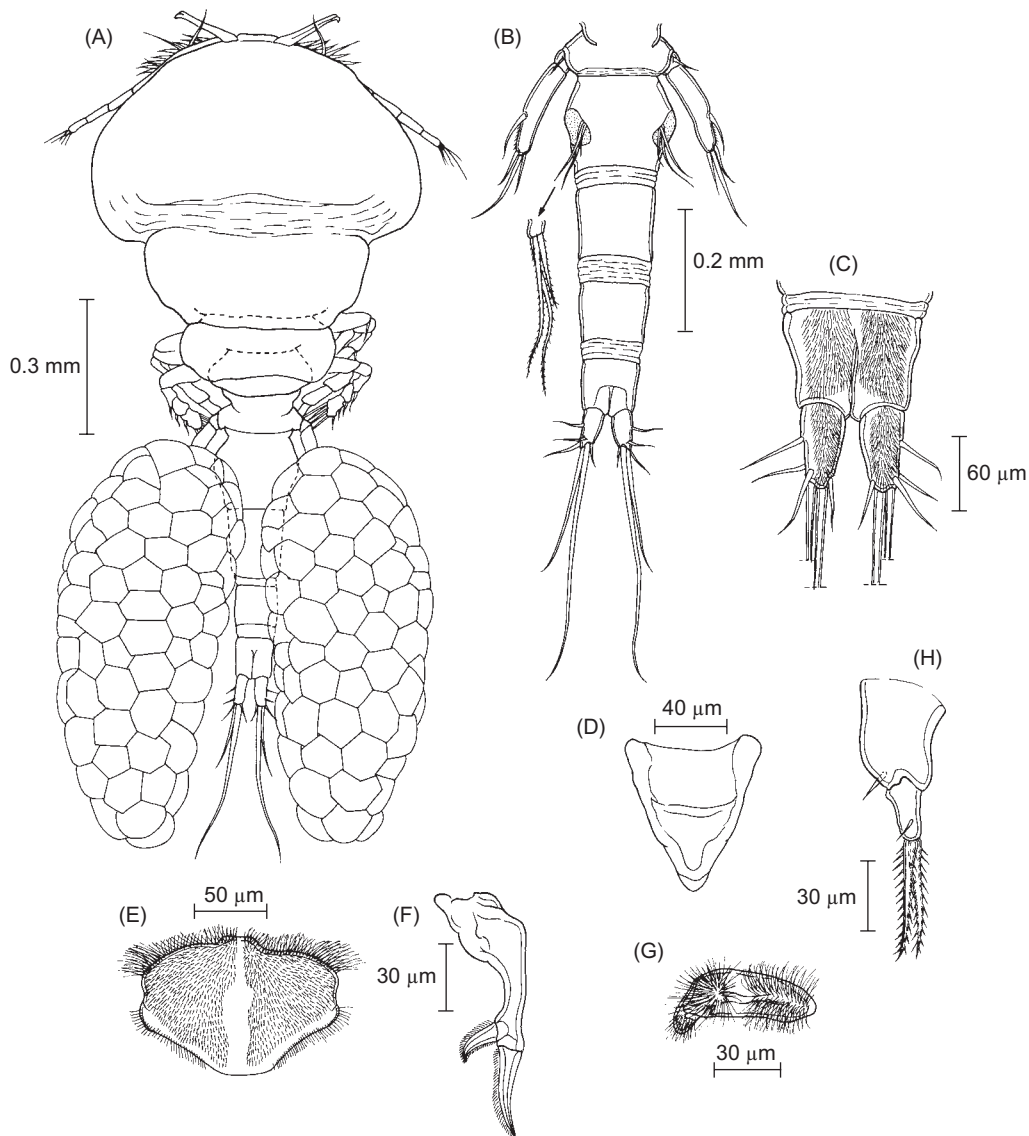


Fig. 7. *Unicolax longispinus* sp. nov., female paratype. (A) Habitus, dorsal view; (B) urosome, dorsal view; (C) anal segment and caudal rami, ventral view; (D) rostrum, ventral view; (E) labrum, ventral view; (F) mandible; (G) paragnath; (H) maxilla.

row of spinules on ventral side across anterior 1/3 and posterior margin of anal somite (Fig. 10B). Caudal ramus (Fig. 10B) longer than wide, 31 (29-32) x 18 (17-19) μm , and armed with 1 long and 5 short, naked setae.

Antennule (Fig. 10C) 5-segmented, with 2-segmented basal part carrying 21 obtuse, plumose, or pilose setae and 4 slender, naked setae; armature of distal 3 segments as in female except for two of 4 setae on 1st segment being large and pilose. Antenna (Fig. 10D) essentially as in female, only smaller and bearing fewer, but larger, denticles on terminal segment (Fig. 10E). Maxilliped (Fig. 10F) 4-segmented; proximal segment armed with a long, plumose seta; 2nd segment largest, with large patch of denticles on mid outer surface and row of long spines on medial margin in addition to 2 myxal setae; 3rd segment smallest and unarmed; terminal segment a long, curved claw with serrations on medial margin of distal 1/2 and 3 basal spiniform setae.

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

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

Basis of leg 1 (Fig. 11A) with posterior process between 2 rami. Outer spines on legs 2 (Fig. 11B), 3 (Fig. 11C), and 4 (Fig. 11D) constructed as those in female with spinules on both sides and a terminal flagellum. Leg 5 (Fig. 11E) with only 2 terminal elements on distal segment. Leg 6 not seen.

Etymology: The species name *longispinus* is a combination of *longi* (= long) and *spina* (= thorn or spine) in Latin. It alludes to the transformation of the 4th element on the antennule into a greatly elongated, large spine.

