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Sea Lice (Copepoda, Caligidae) Parasitic on Silver Pomfret (*Pampus argenteus*) of Taiwan

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ABSTRACT

Two species of Caligus were found parasitic on the body surface and gill cavities of the silver pomfret, *Pampus argenteus* (Euphrasen), taken from the Strait of Taiwan. They are: *C. multispinosus* Shen, 1957 and *C. pampi* n. sp. The new species is unique for the *Caligus* in having the two tines of the sternal furca attached to each other. Other characteristic features are: (1) middle 2 of the 4 terminal elements on the exopod of leg 1 with accessory process, (2) proximal outer spine on the terminal segment of exopod of leg 2 located subterminally, and (3) 2-segmented exopod of leg 4 with an armature formula of I-0; III.

***Key words**: sea lice, Caligus, parasitic copepods, Pampus argenteus, Taiwan*

INTRODUCTION

The silver pomfret [*Pampus argenteus* (Euphrasen)] is an important commercial fish in Asian countries. It has a fairy wide distribution in the waters of Indo-West Pacific, ranging from the Persian Gulf east to Indonesia and northward to Hokkaido, Japan. Therefore, it is not surprising to find that as many as six species of parasitic copepods have been recorded from this fish host. They are: *Bomolochus decapteri* Yamaguti from Japan (Yamaguti, 1939a); *Caligus multispinosus* Shen from India (Pillai, 1985); *Hatschekia conifera* Yamaguti from Japan (Yamaguti, 1939b); *Notobomolochus triceros* (Bassett-Smith) from Japan (Yamaguti, 1939a; Ho *et al.*, 1983), China (Shen, 1957), India (Pillai, 1965) and Kuwait (Ho *et al.*, 2000); *Paralebion aliuncus* (Rangnekar) from India (Rangnekar, 1955) and *Synestius caliginus* Heller from China (Shen, 1957) and India (Pillai, 1985). Three synonyms of *P. argenteus* are known (Frose and Pauly, 2001) and all of them have been used in the recording of the aforementioned copepod parasites. Pillai (1985), Shen (1957), and Yamaguti (1939a, 1939b) used "*Stromateoides argenteus*"; Bassett-Smith (1898) used "*Stromateus cinereus*"; and Heller (1865) used "*Stromateus argenteus*".

In this paper we shall add another species of parasitic copepod, *Caligus pampi* n. sp., to this list and redescribe *C. multispinosus*. The redescription of the latter was prompted by the fact that it is new to the Strait of Taiwan and the original description by Shen (1957), based on the specimens found on the silver pomfret taken from Kwangtung (southern China), lacks information on the fine structures of the appendages that are

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essential in the modern taxonomy of the Copepoda.

MATERIALS AND METHODS

Host fishes landed at Dong-Shih Fishing Port located in Chiayi County were purchased and transported in an icebox to National Chiayi University where the laboratory examination of the fish for copepod parasites was carried out. The copepod parasites removed from the fish hosts were preserved in 70% ethanol. They were later cleared in 85% lactic acid for 1 to 2 hours before making dissection in a drop of lactic acid on a wooden slide under the dissection microscope (Humes and Gooding, 1964). The removed body parts and appendages were examined in a drop of lactic acid under the compound microscope with a series of magnification up to x 1,500. All drawings were made with the aid of a camera lucida. Measurements of the body and body parts were taken from 10 randomly selected specimens when there were more than that number of specimens in the collection. The various measurements given in the description are the average with its range shown in the parentheses that follows. Identification of the fishes was based on the information provided in Shen (1933) and Shao (1996). Scientific names as well as the common names of the host fishes followed those adopted in Frose and Pauly (2001).

RESULTS

Caligus multispinosus Shen, 1957 (Figs. 1, 2, 3)

Caligus multispinosus Shen, 1957: 355-357, figs. 37-48; Pillai, 1961: 89-91, figs. 2A-T; Yamaguti, 1963: 57, pl. 66, fig. 5; Pillai, 1985: 319-31, figs. 106A-H.

Caligus rotundigenitalis, Leong, 1984: 168-173, figs. 16-19. (not Yü, 1933)

Matrial examined: 324 (309 ♀ ♀ and 15 ♂ ♂) parasites found in branchial cavities of 89 *Pampus argenteus* (Euphrasen) landed at Dong-Shih Fishing Port on following eight dates: 7 ♀ ♀ from 5 hosts on 25 June 1999, 76 ♀ ♀ and 7 ♂ ♂ from 11 hosts on 15 October 1999, 6 ♀ ♀ and 1 ♂ from 6 hosts on 19 November 1999, 15 ♀ ♀ from 8 hosts on 3 December 1999, 31 ♀ ♀ from 16 hosts on 13 January 2000, 62 ♀ ♀ and 4 ♂ ♂ from 22 hosts on 31 March 2000, 104 ♀ ♀ and 3 ♂ ♂ from 14 hosts on 17 August 2000, and 8 ♀ ♀ and 1 ♂ from 7 hosts on 31 March 2001.

Female: Body (Fig. 1A) 4.53 (3.06-5.06) mm long, excluding setae on caudal rami. Cephalothoracic shield wider than long, 1.62 (1.40-1.76) x 1.83 (1.60-2.04) mm, excluding lateral hyaline membranes. Fourth pediger 1.4 times wider than long. Genital complex slightly wider than long, 1.20 (0.90-1.36) x 1.29 (1.02-1.54) mm. Abdomen indistinctly 2-segmented, with proximal somite, 1.01 (0.74-1.34) x 0.41 (0.34-0.50) mm, longer and wider than anal somite, 0.33 (0.22-0.38) x 0.31 (0.26-0.38) mm. Caudal ramus (Fig. 3C) 1.43 times longer than wide; medial margin bearing a row of long setules; armed with 3 short, subterminal setae and 3 long, terminal setae. Egg sac nearly as long as body, containing up to 74 eggs.

