

Six New Species of *Enalcyonium* (Copepoda, Cyclopoida, Lamippidae) Parasitic in Octocorals from New Caledonia

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ABSTRACT

Six new species of the genus *Enalcyonium* are described as parasites of octocorals of New Caledonia. They are *Enalcyonium lobophyti*, *E. humesi*, *E. caledonensis*, and *E. auriculatum* from the alcyonacean *Lobophyton schoedei* Moser, *E. capillatum* from the gorgonacean *Rumphella antipathes* (L.), and *E. bullatum* from the gorgonacean *Siphonogorgia variabilis* (Hickson). This is the first record on the species of *Enalcyonium* from the South Pacific.

Key words: *Enalcyonium*, new species, Copepoda, Lamippidae, New Caledonia

INTRODUCTION

Enalcyonium Olsson, 1870, the largest genus of the family Lamippidae, consists of 22 known species (Boxshall and Halsey, 2004). Most of these species have been reported from the Atlantic and Mediterranean seas (Stock, 1973), but none of them from the South Pacific.

Copepod specimens of *Enalcyonium* studied in the present study were collected by the late Dr. A. G. Humes from the Alcyonacea and Gorgonacea in New Caledonia. The specimens were originally a part of his collection that was later moved to the National Museum of Natural History, Smithsonian Institution, Washington, D. C. These specimens were, in turn, loaned to me for a study. While examining the copepods from New Caledonia, I could find six new species of

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Enalcyonium those are to be described in the present report.

It is necessary to mention terminology for the leg morphology used in the description. The lobe on the medial side of legs 1 and 2 is interpreted as the "inner lobe" ("a" of Fig. 1H) of basis (not as an endopod), as Stock (1988) suggested. This lobe is located on the same plane with the exopod. However, the lobe located anteriorly between the exopod and inner basal lobe of leg 2 is here called as the "anterior lobe" ("b" of Fig. 1H), not as an endopod. The anterior lobe is always positioned anterior to the exopod and basis, and usually bears two terminal setae (or processes). In some species there are an additional lobe on the legs 1 and 2 just posterior to anterior lobe. I would like to call this as "interramal lobe" ("c" of Fig. 1H).

In the description, the body length is measured from the apex of cephalic area to the posterior end of trunk excluding caudal rami. The lengths of segments of antenna are taken the average length of the inner and outer margins.

SYSTEMATIC ACCOUNTS

Family Lamippidae Joliet, 1882

Genus *Enalcyonium* Olsson, 1870

***Enalcyonium lobophyti* n. sp. (Fig. 1)**

Material examined. 11 ♀♀, 6 ♂♂ from *Lobophyton schoedei* Moser, in 1 m, Ricaudy Reef, Noumea, New Caledonia, 20 July 1971, collected by A. G. Humes. Holotype (♀), allotype (♂), and paratypes (9 ♀♀, 4 ♂♂) will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington D.C. Dissected paratypes (1 ♀, 1 ♂) are in the collection of the author.

Female. Body (Fig. 1A, B) fusiform, dorsoventrally deeper than laterally wider. Length 875 µm. Maximum width 180 µm across anterior two-fifths of body. Maximum depth 205 µm. Cephalic area (Fig. 1C) slightly projected anteriorly between bases of antennules, with weak posterodorsal sclerotization and distinct semicircular anterolateral process (82 µm across these processes) on both sides.

Caudal rami divergent. Each ramus slightly tapering, bluntly terminated, 45 µm long measured along inner margin from junction of rami to posterior tip. Caudal elements 5 in number (Fig. 1D): 3 digitations of identical length (20 µm) and 2 setae (each 16 and 19 µm).

Antennule (Fig. 1E) unsegmented, approximately 66 µm long including terminal seta and tapering, with 12 setae including terminal aesthetasc-like seta (this seta 27 µm long). Antenna (Fig. 1F) 3-segmented, each 25, 22, and 23 µm from proximal to terminal (average lengths of inner and outer margins). First and second segments unarmed. Third segment with 1 inner proximal seta and 2 minute, obscure terminal setae. Claw 19 µm long, curved and acute. Oral cone prominent in lateral view (Fig. 1B). Oral appendages lacking.

Leg 1 (Fig. 1G) with exopod, interramal lobe, and inner lobe. Protopod unarmed. Exopod with 2 unequal, widely isolated setae (distal one much smaller) and 2 spines, outer one of them bearing small seta on inner margin (armature formula 2, II). Interramal lobe broad. Inner lobe distinct, its distal margin slightly concave. Leg 2 (Fig. 1H) with exopod, interramal lobe, anterior lobe, and inner lobe. Basis unarmed. Exopod with 1 seta and 2 spines (armature formula 1, II). Outer spine