Remarks: The melon seed, *Psenopsis anomala* (Temminck and Schlegel), is a commercial fish commonly caught by trawlers along the west coast of Taiwan in the later part of the year from Oct. to Jan. In our past 7 yrs of surveys, we have examined 167 melon seeds on 3 occasions and found 342 females and 6 males of *U. longispinus* in the nostrils of 94 (40%) of them. In spite of thorough

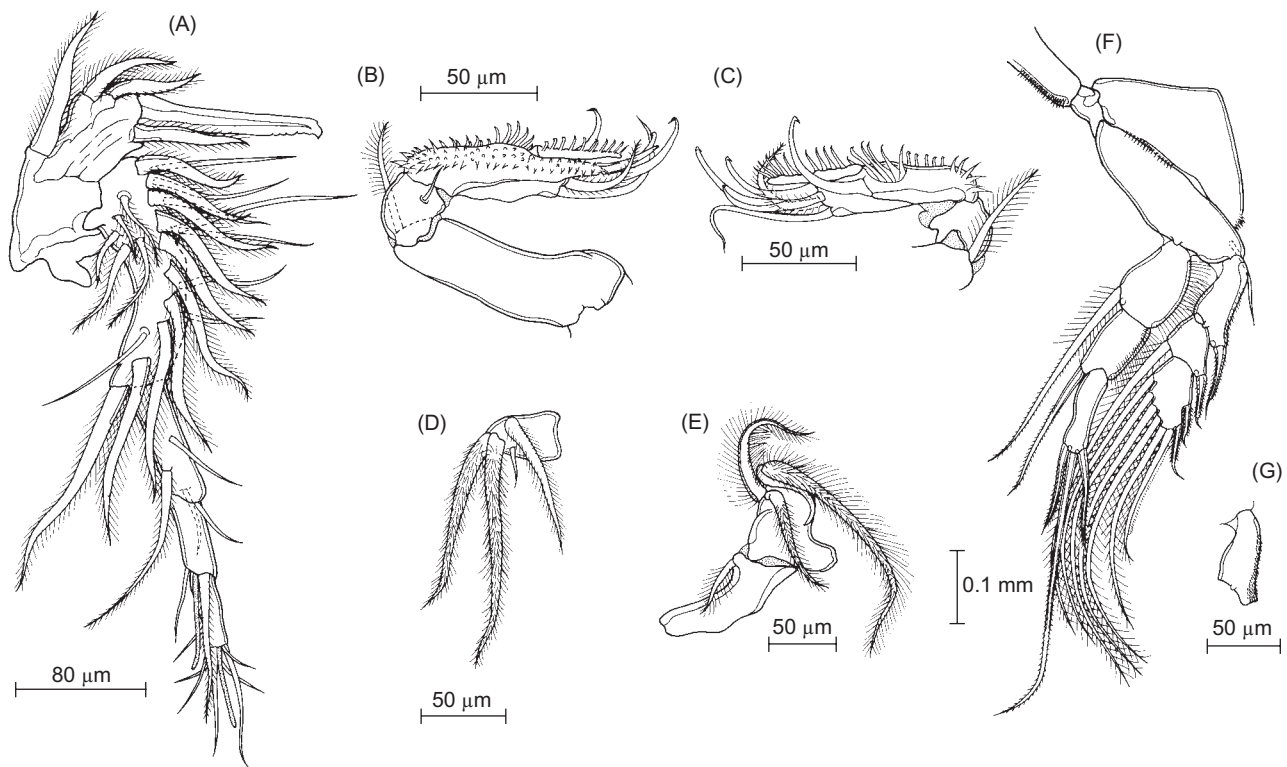


Fig. 8. *Unicolax longispinus* sp. nov., female paratype. (A) Antennule, ventral view; (B) antenna, anterior view; (C) distal 1/2 of antenna, posterior view; (D) maxillule; (E) maxilliped; (F) leg 4 and intercoxal plate, ventral view; (G) proximal segment of leg 4 exopod, dorsal view.

and attentive examination, no other parasitic copepods were found on this demersal fish.

As the species name indicates, the new species is characterized by having its 4th element on the antennule transformed into a long, straight spine longer than its neighboring plumose setae. Another characteristic feature of this species is having only 1 medial seta on the middle segment of the endopod of leg 2.

***Uicolax quadrispinulus* sp. nov.**
(Figs. 12-14)

Material examined: In total, 30 ♀♀ and 1

larva recovered in nasal sinuses of the silver sillago, *Sillago sihama* (Forsskål): 20 ♀♀ and 1 copepodid on 13 (of 82) hosts landed at Hsing-Dah Fishing Port on 24 Dec. 1997; and 10 ♀♀ on 9 (of 67) hosts landed at Dong Shih Fishing Port on 15 Oct. 1999. Holotype (USNM 1072191) and 10 paratypes (USNM 1072192) have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC.

Female: Body (Fig. 12A) 732 (640-867) µm long, excluding setae on caudal rami. Cephalothorax protruding anteriorly and wider than long, 259 (186-324) x 404 (365-446) µm. First pediger completely fused to cephalosome, 2nd