Antennule (Fig. 1B) 2-segmented; proximal segment with 27 setae on anterodistal surface, distal segment with 1 subterminal seta on posterior margin and 11 setae plus 2 aesthetascs on distal margin. Antenna (Fig. 1C) 3-segmented; proximal segment smallest and unarmed; second segment subquadrate and unarmed; distal segment bent claw bearing 2 short setae in proximal region. Postantennary process (Fig. 1C) small and pointed, carrying 2 basal papillae with each bearing 4 setules; another similar papilla located nearby on sternum. Mandible (Fig. 1D) 4-segmented; with 12 teeth on medial margin of distal blade. Maxillule (Fig. 1C) comprising dentiform process and basal papilla with 3 short setae. Maxilla (Fig. 1E) 2-segmented; proximal segment (lacertus)

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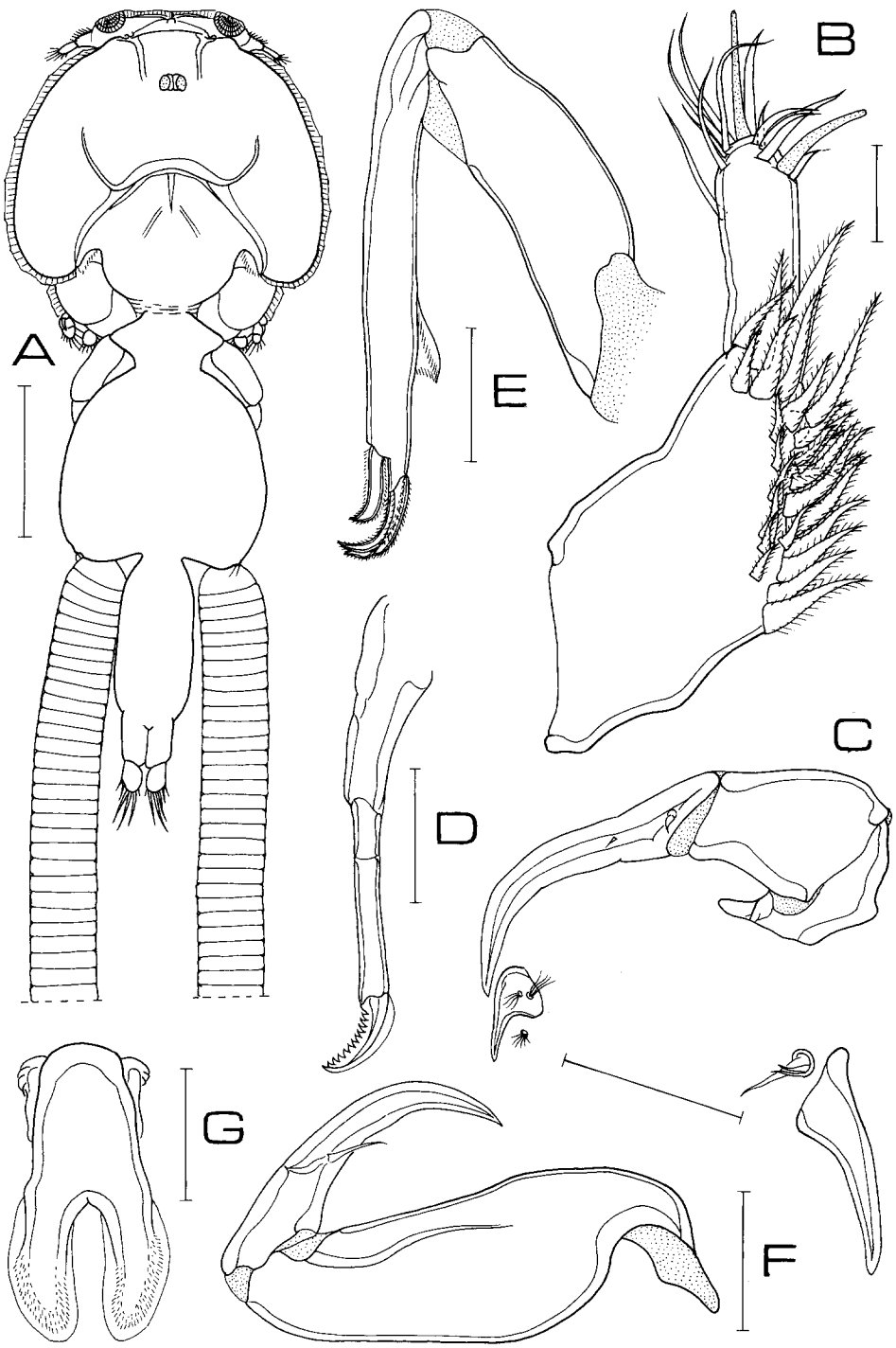

Fig. 1. *Caligus multispinosus* Shen, female. A: habitus, dorsal; B: antennule, ventral; C: antenna, postantennary process, and maxillule, ventral; D: mandible; E: maxilla; F: maxilliped; G: sternal furca. Scale bars: 1 mm in A; 50 μm in B; 0.2 mm in C; 70 μm in D; 0.1 mm in E, G; 0.15 mm in F.