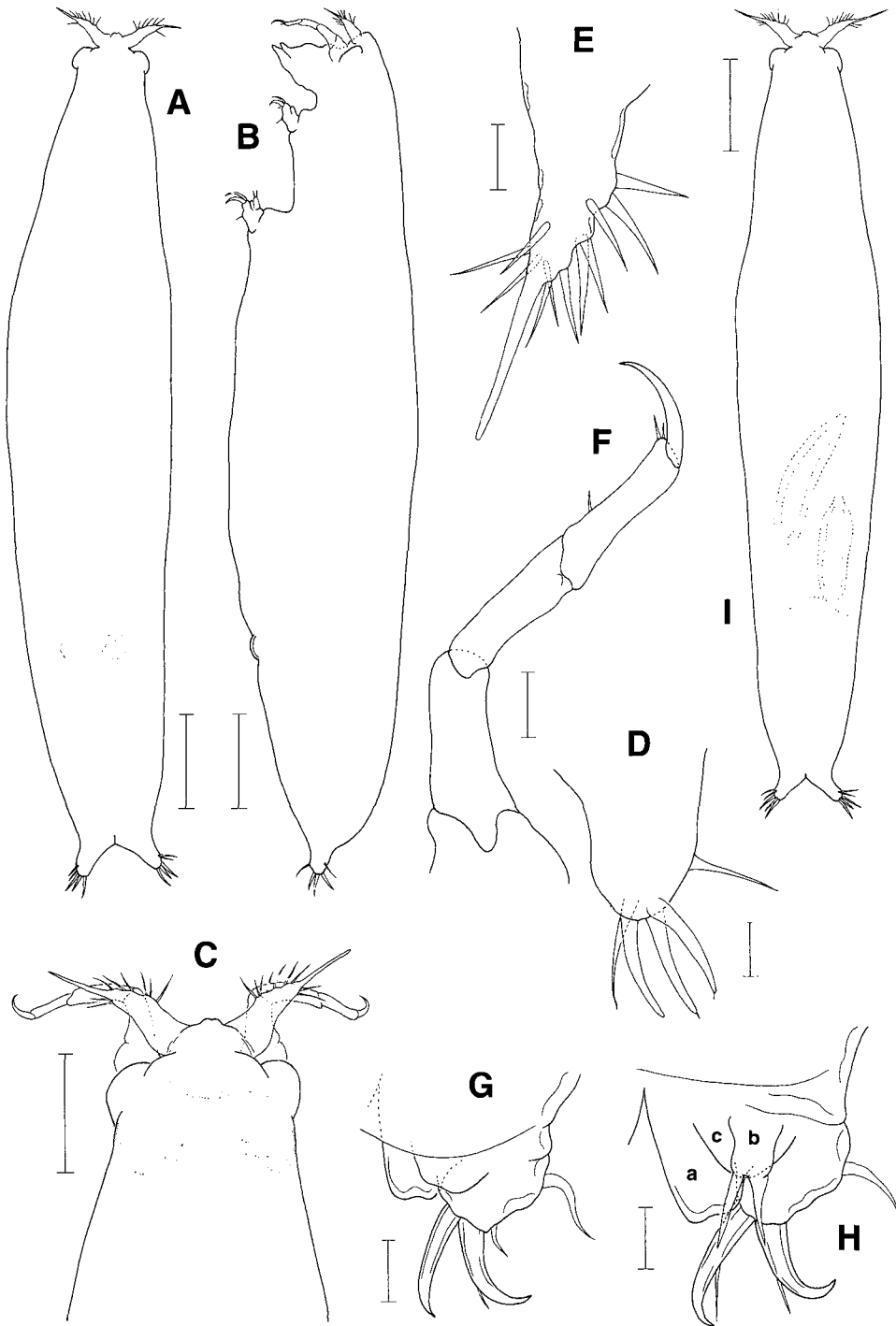


Fig. 1. *Enalcyonium lobophyti* n. sp. Female: A, habitus, dorsal; B, habitus lateral; C, cephalic area, dorsal; D, caudal rami; E, antennule; F, antenna; G, leg 1, anterior; H, leg 2, anterior. Male: I, habitus, dorsal. Scales = 10 μ m (D-H), 50 μ m (C), 100 μ m (A, B, I).

with seta on inner margin. Inner spine with seta on outer margin. Anterior lobe distinct, with 2 terminal setae. Legs 3-6 absent.

Male. Body (Fig. 1I) resembling that of female. Length 805 μm . Maximum width 155 μm . Caudal rami, antennule, antenna, and legs as in female.

Etymology. The specific name *lobophyti* is taken from the generic name of the host *Lobophyton schoedei* Moser.

Remarks. Species of *Enalcyonium* carry a maximum of five elements on the caudal ramus.

These elements may be digitations having truncate end, or large or small setae. The combination and nature of these elements act as a role of a diagnostic character in the classification of species of the Lamippidae (Bouligand, 1960). With three digitations and two setae on the caudal ramus, the new species can be distinguished from all congeners.

Several species have the setation of legs 1 and 2 similar to that of *E. lobophyti*, but only one species of them, *E. confusum* Stock, 1988, possess two terminal setae on the anterior lobe of leg 2, like *E. lobophyti*. However, this Mediterranean species differ from *E. lobophyti* by having the inner lobe of leg 1 and 2 which is longer than wide (wider than long in *E. lobophyti*).

***Enalcyonium humesi* n. sp. (Fig. 2)**

Material examined. 56 ♀♀, 16 ♂♂ from *Lobophyton schoedei* Moser, in 1 m, Ricaudy Reef, Noumea, New Caledonia, 20 July 1971, collected by A. G. Humes. Holotype (♀), allotype (♂), and paratypes (53 ♀♀, 13 ♂♂) will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington D.C. Dissected paratypes (2 ♀♀, 2 ♂♂) are in the collection of the author.

Female. Body (Fig. 2A, B) fusiform and anteriorly tapering. Length 745 μm . Maximum width 185 μm . Maximum depth 188 μm . Cephalic area (Fig. 2C) 68 μm wide, with rounded anterior margin, W-shaped posterior sclerotization, and ear-like anterolateral process on both sides. This process incurved and pointed distally.

Caudal rami well-isolated from each other, slightly divergent. Each ramus (Fig. 2D) tapering, longer than wide, armed with 3 small and 2 larger setae; terminal larger seta 95 μm and fused to ramus; subterminal larger seta 80 μm .

Antennule (Fig. 2E) unsegmented, approximately 66 μm long including terminal seta and tapering, with 12 setae including large terminal process-like seta (this seta 39 μm long). Antenna (Fig. 2F) 3-segmented, each 20, 18, and 23 μm from proximal to terminal (average lengths of inner and outer margins). First and second segments unarmed. Third segment longer than second segment, with 1 inner distal seta. Claw 16 μm long, distally curved and acute. Oral cone weakly projected ventrally in lateral view (Fig. 2B). Oral appendages lacking. Leg 1 (Fig. 1G) with exopod, interramal lobe, and inner lobe. Protopod unarmed. Exopod with 2 unequal, widely isolated setae (distal one much smaller) and 2 spines, outer one of them bearing small seta on inner margin (armature formula 2, II). Interramal lobe broad. Inner lobe distinct, its distal margin slightly concave. Leg 2 (Fig. 1H) with exopod, interramal lobe, anterior lobe, and inner lobe. Basis unarmed. Exopod with 1 seta and 2 spines (armature formula 1, II). Outer spine with seta on inner margin. Inner spine with seta on outer margin. Anterior lobe distinct, with 2 terminal setae. Legs 3-6 absent.