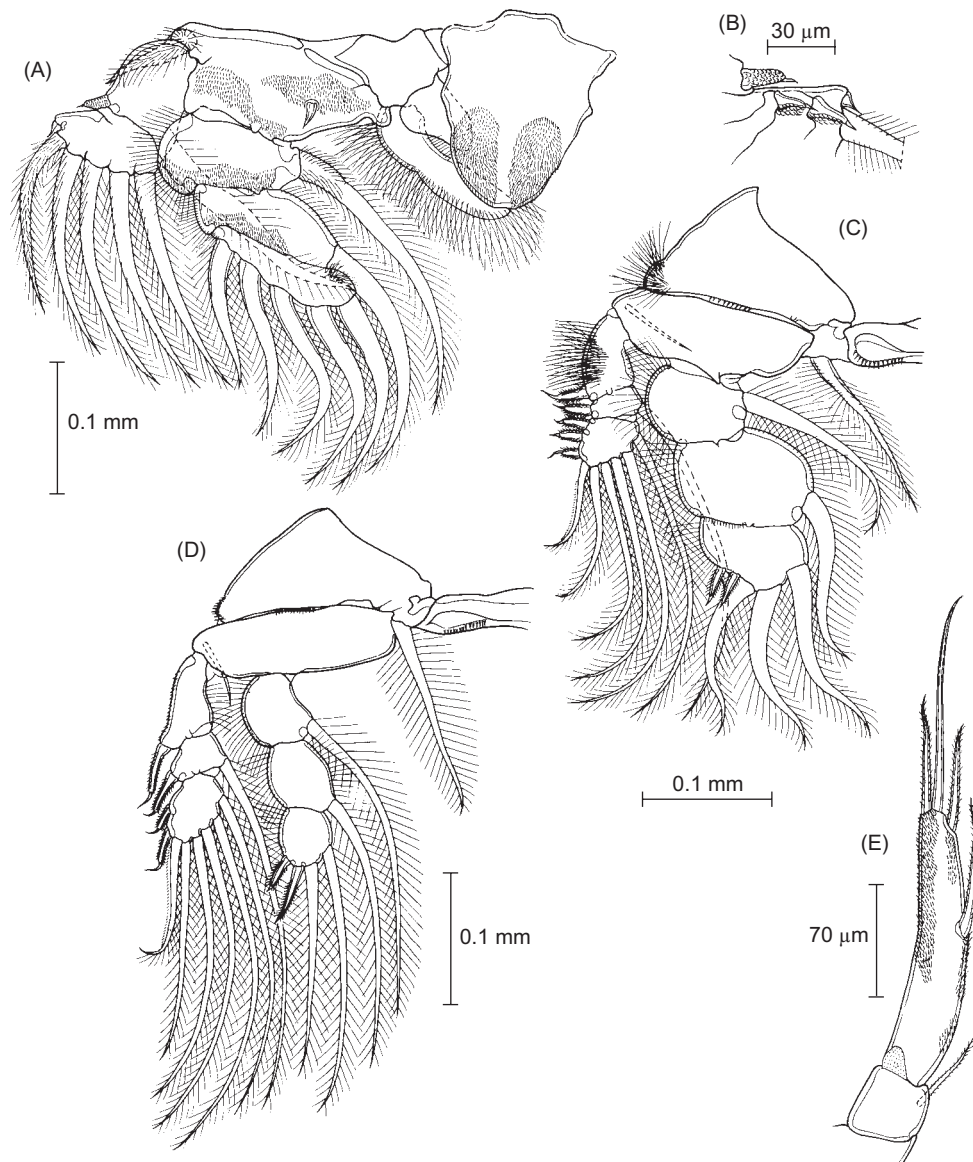


Fig. 9. *Uicolax longispinus* sp. nov, female paratype. (A) Leg 1 and intercoxal plate, anterior view; (B) outer spines on exopod of leg 1, posterior view; (C) leg 2 and intercoxal plate, ventral view; (D) leg 3 and intercoxal plate, ventral view; (E) leg 5, anterior view.

pediger (1st free somite posterior to cephalosome) distinctly larger than following 2 somites (3rd and 4th pedigers) combined. Urosome distinctly shorter than prosome, occupying only 37.6% of body length. Genital complex (Fig. 12B) wider than long, 88 (81-104) x 120 (105-154) μm , with area of egg sac attachment protruding laterally. Abdomen (Fig. 12B) 3-segmented, all somites wider than

long, ventral surface of anal somite almost completely covered with spinules (Fig. 12C). Caudal ramus (Fig. 12C) longer than wide, 32 (24-36) x 17 (16-20) μm , and armed with 5 short, naked setae and 1 long, spiniform seta. Egg sac (Fig. 12A) large, longer than prosome, containing numerous rows of eggs.