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large and unarmed; slender, distal segment (brachium) carrying subterminal, hyaline membrane on outer edge, terminal calamus only shortly longer than subterminal canna. Maxilliped 3-segmented (Fig. 1F); proximal segment (corpus) largest but unarmed; middle (shaft) and distal (claw) segments fused to form subchela, claw sharply pointed, with barbell at base. Box of sternal furca (Fig. 1G) subrectangular; tines shorter than box, with blunt tip and fringed with hyaline membrane.

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

	Exopod	Endopod
Leg 1	1-0; IV,3	(vestigial)
Leg 2	I-1; I-1; II,I,5	0-1; 0-2; 6
Leg 3	I-0; I-1; III,4	0-1; 6
Leg 4	I-0; I-0; III	(absent)

Leg 1 protopod (Fig. 2A) with long, plumose outer seta and another small, plumose inner seta, in addition to a papilla bearing 2 setules on outer margin of coxa; vestigial endopod a small process tipped with 2 unequal setules; first segment of exopod with row of setules on posterior edge and small pecten on outer distal corner at base of spiniform seta; middle 2 of 4 terminal elements on last segment of exopod without accessory process, outer 3 elements bilaterally pinnate but innermost element naked (Fig. 2B). Leg 2 (Fig. 2C) coxa small, with large, plumose, inner seta on posterior edge and a papilla on ventral surface bearing a setule; basis carrying small seta on outer distal corner, hyaline membrane on posterior margin, and a setule-bearing papilla on ventral surface close to base of marginal membrane; anterodistal surface of basis and first segment of exopod with large marginal membrane; outer surface of middle and terminal segments of endopod covered with spinules. Leg 3 (Fig. 2D) protopod (apron) with small, plumose, outer seta and long, plumose inner seta in addition to an outer and a posterior, marginal, hyaline membrane; setule-bearing papilla on ventral surface at outer and inner ends of latter membrane; velum well developed and fringed with marginal setules; proximal segment of exopod with 2 setules on outer margin and pecten at base of spine which is serrated bilaterally. Leg 4 (Fig. 3A) protopod large, with plumose seta at outerdistal corner; outer margin of proximal segment of exopod slightly protruded and tipped with setule; pecten at base of each outer 4 spines on exopod; outer spines covered with spinules except for distal most one which is bilaterally pinnate. Leg 5 (Fig. 3B) represented by 2 papillae on posterolteral corner of genital complex, 1 tipped with small plumose seta, other with 3 similar setae.

Male: Body (Fig. 3D) 2.25 (2.02-2.34) mm long, excluding setae on caudal rami. Cephalothoracic shield slightly wider than long, 1.10 (0.96-1.20) x 1.15 (1.04-1.18) mm, excluding lateral hyaline membranes. Fourth pediger 1.88 times wider than long. Genital complex subquadrate, 0.41 (0.38-0.44) x 0.36 (0.32-0.40) mm. Abdomen 2-segmented, proximal somite (0.13 x 0.20 mm) smaller than anal somite (0.26 x 0.23 mm). Caudal ramus 1.18 times longer than wide and armed as in female. Antenna (Fig. 3E) 3-segmented; proximal segment smallest and unarmed; middle segment largest, armed with 3 small corrugated adhesion pads; terminal segment a sharp claw armed with a basal, inner seta and a large basal tooth. Postantennal process (Fig. 3F) generally as in female but 2 basal papillae bearing only 2 setules. Dentiform process of maxillule (Fig. 3G) equipped with subterminal seta. Maxilliped (Fig. 3H) with small myxa on corpus. Leg 5 (Fig. 3I) constructed as in female but located differently from female at about midway along lateral margin of genital complex. Leg 6 (Fig. 3I) represented by 3 setae on small, posterolaterl lobe on genital complex.

Remarks: Ho *et al.* (2000) pointed out that *C. multispinosus* bears the closest