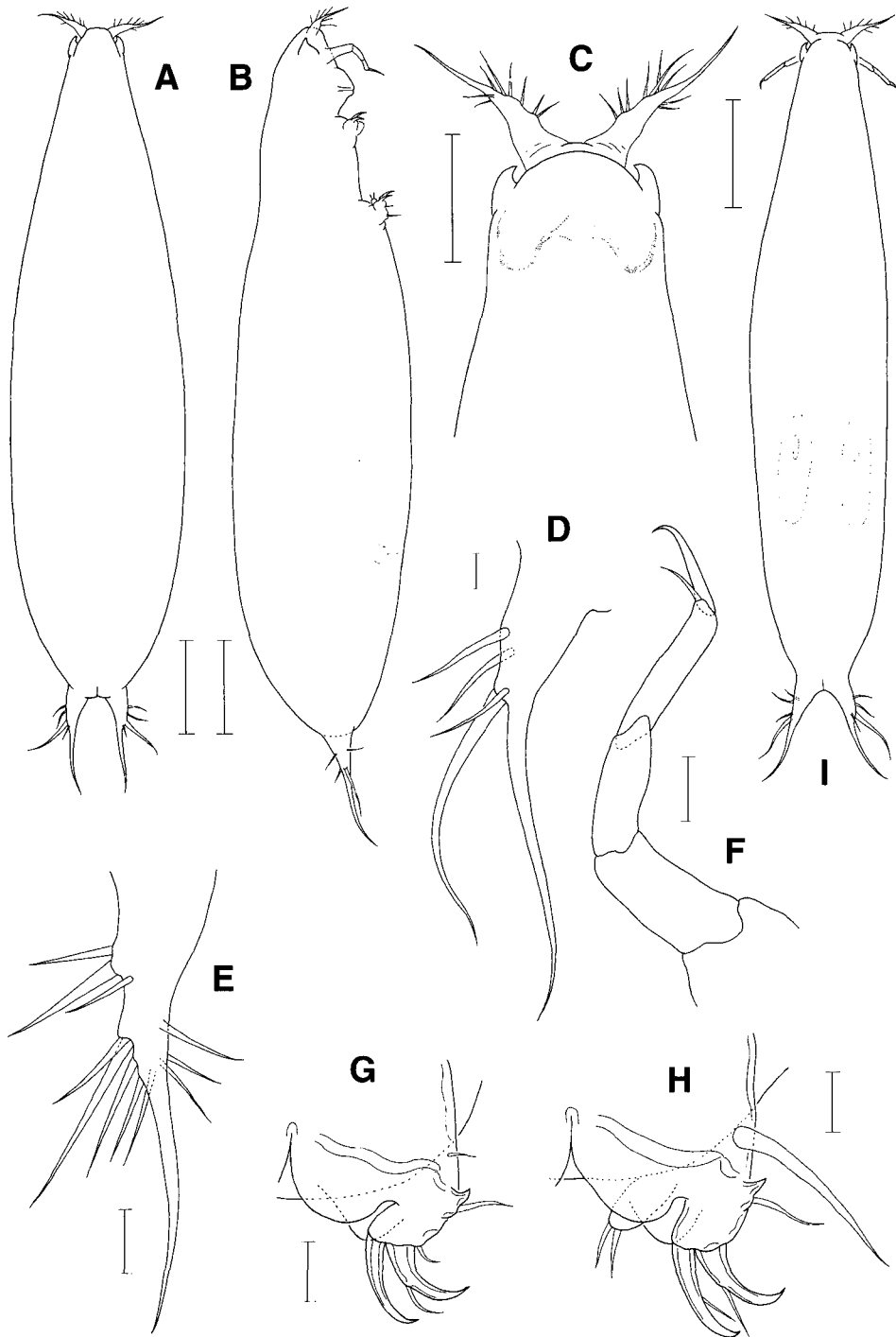


Fig. 2. *Enalcyonium humesi* n. sp. Female: A, habitus, dorsal; B, habitus, lateral; C, cephalic area, dorsal; D, caudal ramus; E, antennule; F, antenna; G, leg 1, posterior; H, leg 2, posterior. Male: I, habitus, dorsal. Scales = 10 μ m (D-H), 50 μ m (C), 100 μ m (A, B, I).

Male. Body (Fig. 11) resembling that of female. Length 805 μm . Maximum width 155 μm . Caudal rami, antennule, antenna, and legs as in female.

Etymology. The specific name *humesi* is taken after the surname of the late Dr. Arthur G. Humes who collected this species.

Remarks. Several species of *Enalcyonium* are known to possess five simple setae on the caudal ramus, without digitation. These five setae are composed of three larger and two smaller setae in *E. affine* (Zulueta, 1908), *E. confusum* Stock, 1988, *E. pusillum* (Zulueta, 1908), and *E. rubicundum* (Olsson, 1868); four larger and one smaller setae in *E. setigerum* (Zulueta, 1908) and *E. variicauda* Stock, 1973; and five similar setae in *E. digitigerum* Ho, 1984. Therefore *E. humesi* n. sp. having two larger and three smaller setae on the caudal ramus differs from these species.

Enalcyonium humesi can be compared with other species in different way. Several species share with *E. humesi* the similar setation on the exopods of legs 1 and 2. Two of these species, *E. confusum* and *E. lobophyti*, carry the anterior lobe on leg 2 bearing two terminal setae. In *E. confusum* the inner lobes of legs 1 and 2 are more prominent than those of *E. humesi* and longer than wide, therefore, it is not confusable with *E. humesi*. *Enalcyonium lobophyti* differs as well from *E. humesi*, because it possesses one proximal and two distal setae on the third segment of antenna.