Rostrum (Fig. 12D), labrum (Fig. 12E), parag-

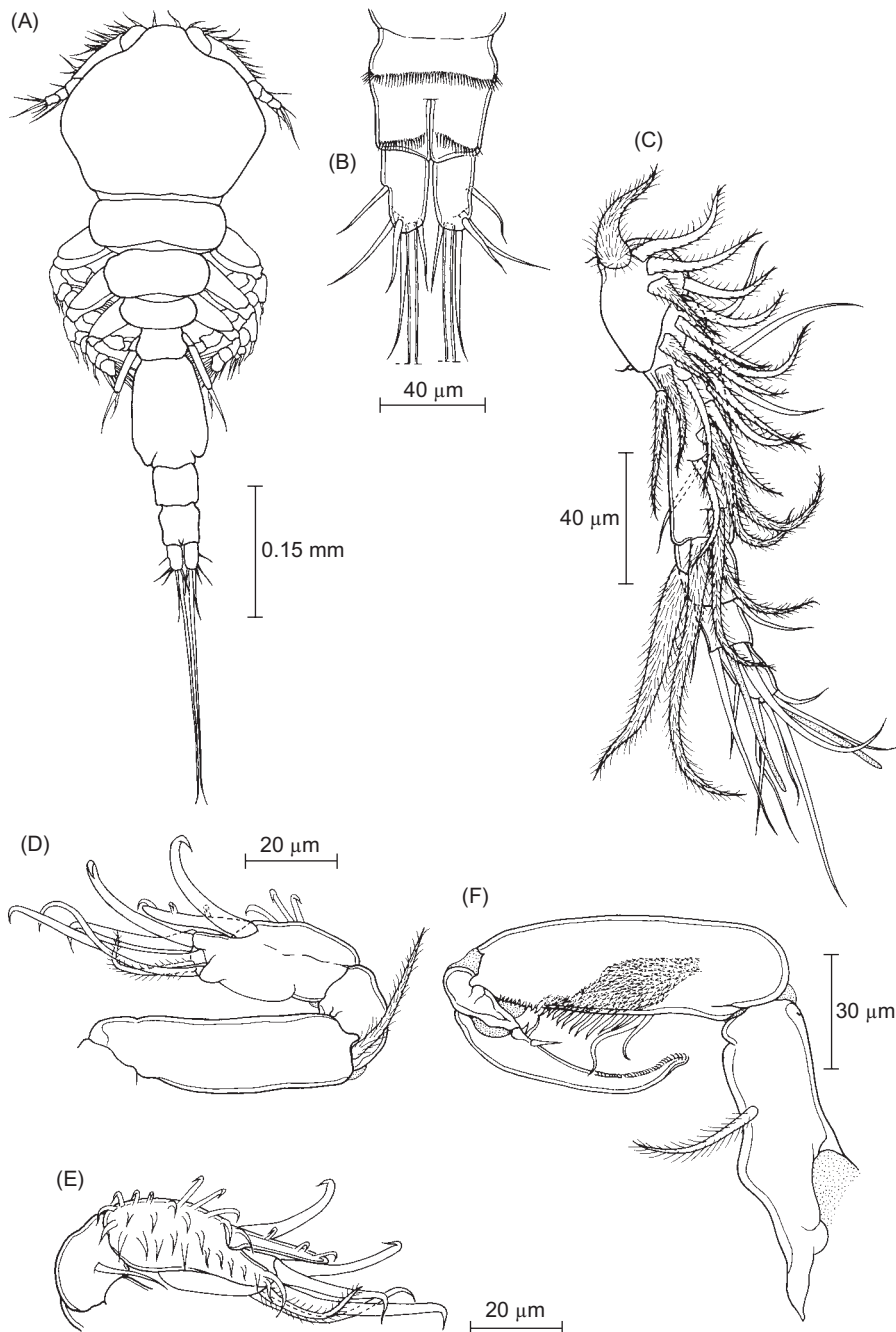


Fig. 10. *Unicolax longispinus* sp. nov., male paratype. (A) Habitus, dorsal view; (B) anal segment and caudal rami, ventral view; (C) antennule, ventral view; (D) antenna, anterior view; (E) distal 1/2 of antenna, posterior view; (F) maxilliped.

nath (Fig. 12G), maxillule (Fig. 13D), maxilla (Fig. 12H), and maxilliped (Fig. 13E) generally as those in *U. ciliatus*. Antennule (Fig. 13A) as in *U. collateralis* with a stout spine on proximal segment. Antenna (Figs. 13B, C) as in *U. collateralis* with terminal 2 segments of endopod indistinguishable due to being fused. Mandible (Fig. 12F) differing from previous 3 species in having both terminal

blades with serrations along posterior margin.

Leg 1 differing from previous 3 species in bearing a small outer spine on terminal segment of endopod (Fig. 14A) and 4 outer spines on terminal segment of exopod (Fig. 14B). Legs 2 (Fig. 14C), 3 (Fig. 14D), and 4 (Fig. 13F) constructed essentially as in *U. longispinus*. Leg 5 (Fig. 13G) 2-segmented, proximal segment short, armed with 1