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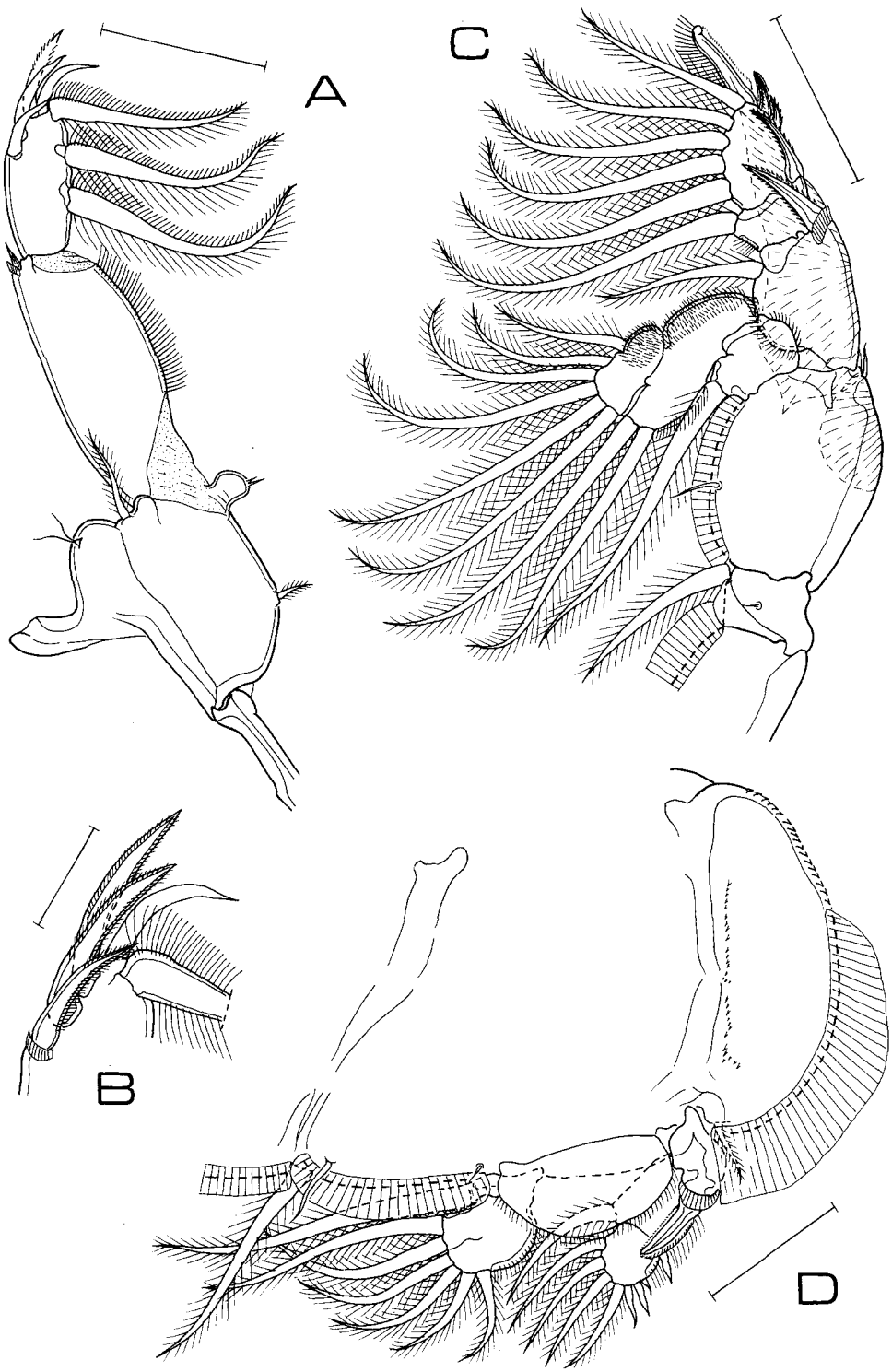

Fig. 2. *Caligus multispinosus* Shen, female. A: leg 1, ventral; B: tip of leg 1 exopod; C: leg 2, ventral; D: leg 3, ventral. Scale bars: 0.15 mm in A, D; 50 μm in B; 0.25 mm in C.

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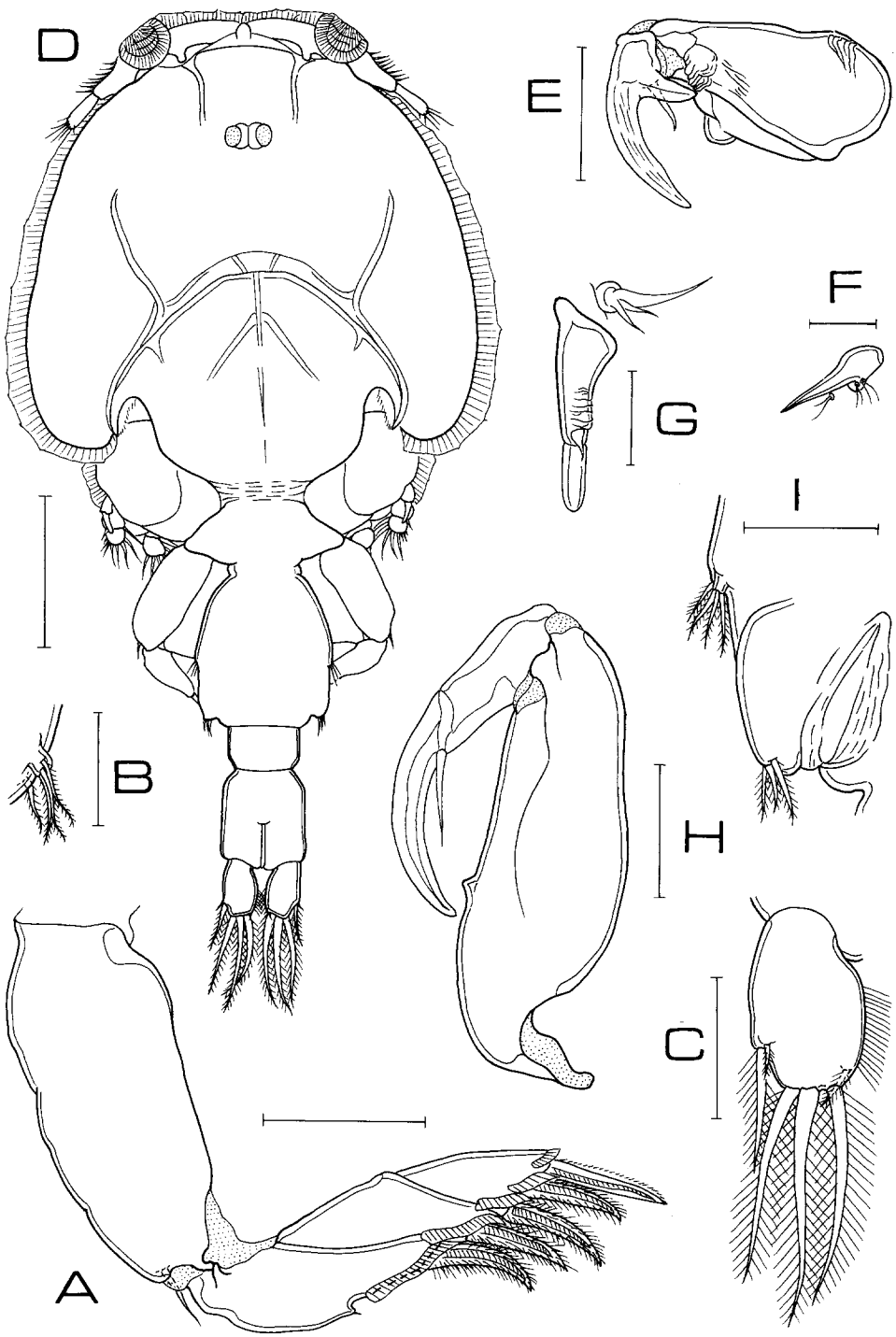