***Enalcyonium caledonensis* n. sp. (Fig. 3)**

Material examined. 8 ♀♀, 4 ♂♂ from *Lobophyton schoedei* Moser, in 1 m, Ricaudy Reef, Noumea, New Caledonia, 20 July 1971, collected by A. G. Humes. Holotype (♀), allotype (♂), and paratypes (5 ♀♀, 2 ♂♂) will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington D.C. Dissected paratypes (1 ♀, 1 ♂) are in the collection of the author.

Female. Body (Fig. 3A) nearly cylindrical, slightly constricted at two-thirds of trunk. Length 718 μm . Maximum width 163 μm across near middle of body. Cephalic area (Fig. 3B) in dorsal view consisting of narrower rostral part and wider, roughly parallel posterior part (59 μm wide across this part), with weak posterodorsal sclerotization.

Caudal rami divergent and broadly separated from each other. Each ramus (Fig. 3C) short, 40 μm (measured along inner margin), bluntly ended, with 3 large similar digitations (longest one 74 μm) and 2 similar setae (longer one 52 μm).

Antennule (Fig. 3D) unsegmented, approximately 108 μm long including terminal seta and tapering, with 12 setae including terminal aesthetasc-like seta of 56 μm long. Antenna (Fig. 3E) slender, 3-segmented, each 41, 34, and 31 μm from proximal to terminal (average lengths of inner and outer margins). First and second segments unarmed. Third segment with 1 inner proximal and 1 terminal setae. Claw 21 μm long, gently curved and acute. Oral cone prominent in lateral view. Oral appendages not seen.

Leg 1 (Fig. 3F) with exopod and inner lobe. Exopod with 1 proximal seta and 3 seta-bearing and 1 naked spines (formula 1, IV). Inner lobe prominent, as long as wide, with rounded distal margin. Leg 2 (Fig. 3G) with exopod, rudimentary anterior lobe, and inner lobe. Protopodal area with 1 large outer seta. Exopod fused completely with protopod, with 1 claw-like proximal spine bearing

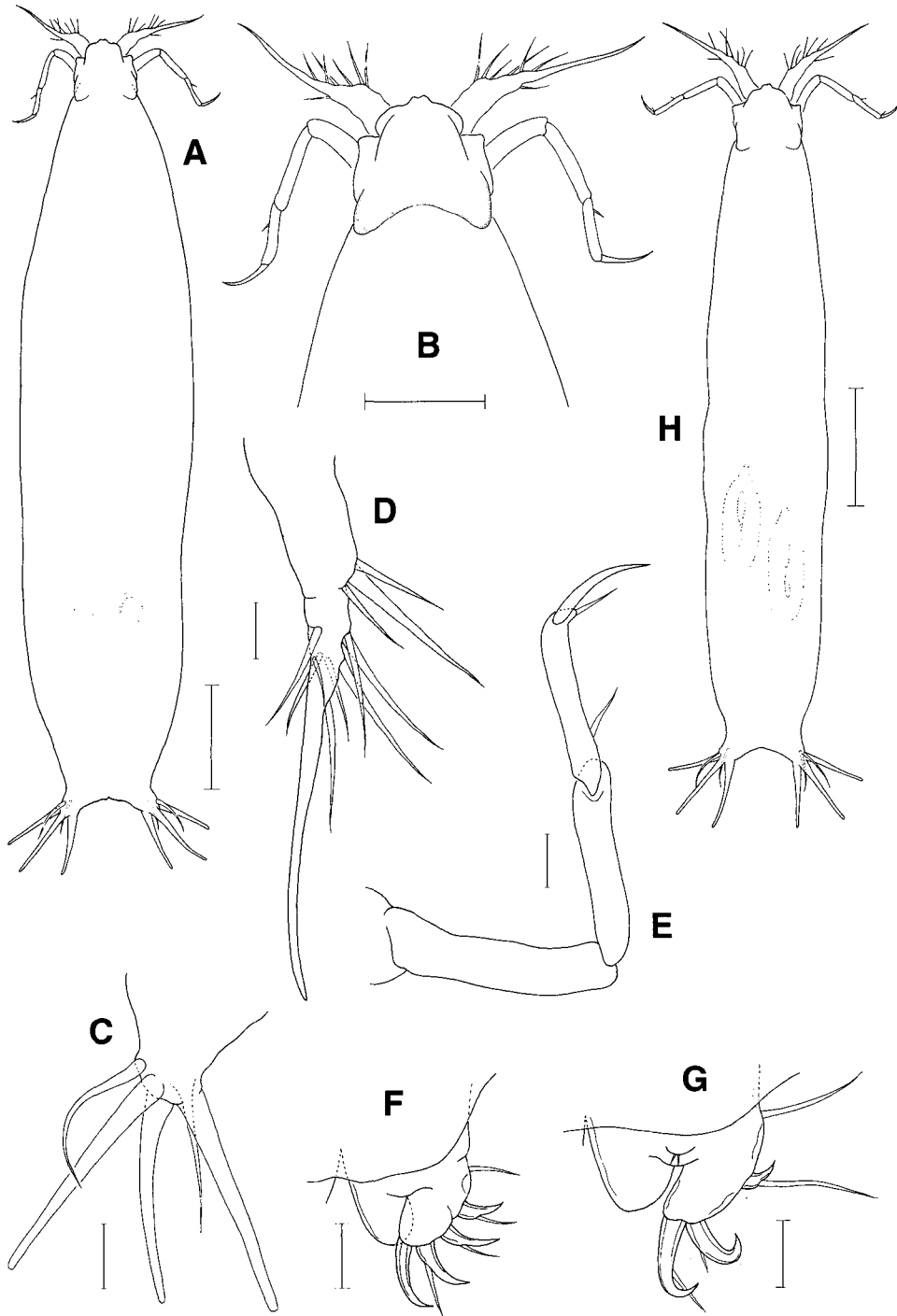


Fig. 3. *Enalcyonium caledonensis* n. sp. Female: A, habitus, dorsal; B, cephalic area, dorsal; C, caudal ramus; D, antennule; E, antenna; F, leg 1, anterior; G, leg 2, anterior. Male: H, habitus, dorsal. Scales = 10 μm (D-G), 20 μm (C), 50 μm (B), 100 μm (A, H).

large inner (distal) seta and 2 distal spines (armature formula 1, III). Outer spine with seta on inner margin. Inner spine with seta on outer margin. Anterior lobe indistinct, with 2 minute setae. Inner lobe broad, less prominent than that of leg 1. Legs 3-6 absent.