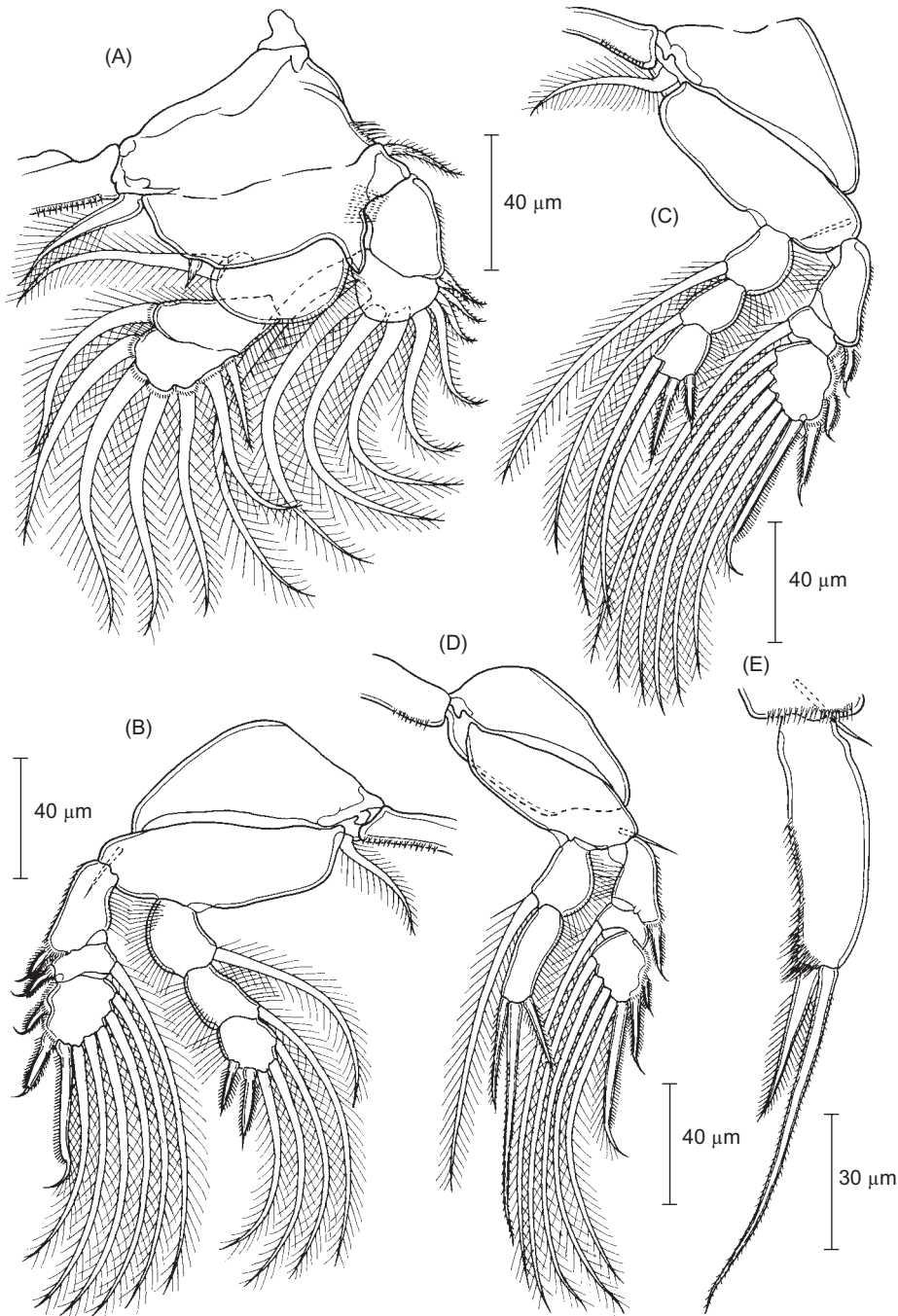


Fig. 11. *Unicolax longispinus* sp. nov., male paratype. (A) Leg 1 and intercoxal plate, ventral view; (B) leg 2 and intercoxal plate, ventral view; (C) leg 3 and intercoxal plate, ventral view; (D) leg 4 and intercoxal plate, ventral view; (E) leg 5, anterior view.

naked, outer seta; distal segment about 3 times as long as wide, ornamented with 2 long patches of spinules, and armed with 3 bilaterally pinnate spines and 1 long, spiniform seta. Leg 6 represented by 3 long, naked setae on protuberance located in pit for attachment of egg sac (Fig. 12B).

Male: Unknown.

Etymology: The species name *quadrispinulus* is a combination of Latin words *quadri* (= 4) and *spinulus* (diminutive of *spina*, or small spine). It alludes to the possession of 4 small spines on the

outer margin of the distal segment of the leg 1 exopod.

Remarks: As most species of *Unicolax* are known to have 3 outer spines on the distal segment of their first exopod, being equipped with 4 spines in the same area in the present species (see Fig. 14B) is unique to the genus. As far as this state of character is concerned, *U. reductus* Cressey and Cressey, 1980 is also unique in the sense that the outer spine on this segment of leg 1 is reduced to only 1 (Cressey and Cressey, 1980).