Fig. 3. *Caligus multispinosus* Shen. Female: A: leg 4; B: leg 5; C: caudal ramus, ventral. Male: D: habitus, dorsal; E: antenna; F: postantennary process; G: maxillule; H: maxilliped; I: posterolateral side of genital complex, showing leg 5 and leg 6. Scale bars: 0.2 mm in A; 0.15 mm in B, C; 0.4 mm in D; 0.1 mm in E, H, I; 50 μm in F; 70 μm in G.

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resemblance to *C. rotundigenitalis* with the major distinction between them found in the relative length of the abdomen in the female. The female abdomen is longer than one-half of its cephalothoracic shield (usually > 75%) in *C. multispinosus* but it is much shorter than that in *C. rotundigenitalis*. In our past three years of collection of parasitic copepods of marine fishes taken from the Strait of Taiwan, we discovered that there is a drastic difference on the host-specificity of these two species. While *C. multispinosus* was found parasitic only on the silver pomfret, we have so far recovered *C. rotundiganitalis* from 20 species of teleosts but silver pomfret.

The specimens of *Caligus* reported by Leong (1984) as "*Caligus rotundigenitalis* Yü, 1933" from the gill filaments of Chinese silver pomfret, *Pampus chinensis* (Euphrasen), caught in Malaysia is a misidentification for *C. multispinosus*. The abdomen of those Malaysian specimens is as long as 77% of its cephalothoracic shield and the outer margin of the first segment of leg 4 exopod bears a papilla tipped with a tiny setule as shown here in Fig. 3A.

Caligus pampi n. sp. (Figs. 4, 5, 6)

Material examined: 2♀♀ on silver pomfret, *Pampus argenteus* (Euphrasen), landed at Dong-Shih Fishing Port: one found on its body surface on 25 June 1999, and another one collected from its gill cavity on 13 January 2000.

Female: Body (Fig. 4A) 6.58 (6.32-6.84) mm long, excluding setae on caudal rami. Cephalothoracic shield longer than wide, 3.55 (3.50-3.61) x 2.53 (2.50-2.56) mm, excluding marginal membranes. Fourth pediger wider than long, 0.28 (0.26-0.30) x 0.80 mm. Genital complex with broadly round protruded posterolateral region, 1.72 (1.60-1.84) x 1.57 (1.44-1.70) mm. Abdomen moderately long, about 2.5 times longer than wide, 1.22 (1.20-1.24) x 0.48 (0.46-0.50) mm. Caudal ramus (Fig. 6D) attached to abdomen diagonally with outer edge 1.5 times longer than inner edge; segment proper more than twice as long as wide, 0.22 (0.19-0.24) x 0.10 (0.09-0.10) mm, and armed with 3 short and 3 very long plumose setae in addition to a papilla tipped with a seta on dorsal surface. Egg sac not seen.

Antennule (Fig. 4B) 2-segmented; proximal segment distinctly longer than distal segment and armed with 29 plumose setae on anterodistal surface; distal segment armed with 1 subterminal seta on posterior margin and 11 setae plus 2 aesthetascs on distal margin. Antenna (Fig. 4C) 3-segmented; proximal segment small; middle segment largest but unarmed; distal segment a claw with small seta on a papilla in basal region and another one in middle region. Basal part of postantennary process (Fig. 4C) with 2 setule-bearing papillae and another similar but isolated papilla on nearby sternum. Mandible (Fig. 4F) 4-segmented; with 12 teeth on medial margin of distal blade. Maxillule (Fig. 4C) comprising bluntly pointed dentiform process and basal papilla armed with 3 naked setae. Maxilla (Fig. 5A) 2-segmented; proximal segment (lacertus) unarmed; distal segment (brachium) carrying subterminal hyaline membrane on outer edge and 2 unequal, terminal elements, short canna and long calamus. Maxilliped (Fig. 4D) with large, long, unarmed corpus; subchela about one-half length of corpus; terminal claw shorter than shaft, barbell at base of claw about half of claw length (Fig. 4E). Sternal furca (Fig. 4G) with 2 blunt-tip tines lined next to each other.