Male. Body (Fig. 3H) more slender, but similar in general form to that of female. Length 555 μm . Maximum width 105 μm . Caudal, antennule, antenna, and legs as in female.

Etymology. The specific name *caledonensis* is derived from New Caledonia where the type locality is located in.

Remarks. In having three digitations and two setae on the caudal ramus, the new species similar superficially to *E. lobophyti* described in this paper. However, in the leg morphology they are not related at all, because the exopod of legs 1 and 2 of *E. lobophyti* are armed respectively with two setae+two spines and one seta+two spines respectively, unlike one seta+four spines and three spines in *E. caledonensis*. The absence in *E. caledonensis* of an inner proximal seta on the third segment of the antenna may be an important trait distinguishing it from *N. lobophyti*.

***Enalcyonium auriculatum* n. sp. (Fig. 4)**

Material examined. 9 ♀♀, 10 ♂♂ from *Lobophyton schoedei* Moser, in 1 m, Ricaudy Reef, Noumea, New Caledonia, 20 July 1971, collected by A. G. Humes. Holotype (♀), allotype (♂), and paratypes (7 ♀♀, 8 ♂♂) will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington D.C. Dissected paratypes (1 ♀, 1 ♂) are in the collection of the author.

Female. Body (Fig. 4A) anteriorly narrower and posteriorly cylindrical. Length 678 μm . Maximum width 128 μm . Cephalic area (Fig. 4B) fused with bases of antennules, 70 μm wide, with W-shaped posterodorsal sclerotization, and anterolateral process on both sides. Anterolateral process directed inward, with 1 sensilla (or hair) on outer (anterior) margin. Posterolateral margins of cephalic area with 1 sensilla as well.

Caudal rami divergent and widely separated from each other. Each ramus (Fig. 4C) bluntly ended, 34 μm long measured along inner margin from junction of rami to posterior tip, armed with 3 digitation of dissimilar lengths (longest terminal one 36 μm) and 2 small setae (both about 20 μm).

Antennule (Fig. 4D) unsegmented, approximately 94 μm long including terminal seta, with 13 setae including terminal aesthetasc-like seta of 48 μm long and 1 minute subdistal seta. Antenna (Fig. 4E) slender, 3-segmented, each segment 33, 30, and 34 μm from proximal to terminal (average lengths of inner and outer margins). First and second segments unarmed. Third segment with 1 relatively large distal seta. No seta on inner margin of this segment. Claw 20 μm long, slightly curved and acute. Oral cone prominent in lateral view. Mouth appendages not seen.

Leg 1 (Fig. 4F) with exopod, interramal lobe, and inner lobe. Protopod unarmed. Exopod not demarcated from protopod, with 1 small seta and 3 spines (formula I, 1, II). Outer proximal spine small, claw-like, with 1 large lateral seta. Outer one of 2 terminal setae with short seta on inner margin. Interramal lobe and inner lobe broad and distinct. Leg 2 (Fig. 4G) consisting of exopod, interramal lobe, anterior lobe, and inner lobe. Protopod with 1 large outer seta. Exopod with 3 spines, without seta (formula III). Proximal spine identical to that of leg 1. Two distal spines with seta on different margins. Interramal lobe and inner lobe as in leg 1. Anterior lobe distinct, longer than wide, with 2 subequal distal setae. Legs 3-6 absent.