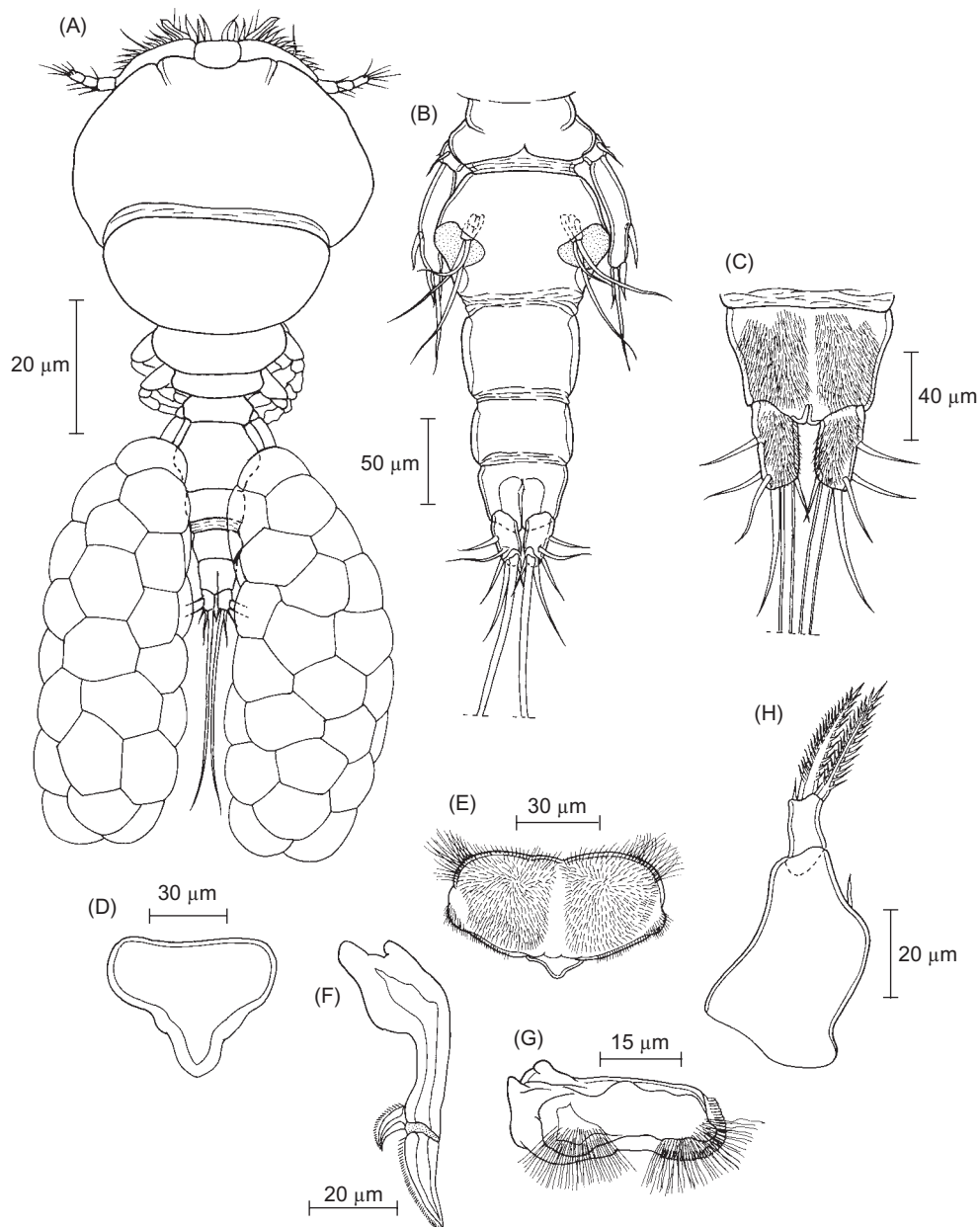


Fig. 12. *Unicolax quadrispinulus* sp. nov., female paratype. (A) Habitus, dorsal view; (B) urosome, dorsal view; (C) anal segment and caudal rami, ventral view; (D) rostrum, ventral view; (E) labrum, ventral view; (F) mandible; (G) paragnath; (H) maxilla.

The silver sillago, *Sillago sihama* (Forsskål), is common to the coastal waters of the Indo-West Pacific region. As far as we are aware, 4 species of parasitic copepods have been reported from this fish: *Acanthochondria shawi* Yü from Japan (Yamaguti 1939), *Lernanthropus sillaginis* Pillai from India (Pillai 1963) and China (Song and Chen 1976), *L. villiersi* Delamare-Deboutteville and Nunes-Riuvio from Sri Lanka (Kirtisinghe 1964), *Parabrachiella sihama* Song and Chen from China

(Song and Chen 1976), and *Caligus epinepheli* Yamaguti from Malaysia (Leong 1984). All of them were found in the gill cavities of their hosts. Therefore, this is the first report of a bomolochid copepod from the silver sillago. In Taiwan, this species of coastal fish carries another species of bomolochid, *Nothobomolochus lateolabracis* (Yamaguti and Yamasu), in the gill cavities (Lin and Ho 2005).

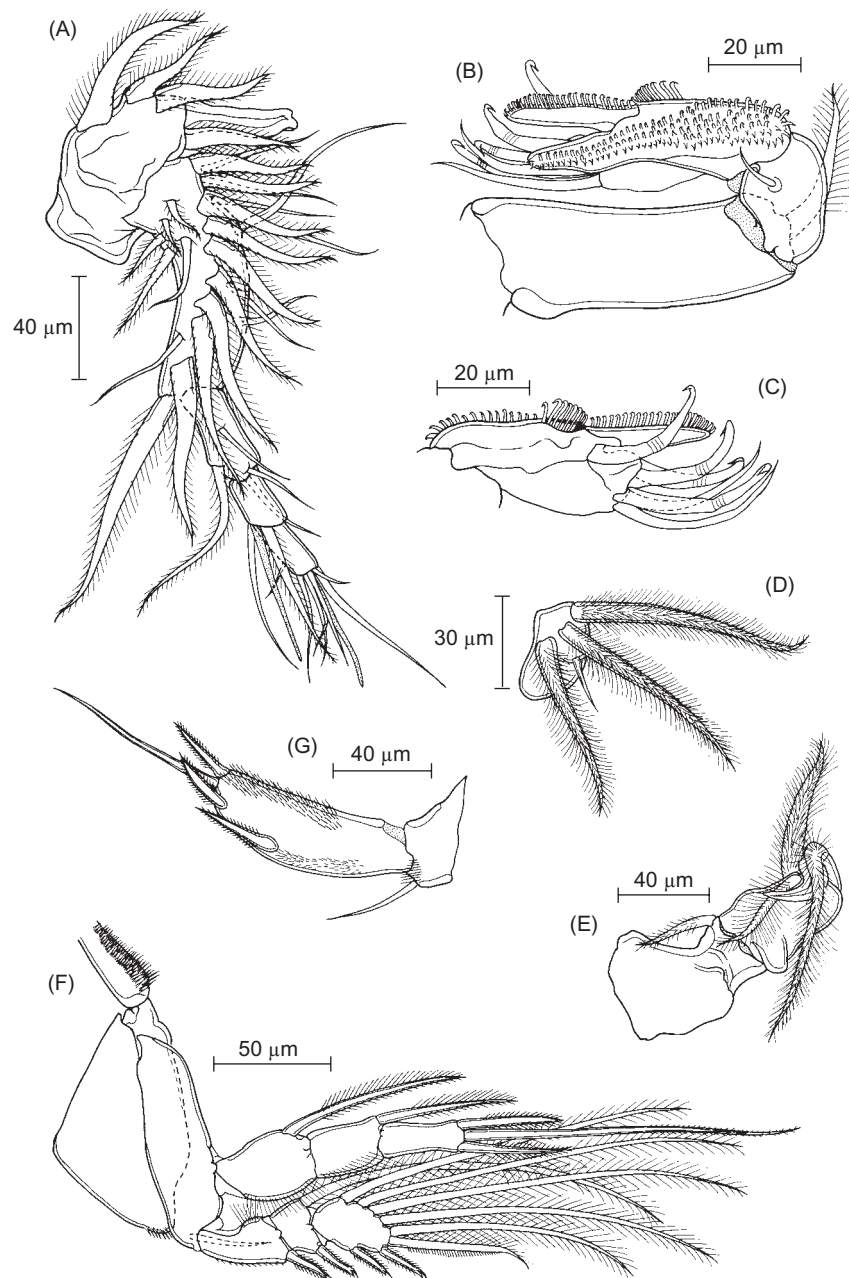


Fig. 13. *Unicolax quadrispinulus* sp. nov., female paratype. (A) Antennule, ventral view; (B) antenna, anterior view; (C) distal 1/2 of antenna, posterior view; (D) maxillule; (E) maxilliped; (F) leg 4 and intercoxal plate, ventral view; (G) leg 5, anterior view.