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

	Exopod	Endopod
Leg 1	1-0; IV,3	(vestigial)
Leg 2	I-1; I-1; II,I,5	0-1; 0-2; 6
Leg 3	I-0; I-1; III,4	0-1; 6
Leg 4	I-0; III	(absent)

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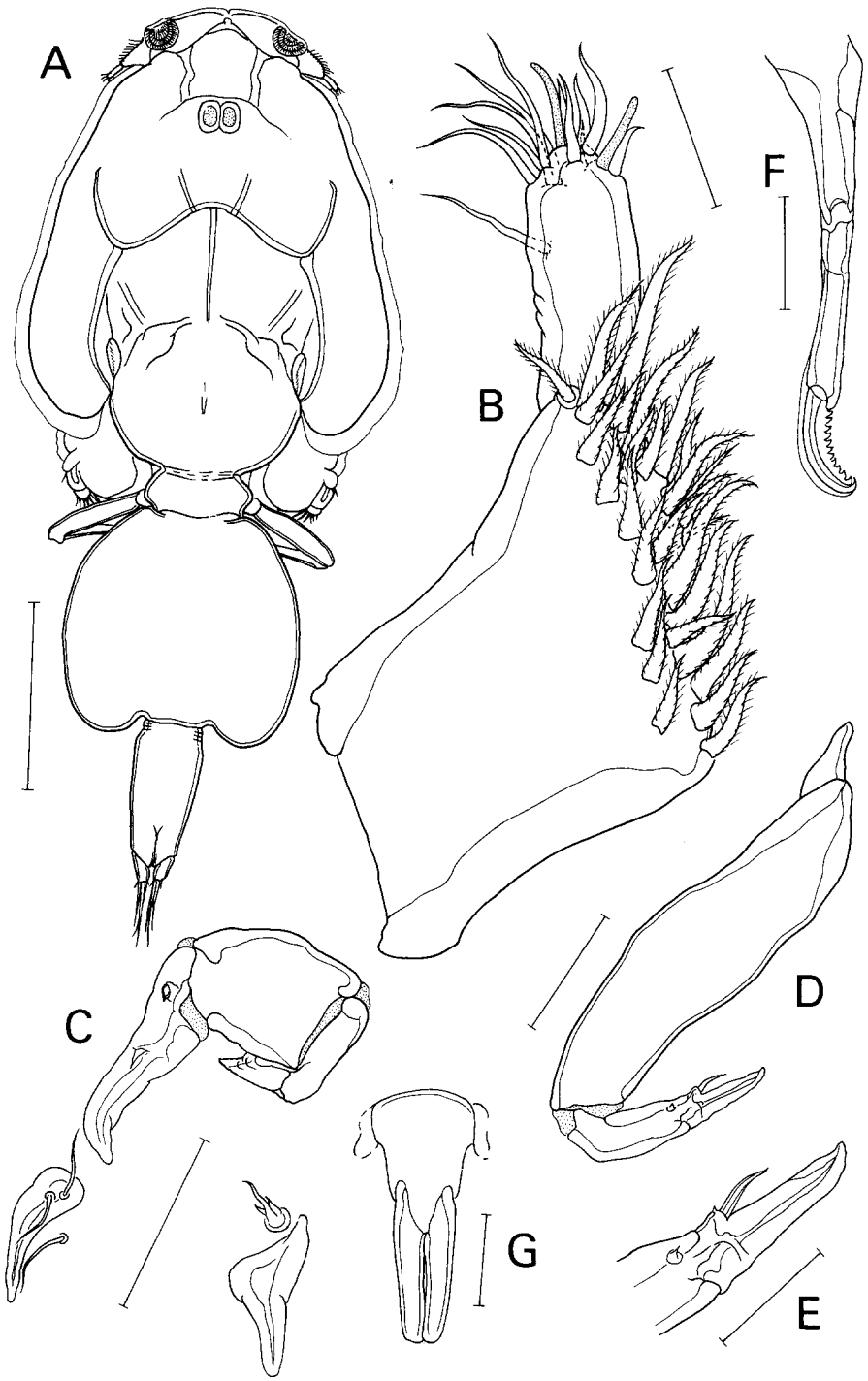

Fig. 4. *Caligus pampi* n. sp. Female. A. habitus, dorsal; B. antennule, ventral; C. antenna, postantennary process and maxillule, ventral; D. maxilliped; E. terminal part of maxilliped; F. mandible; G. sternal furca, ventral. Scale bars: 1.5 mm in A, D, G ; 0.1 mm in B; 0.3 mm in C, E; 70 μm in F.