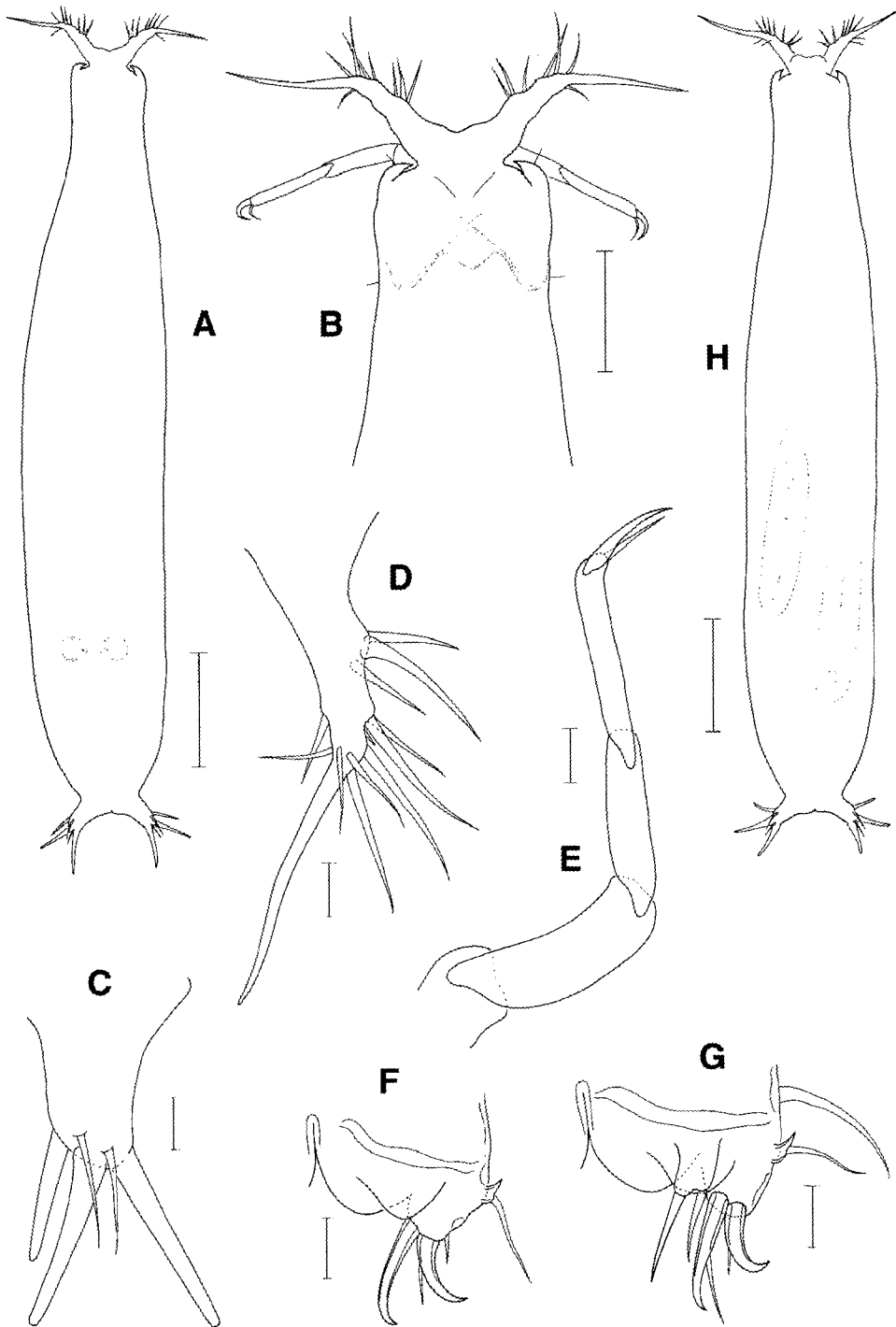


Fig. 4. *Enalcyonium auriculatum* n. sp. Female: A, habitus, dorsal; B, cephalic area, dorsal; C, caudal ramus; D, antennule; E, antenna; F, leg 1, anterior; G, leg 2, anterior. Male: H, habitus, dorsal. Scales = 10 μ m (D-G), 20 μ m (C), 50 μ m (B), 100 μ m (A, H).

Male. Body (Fig. 4H) almost identical to that of female. Length 673 μm . Maximum width 118 μm . Caudal rami, antennule, antenna, and legs as in female.

Etymology. The specific name *auriculatum* is derived from the Latin *auricula* (the lobe of the ear). It alludes to the ear-like anterolateral processes on the cephalic area.

Remarks. In the possession of three digitations and two setae on the caudal rami, *E. auriculatum* n. sp. is comparable with *E. lobophyti* and *E. caledonensis* both described in this paper. However, it is not related to these two species in the absence of a proximal seta on the third segment of antenna and in the presence of different setation on legs 1 and 2. The combination of armature of legs 1 (formula I, 1, II) and 2 (III) alone may differentiate this species from all congeners. Sharing the anterolateral processes on the cephalic area of *Enalcyonium auriculatum* with *E. humesi* is noticed, otherwise, these two species are not related.

***Enalcyonium capillatum* n. sp. (Fig. 5)**

Material examined. 6 ♀♀, 13 ♂♂ from the gorgonacean *Rumphella antipathes* (L.), in 1 m, Ricaudy Reef, Noumea, New Caledonia, 29 July 1971, collected by A. G. Humes. Holotype (♀), allotype (♂), and paratypes (4 ♀♀, 11 ♂♂) will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington D.C. Dissected paratypes (1 ♀, 1 ♂) are in the collection of the author.

Female. Body (Fig. 5A) slender, with more than 10 transverse rows sensillae (or hairs). Cephalothorax delimited by weak constriction in front of slight lateral expansion representing first pedigerous area (Fig. 5B). Length 788 μm . Maximum width 180 μm across near middle. Maximum dorsoventral depth 130 μm . Cephalothorax composed of narrower, triangular anterior part and wider posterior part bearing nearly parallel lateral margins. Rostrum digitiform, projected anteriorly.

Caudal rami (Fig. 5C) located close to each other. Each ramus root-like, tapering, about 29 μm long, with 1 large terminal (183 μm long), 2 medium sized subterminal setae, and 2 smaller proximal setae. Antennule (Fig. 5D) slender, unsegmented, approximately 145 μm including terminal seta, with 11 setae. Terminal seta 78 μm long, not delimited at base. Antenna (Fig. 5E) 3-segmented, each 41, 35, and 32 μm from proximal to terminal (average lengths of inner and outer margins). First segment tapering, distinctly thicker than other segments and unarmed. Second segment also unarmed. Third segment with 1 inner proximal and 2 terminal setae. Claw 26 μm long, very thin. Oral cone prominent in lateral view. Mouth appendages absent.

Legs 1 and 2 (Fig. 5F, G) characteristic in absence of inner lobe. Exopod of both legs fused completely with protopod. Exopod of leg 1 with 4 spine (formula IV), all bearing seta on inner margin. Leg 2 with no trace of anterior lobe. Exopod with 3 spines (formula III): proximal spine with seta on inner margin; second spine unarmed; inner spine with seta on outer margin. Legs 3-6 absent.

Male. Body (Fig. 5H) almost identical in form to, but larger than, that of female. Length 870 μm . Maximum width 145 μm . Caudal rami, antennule, antenna, and legs as in female.

Etymology. *Enalcyonium capillatum* is named as such because of its hairy body. The Latin *capillatus* means "with hairs".