Key to the species of *Unicolax*

At the time when Cressey and Cressey (1980) established the genus *Unicolax* to accommodate 3 species of bomolochids obtained from the nasal sinuses of tuna-like fishes (Scombridae), they also transferred to it 2 species of *Parabomolochus* reported by Vervoort (1965) also from the nasal fossae of scombrids. Those 5

species of *Unicolax* are *U. anonymous* (Vervoort, 1965); *U. ciliatus* Cressey and Cressey, 1980; *U. collateralis* Cressey and Cressey, 1980; *U. mycterobius* (Vervoort, 1965); and *U. reductus* Cressey and Cressey, 1980 (Table 1).

Three yrs later, Roubal et al. (1983) reported a 6th species of the genus *Unicolax*, *U. chrysophryenus* Roubal, Armitage and Rohde, 1983, from a non-scombrid fish, *Chrysophrys aura-*

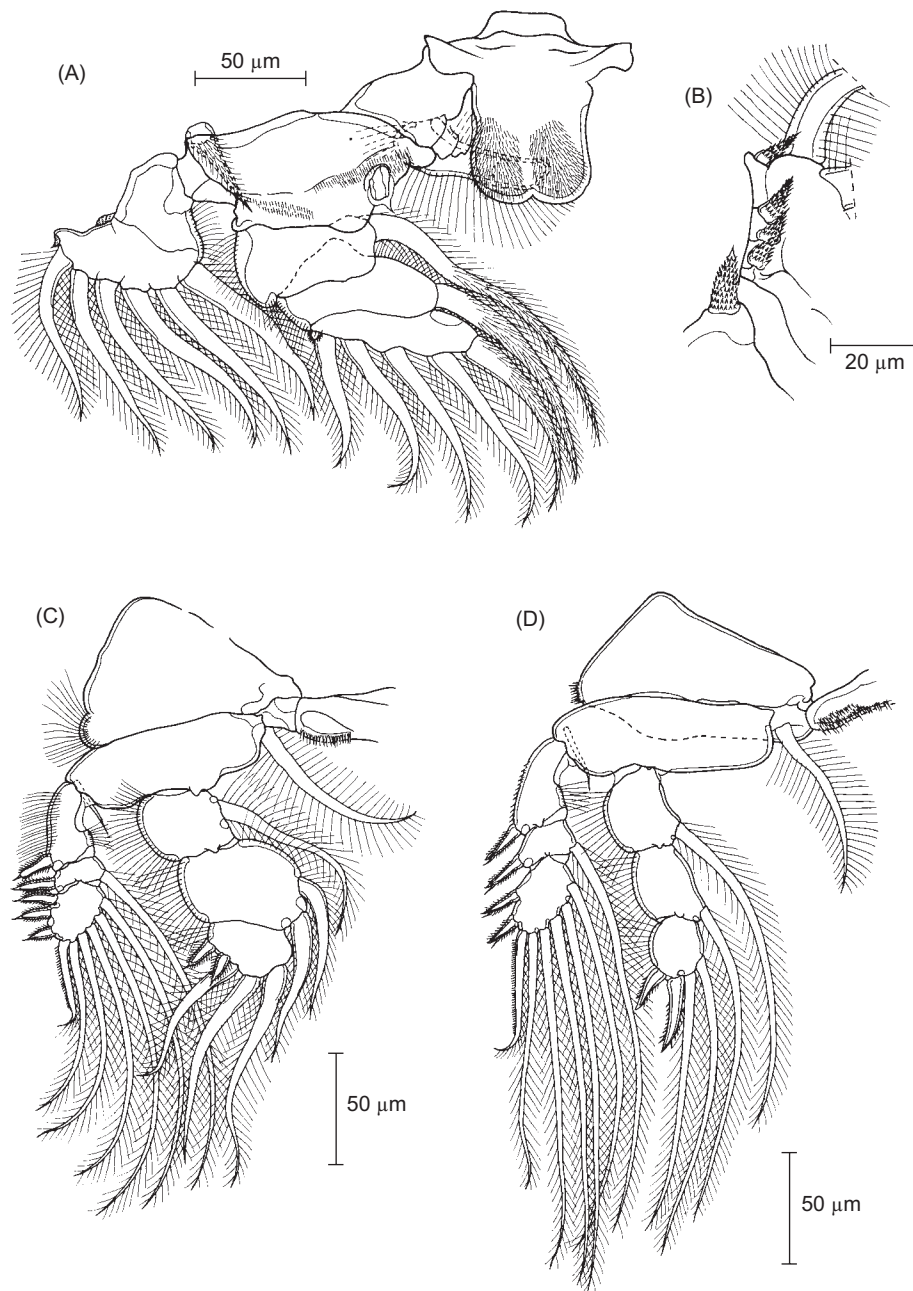


Fig. 14. *Unicolax quadrispinulus* sp. nov., female paratype. (A) Leg 1 and intercoxal plate, anterior view; (B) outer spines on exopod of leg 1, posterior view; (C) leg 2 and intercoxal plate, ventral view; (D) leg 3 and intercoxal plate, ventral view.

tus (Forster), in New Zealand. Although Byrnes (1986) transferred *U. chrysophryenus* to *Bomolochus*, Sharples and Evans (1993) rejected the transfer and moved the species back to *Unicolax*. Nevertheless, our close reexamination of both works by Roubal et al. (1983) and Sharples and Evans (1993) shows that the bomolochid in question is a species of *Naricolax*. The fish nostril habitat, the possession of a spine on the basal segment of the antennule, and 2 medial setae on the middle segment of leg 3 endopod are some of the evidence supporting its placement in *Naricolax*. Therefore, before the present work, there were still 5 species of *Unicolax* known as in 1980 when Cressey and Cressey proposed the establishment of the genus.