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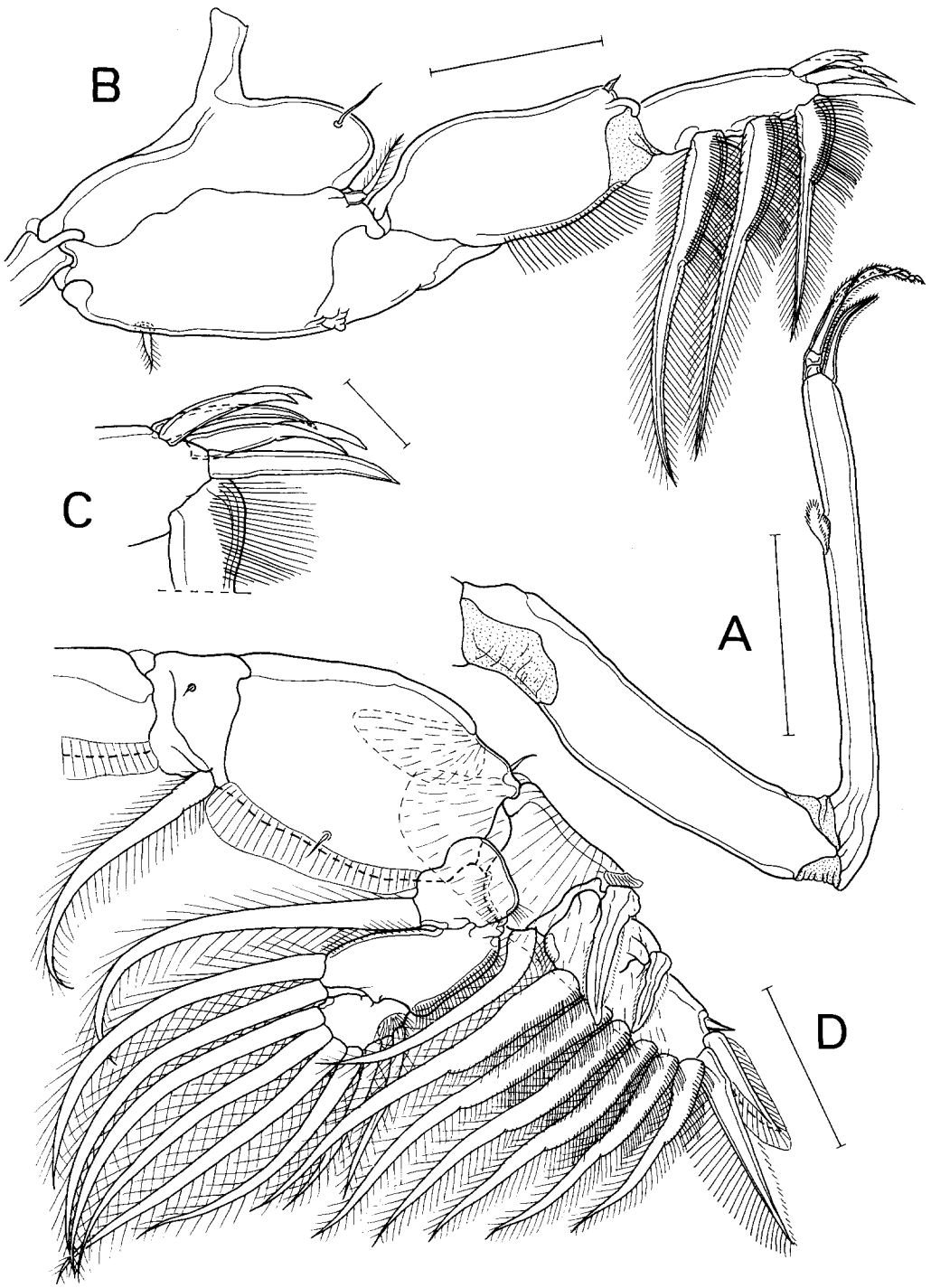

Fig. 5. *Caligus pampi* n. sp. Female. A. maxilla; B. leg 1, ventral; C. tip of leg 1 exopod; D. leg 2, ventral. Scale bars: 0.3 mm in A, D; 0.2 mm in B; 0.05 mm in C.

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Coxa of Leg 1 (Fig. 5B) with long ventral setule close to outer margin; basis with plumose outer seta and another plumose inner seta; vestigial endopod tiny and unarmed; first segment of exopod with row of long setules on posterior edge and small, spiniform seta in anterodistal corner; middle 2 of 4 terminal elements on last segment of exopod with accessory process (Fig. 5C); 3 plumose setae on posterior surface of this segment large. Leg 2 (Fig. 5D) coxa small, with spinule bearing papilla on anterior surface and large, plumose inner seta on posterior edge; basis with small, naked outer seta in addition to a posterior, marginal setule on ventral surface and a long, narrow membrane on posterior margin; outer edges of both basis and first exopodal segment fringes with large marginal membrane. Leg 3 (Fig. 6A) protopod (apron) armed with short, plumose, outer seta and long, plumose, inner seta in addition to a membrane on outer and another one on posterior edges; additionally, outer edge anterior to membrane corrugated and 2 marginal setules close to posterior membrane. Leg 4 (Fig. 6B) protopod with small, plumose outer seta; pectens on exopod segments at insertion of each of 4 spines. Leg 5 (Fig. 6C) represented 2 papillae bearing 3 pinnate setae located on posterolateral margin of genital complex.

Male: Unknown.

Etymology: The name of the new species is taken from the genus name of its host - *Pampus*.

Remarks: The most outstanding characteristic of the new species is the possession of a sternal furca with its two tines attaching to each other (Fig. 4G). This feature is unique in *Caligus* where there are more than 250 nominal species. The only other species of Caligus shows an unusualness of the sternal furca is *C.* (*Subcaligus*) *bocki* Heegaard. It has the two tines joined together to form a "laminal spine" (Heegaard, 1943). It is a parasite of shark and differs from *C. pampi* in the structure of legs 1 and 4. According to Heegarrd's (1943) description, its leg 1 lacks the three medial, plumose setae on the terminal segment of exopod and the armature formula of leg 4 is I-0; IV.

The new species resembles *C. oviceps* Shiino, 1952 in the fine structures of the appendages. Thus, the seven species of *Caligus* (*C. brevis* Shiino, 1954; *C. longipedis* Bassett-Smith, 1898; *C. orientalis* Gusev, 1951; (*C. patulus* Wilson, 1937; *C. punctatus* Shiino, 1955; *C. stokesi* Byrnes, 1987; and *C. truncatogenitalis* Roubal, 1981) enumerated by Lin *et al.* (1996) to be closely allied with *C. oviceps* applies also to the present new species. However, *C. pampi* can be easily distinguished from these eight species of congeners by the following three obvious differences: (1) long abdomen (about 2.5 times longer than wide), (2) caudal ramus attached diagonally to the anal segment with outer edge 1.5 times longer than inner edge, and (3) the tines of sternal furca parallel and closely attached to each other.