Remarks. Only one species in *Enalcyonium*, *E. ciliatum* Stock, 1972, was recorded to have rows of sensillae (hairs) on body surface (Stock, 1972), like the new species. *Enalcyonium*

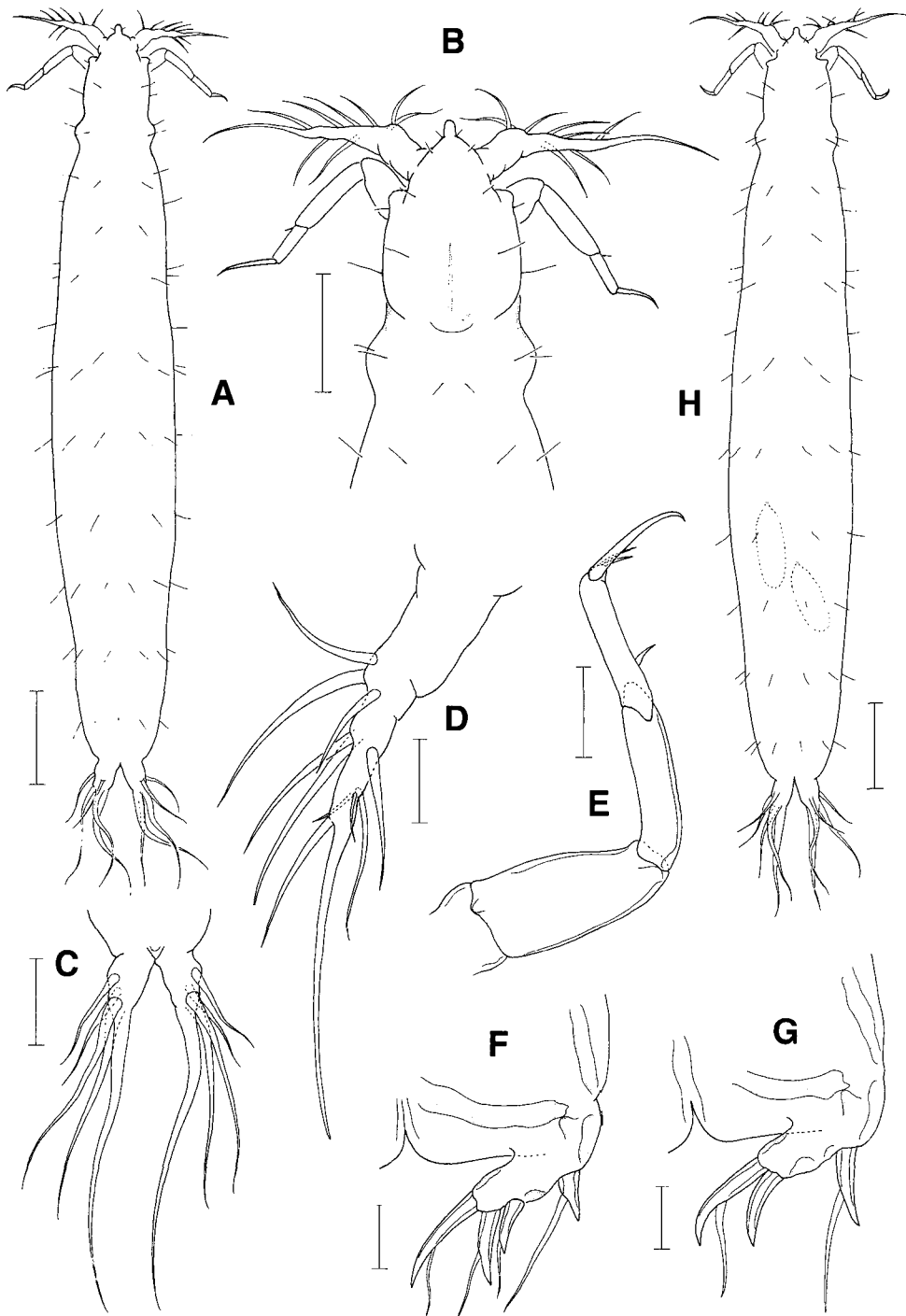


Fig. 5. *Enalcyonium capillatum* n. sp. Female: A, habitus, dorsal; B, cephalic area, dorsal; C, caudal rami; D, antennule; E, antenna; F, leg 1, anterior; G, leg 2, anterior. Male: H, habitus, dorsal. Scales = 10 μm (A, F-H), 20 μm (D, E), 50 μm (B, C).