Since four of the 7 species of *Unicolax* are known from Taiwan and identification of the species in the genus has not been made clear in the past, we felt it was timely to provide a key for the quick and easy identification of the 7 species.

As in many species of parasitic copepods, the male is not known for all 7 species of *Unicolax*. Therefore, while 7 species are found in the following key for females, only 6 species are dealt with in that for males.

Key to females

1. Second pediger with a pair of dorsolateral, aliform expansions; armature of leg 3 exopod II,1,4 *reductus*
Second pediger without aliform expansion; armature of leg 3 exopod II,1,5 (Fig. 6B) 2
2. Cephalothorax with posterodorsal expansion; formula of leg 4 exopod II,1,4 *anonymous*
Cephalothorax without posterodorsal expansion; armature of leg 4 exopod II,1,5 (Fig. 6C) 3
3. Proximal outer spine on 3rd segment of leg 2 exopod bilaterally pinnate (Fig. 6A), other 2 spines with teeth on both edges *collateralis*
All outer spines on 3rd segment of leg 2 exopod bilaterally pinnate (Fig. 3A) 4
4. Outer margin of proximal segment of leg 2 exopod without long setules, all outer spines on this ramus armed with teeth on both edges *mycterobius*

Table 1. Hosts and localities of the 7 species of *Unicolax*

<i>U. anonymus</i> (Vervoort, 1965)	<i>Euthynnus alletteratus</i> (Rafinesque)	Gulf of Guinea, Gulf of Mexico
<i>U. ciliatus</i> Cressey and Cressey, 1980	<i>Scomberomorus commerson</i> (Lacepède)	Madagascar, India, Thailand, Hong Kong, the Philippines, Java, Taiwan
	<i>Scomberomorus guttatus</i> (Bloch and Schneider)	India, Sumatra, Singapore, Java, Hong Kong, China
	<i>Scomberomorus nipponius</i> (Cuvier)	Korea, China
	<i>Scomberomorus plurilineatus</i> Fourmanoir	Zanzibar Channel
	<i>Scomberomorus semifasciatus</i> (Macleay)	New Guinea
	<i>Scomberomorus tritor</i> (Cuvier)	Liberia, Ghana, Nigeria
<i>U. collateralis</i> Cressey and Cressey, 1980	<i>Auxis</i> sp.	Massachusetts, Lebanon, Egypt, Hong Kong, Japan, Philippines, China, Hawaii
	<i>Cybiosarda elegans</i> (Whitley)	Australia
	<i>Euthynnus affinis</i> (Cantor)	Israel, Mozambique, Java, the Seychelles, Madagascar, the Arabian Sea, Hong Kong, the Philippines, Palau, Okinawa, Japan, Australia, Taiwan
	<i>Euthynnus alletteratus</i> (Rafinesque)	Lebanon, Caribbean, Brazil
	<i>Euthynnus lineatus</i> Kishinouye	Galapagos, Costa Rica, Lower California, Mexico
	<i>Orcynopsis unicolor</i> (Geoffroy Saint-Hilaire)	Lebanon
	<i>Sarda australis</i> (Macleay)	Australia
	<i>Sarda orientalis</i> (Temminck and Schlegel)	Panama, South Africa
<i>U. longispinus</i> sp. nov.	<i>Psenopsis anomala</i> (Temminck and Schlegel)	Taiwan
<i>U. mycterobius</i> (Vervoort, 1965)	<i>Auxis</i> sp.	Massachusetts, Egypt, Taiwan, the Philippines, Australia, Hawaii, Japan
	<i>Euthynnus affinis</i> (Cantor)	Japan
	<i>Euthynnus alletteratus</i> (Rafinesque)	Florida, Lebanon
<i>U. reductus</i> Cressey and Cressey, 1980	<i>Katsuwonus pelamis</i> (Linnaeus)	Australia, Tahiti, Japan
<i>U. quadrispinulus</i> sp. nov.	<i>Silago sihama</i> (Forsskål)	Taiwan

- Outer margin of proximal segment of leg 2 exopod with row or rows of long setules and all outer spines on this ramus bilaterally pinnate (Fig. 3A) 5
5. Four outer spines on terminal segment of leg 1 exopod (Fig. 14B) *quadrispinulus*
Three outer spines on terminal segment of leg 1 exopod (Fig. 9B) 6
6. Length/width ratio of caudal ramus 1.79: 1; 1 seta on middle segment of leg 2 endopod (Fig. 9C) *longispinus*
Length/width ratio of caudal ramus 2.70: 1; 2 setae on middle segment of leg 2 endopod (Fig. 3A) *ciliatus*

Key to males

1. Leg 4 endopod 3-segmented *mycterobius*
Leg 4 endopod 2-segmented (Fig. 11D) 2
2. Armature of terminal segment of leg 4 exopod II, I, 3 *reductus*
Armature of terminal segment of leg 4 exopod II, I, 4 (Fig. 11D) 3
3. Ventral surface of anal somite with 2 large patches of fine spinules 4
Ventral surface of anal somite smooth, without patches of spinules (Fig. 10B) 5
4. Patch of stout spinules on free segment of leg 5 extending from about middle of segment distally to outer distal edge *collateralis*
Patch of elongate spinules on free segment of leg 5 not extending distally to outer distal edge *anonymous*
5. Patch of spinules on ventral surface of caudal ramus; spines on legs 2-4 armed with teeth bilaterally *ciliatus*
Ventral surface of caudal ramus without patch of spinules (Fig. 10B); spines on legs 2-4 pinnate bilaterally (Fig. 11B-D) *longispinus*

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