This is a rather rare parasite. Although in the past three years, from June 1999 to March 2001, we found parasitic copepods on 155 of the 209 silver pomfrets collected at 11 occasions from Dong-Shih Fishing Port, *C. pampi* was seen at only two occasions with one specimen at each time; namely, 25 June 1999 and 13 January 2000. In both occasions, *C. multispinosus* Shen, 1957 was the major parasite collected.

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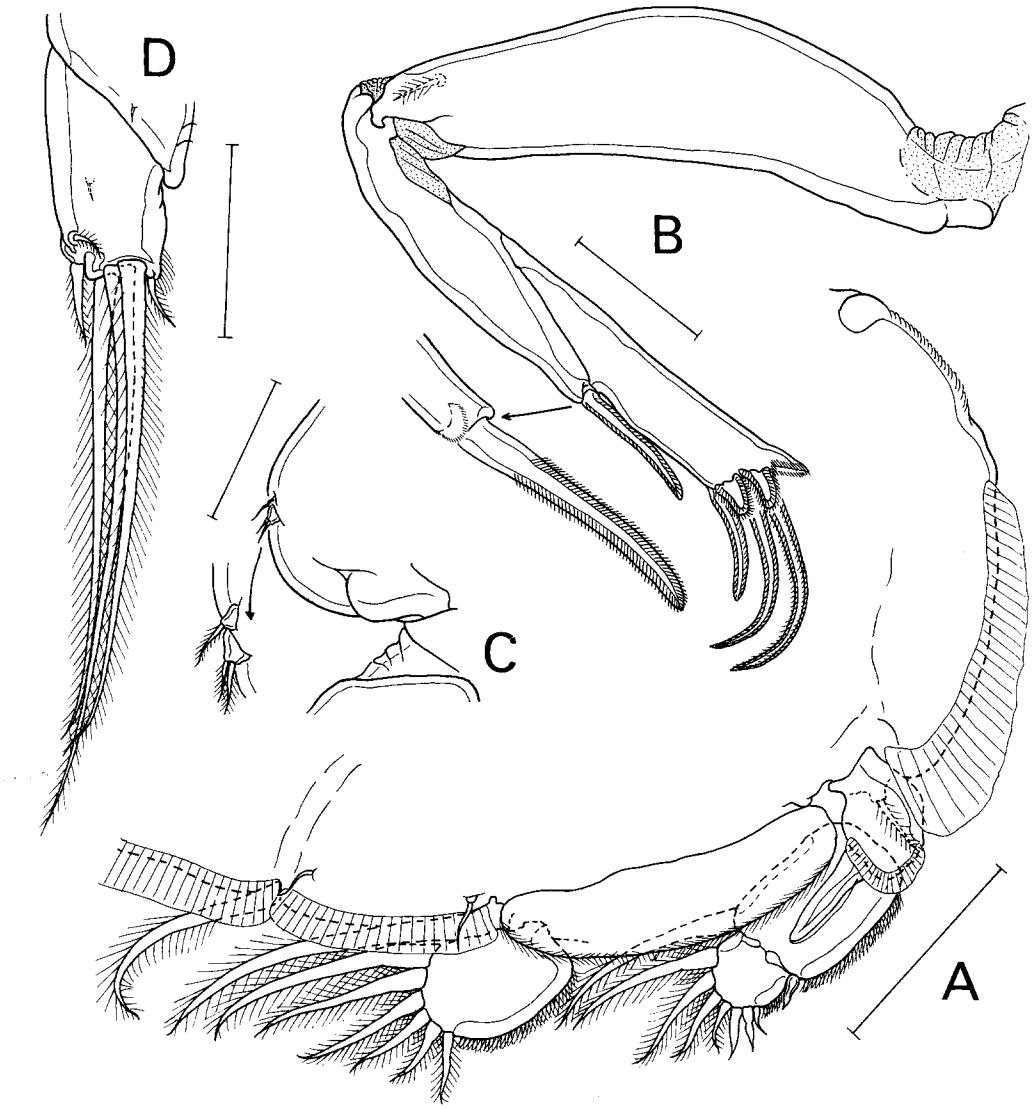

Fig. 6. *Caligus pampi* n. sp. Female. A. leg 3, ventral; B. leg 4; C. postlateral corner of genital segment, ventral; D. caudal ramus, ventral. Scale bars: 0.3 mm in A; 0.2 mm in B, C, D.

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寄生在台灣產銀鯧(*Pampus argenteus*)體上的兩種海水魚虱(橈足亞綱、魚虱科)

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從產於台灣海峽的銀鯧，*Pampus argenteus* (Euphrasen)，的體表上和鰓腔內發現兩種魚虱(*Caligus*)，*C. multispinosus* Shen, 1957 和 *C. pampi* n. sp. 的寄生。後者為世界新種，其最顯著特徵是其胸叉(sternal furca)的兩條分叉相互緊貼。此外，其他值得一提的特徵有：(1)第一對胸腳的外肢其末端的四根硬棘中之中間兩根具副屬枝。(2)第二對胸腳外肢的末節上之第一根硬棘緊靠頂端。(3)第四對胸腳的外肢由兩節構成，其上的棘數與分佈形式為“I-0; III”。

關鍵詞：海水魚虱，魚虱屬，寄生橈足類，銀鯧，台灣。

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