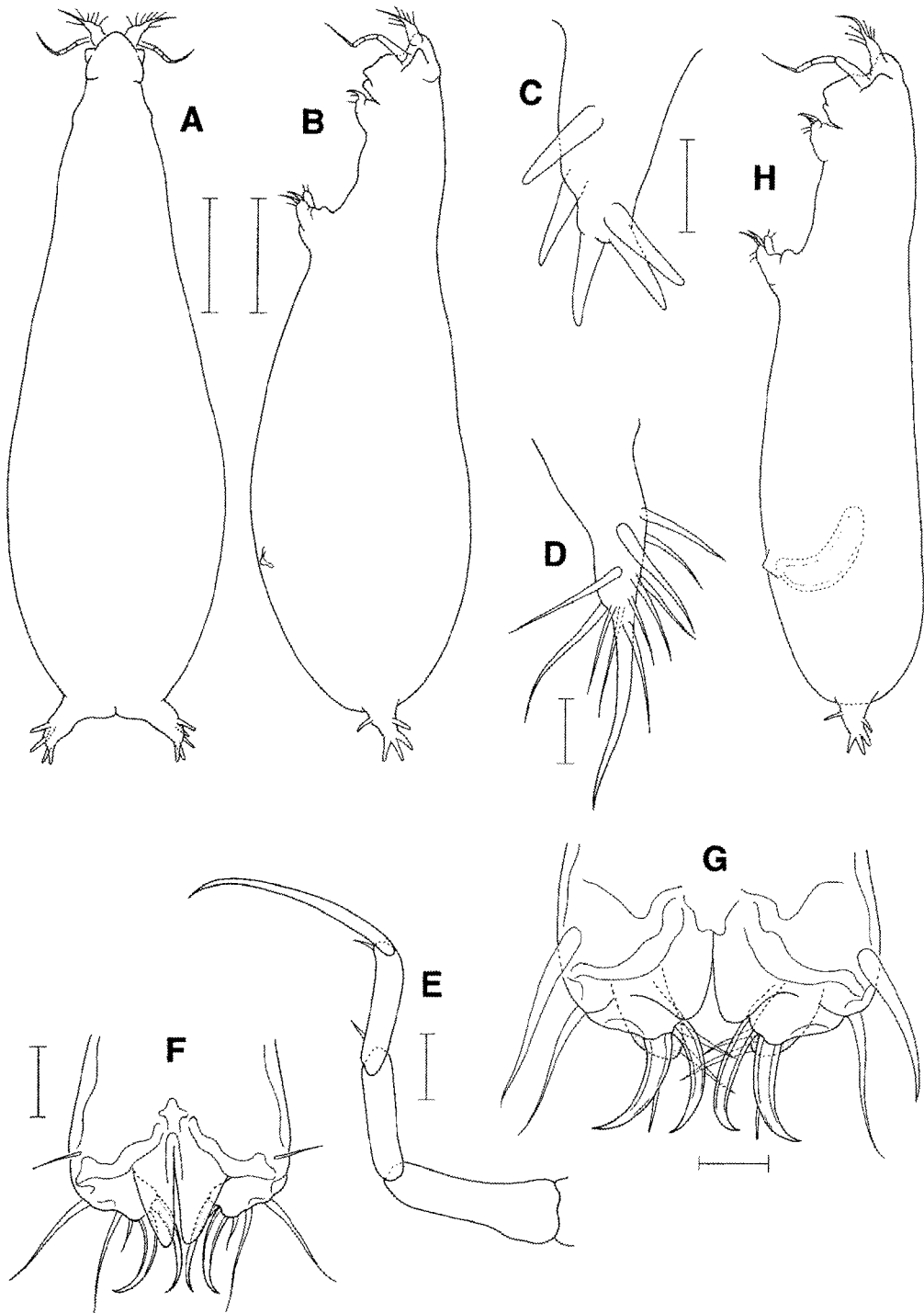


Fig. 6. *Enalcyonium bullatum* n. sp. Female: A, habitus, dorsal; B, habitus, lateral; C, caudal ramus; D, antennule; E, antenna; F, leg 1, posterior; G, leg 2, posterior. Male: H, habitus, lateral. Scales = 10 μ m (A, B, D-H), 20 μ m (C).

capillatum n. sp. is clearly defined from *E. ciliatum* by the different armature on the caudal ramus: three large and two smaller setae in *E. capillatum* in contrast to one large and two small setae in *E. ciliatum*.

***Enalcyonium bullatum* n. sp. (Fig. 6)**

Material examined. 23 ♀♀, 13 ♂♂ from the gorgonacean *Siphonogorgia variabilis* (Hickson), in 30 m, off Noumea, New Caledonia, 23 July 1971, collected by A. G. Humes. Holotype (♀), allotype (♂), and paratypes (21 ♀♀, 11 ♂♂) will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington D.C. Dissected paratypes (1 ♀, 1 ♂) are in the collection of the author.

Female. Body (Fig. 6A, B) remarkably inflated posteriorly. Length 598 µm. Maximum width 190 µm. Maximum depth 194 µm. Cephalothorax delimited by weak lateral constriction, 51 µm wide, nearly triangular in dorsal view, with small, ear-like, triangular anterolateral processes.

Caudal rami distinctly divergent, remotely separated from each other, with 5 similar digitations of 19–23 µm long (Fig. 6C).

Antennule (Fig. 6D) tapering, unsegmented, approximately 61 µm long, with 12 setae including terminal process-like seta of 28 µm long. Antenna (Fig. 6E) 3-segmented, slender, each segment 26, 18, and 18 µm from proximal to terminal (average lengths of inner and outer margins). First and second segments unarmed. Third segment with 1 inner proximal and 1 terminal setae. Claw characteristically longer than segments, 32 µm and very slender. Oral cone as in Fig. 6B. Mouth appendages lacking.

Leg 1 (Fig. 6F) with 1 small outer seta on protopod. Exopod with 2 larger proximal setae, 1 smaller subdistal seta, and 2 smooth spines (formula 3, II). Interramal lobe lacking. Inner lobe prominent, longer than wide, extending well over distal margin of exopod. Leg 2 (Fig. 6G) with 1 large outer seta on protopod. Exopod with 1 large proximal seta and 2 distal spines (formula 1, II); outer one of these 2 spines with small seta on inner margin. Inner lobe less prominent than that of leg 1. Anterior lobe well-developed, longer than wide, extending over distal margin of exopod, distally with 2 setae. Legs 3–6 absent.

Male. Body (Fig. 6H) less inflated posteriorly than that of female. Length 469 µm. Maximum dorsoventral depth 115 µm. Caudal rami, antennule, antenna, and legs as in female.

Etymology. The specific name *bullatum* is taken from the Latin *bullatus* (=inflated), alluding to the distinctly inflated posterior part of female body.

Remarks. Two previously known species, *Enalcyonium chattoni* (Zulueta, 1908) and *E. pallidum* (Zulueta, 1908), both recorded from the Mediterranean Sea, are recorded to have five digitations on the caudal ramus, as in *E. bullatum* n. sp. According to Bouligand (1964), in these Mediterranean species the terminal claw of antenna is distinctly shorter than the third segment. The setation of leg 1 exopod of these species differs also from that of *E. bullatum*: four spines (formula IV) in *E. chattoni* and one seta plus three spines (1, III) in *E. pallidum*, compared to three setae plus two spines (3, II) in *E. bullatum*.

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뉴칼레도니아의 팔방산호류에 기생하는 *Enalcyonium* 속의 6신종
(요각아강, 검물벼룩목, 산호속살이과)

김 일 회

(강릉대학교 자연과학대학 생물학과)

요 약

뉴칼레도니아의 팔방산호에 기생하는 *Enalcyonium* 속의 요각류 6신종을 기재하였다. 이들은 해계두류 *Lobophyton schoedei* Moser에 기생하는 *Enalcyonium lobophyti*, *E. humesi*, *E. caledonensis* 및 *E. auriculatum*, 해양류 *Rumphella antipathes* (L.)에 기생하는 *E. capillatum*, 그리고 해양류 *Siphonogorgia variabilis* (Hickson)에 기생하는 *E. bullatum*이다. 이 논문은 남태평양산 *Enalcyonium* 속 요각류에 대한 첫 기록이다.