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A New Species of *Farranula* (Copepoda: Cyclopoida: Corycaeidae) from the West Central Pacific, with a Key to Species of the Genus

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ABSTRACT

A new species of the genus *Farranula* Wilson, 1942 (Cyclopoida, Corycaeidae) is described based on both sexes collected off Chuuk Island in Micronesia (West Central Pacific). The new species *F. dahlae* differs from its close congener *F. gibbula* (Giesbrecht, 1891) in the following combination of characters in both sexes: body length is longer, length to width ratio of caudal rami is larger, basal element of maxilliped is distinctly longer, and terminal spine to distal segment ratio of P4 is smaller; while in females, lateral margins of fourth pedigerous somite are extended to mid-region of second urosomal somite, maximum width of the second urosomal somite is located at middle region in dorsal and lateral views, and length ratio of caudal seta III to seta V is much larger; and in males, sharply contracted portion of second somite is located at two-thirds distance from anterior margin. Some additional morphological details of *F. gibbula* are given and a key to species of the genus *Farranula* is provided.

Keywords: Cyclopoida, Corycaeidae, *Farranula*, West Central Pacific, key to species

INTRODUCTION

The family Corycaeidae Dana, 1852 includes two genera, *Corycaeus* Dana, 1845 and *Farranula* Wilson, 1932, of copepods that typically occur in the epipelagic zone of tropical to temperate seas (Motoda, 1963; Boxshall and Halsey, 2004). The genus *Farranula* is currently composed of eight species: *Farranula carinata* (Giesbrecht, 1891), *F. concinna* (Dana, 1849), *F. curta* (Farran, 1911), *F. gibbula*, *F. gracilis* (Dana, 1849), *F. longicaudis* (Dana, 1849), *F. orbisa* (Wi and Soh, 2013), and *F. rostrata* (Claus, 1863). Most of these species have been recorded worldwide, e.g., *F. gibbula*, *F. carinata*, *F. concinna*, and *F. rostrata*.

However, recent detailed morphological examination and genetic analysis of many of the alleged cosmopolitan species of small cyclopoid copepods, such as oncaeids, have proven to be species complexes, which comprise two or more closely related species (Wi et al., 2010, 2012; Böttger-Schnack and Machida, 2011). In addition, since previous studies of most species of *Farranula* have been based mainly on gross features, such as the proportions of the prosome and urosome, the distance between the eyes, and the lateral and dorsal shape of the second urosomal somite from the both lateral and dorsal aspects (Farran, 1911; Tanaka, 1957; Motoda, 1963), the precise identification of closely related species sharing similar morphological characteristics has been very difficult. Recently, as a part of overcoming this taxonomic limitation, Wi and Soh (2013a, 2013b) examined the *Farranula* species from Korea waters in detail, and verified that mouthpart armature, the surface ornamentation of the second urosomal somite, and the lengths of the exopodal spines of each leg are all useful characteristics, for identifying species of the genus

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Farranula from the world's oceans and through their detailed morphological comparisons, they concluded that the species recorded as *F. rostrata* in the East China Sea (Chen et al., 1974) and *F. curta* from the Indian Ocean (Dahl, 1912) were identical.

Farranula gibbula is one of the most widely distributed corycaeids, and has been recorded in epipelagic layers of the Pacific (Giesbrecht, 1893 ["1892"]; Tanaka, 1957; Motoda, 1963; Chen et al., 1974; Wi and Soh, 2013a, 2013b); Atlantic; Mediterranean Sea (Wilson, 1942); and Indian Ocean (Farran, 1911; Dahl, 1912). However, the *F. gibbula* described by Dahl (1912) consisted of two forms, small and large, of which the small form matches closely the original description of Giesbrecht (1891), whereas the ratio of compound genital somite to the caudal ramus of the large form is much greater than that of the small form. Farran (1911) and Motoda (1963) also mentioned *F. gibbula* showing different body lengths, caudal rami, and caudal setae, but they just confirmed that the small form agreed with *F. gibbula* from their study areas (Christmas Island, and Hawaiian waters). Material collected from off Chuuk Island, in Micronesia agrees closely in its morphological characteristics with the large form of *F. gibbula* described by Dahl (1912).

In this study, we confirm that the material from Chuuk Island represents a new species and provide a full description of this new species. In addition, some comparisons of morphological characteristics between the new species and *F. gibbula* and key to eight species within *Farranula* is provided.

MATERIALS AND METHODS

Zooplankton was taken from off Chuuk Island in Micronesia, on 12 June 2012 (Fig. 1A). A conical net (mesh size 100 μm, mouth diameter 45 cm) was towed vertically from near bottom to the surface. According to the vertical CTD profiles (Sea-bird Electronics, Inc., Bellevue, WA, USA), a warmer water mass (>28°C) was found above 50 m, and the maximum salinity layer (>35 psu), with a thickness of ca. 50 m was located at a depth of 150–200 m. After collection, samples were immediately preserved on board, in a 4% formaldehyde-seawater solution buffered with borax. Specimens of the new species were sorted out for study. Material of *F. gibbula*, collected from the East China Sea south of Jeju Island, Korea, on 10 Sep 2010 (Fig. 1B), was used to compare with the new species. The surface water temperature above 10 m ranged from 18.1–21.5°C between stations, and surface salinity ranged from 34.1–34.5 psu. Each specimen was dissected under a dissecting microscope (Nikon, SMZ645; Nikon, Tokyo, Japan) in CMC-10 aqueous mounting medium (Masters Company Inc., Wood Dale, IL, USA), mounted on slides, and sealed with high-quality nail varnish. Drawings were done using a stereo microscope (Nikon AFX-II) equipped with a drawing tube. Scale bars are given in μm. Total body length and the ratio of prosome to urosome (including caudal rami) were measured along the lateral aspect, and telescoping of somites was not considered. However measurements of the relative lengths of different urosomal segments were adjust-

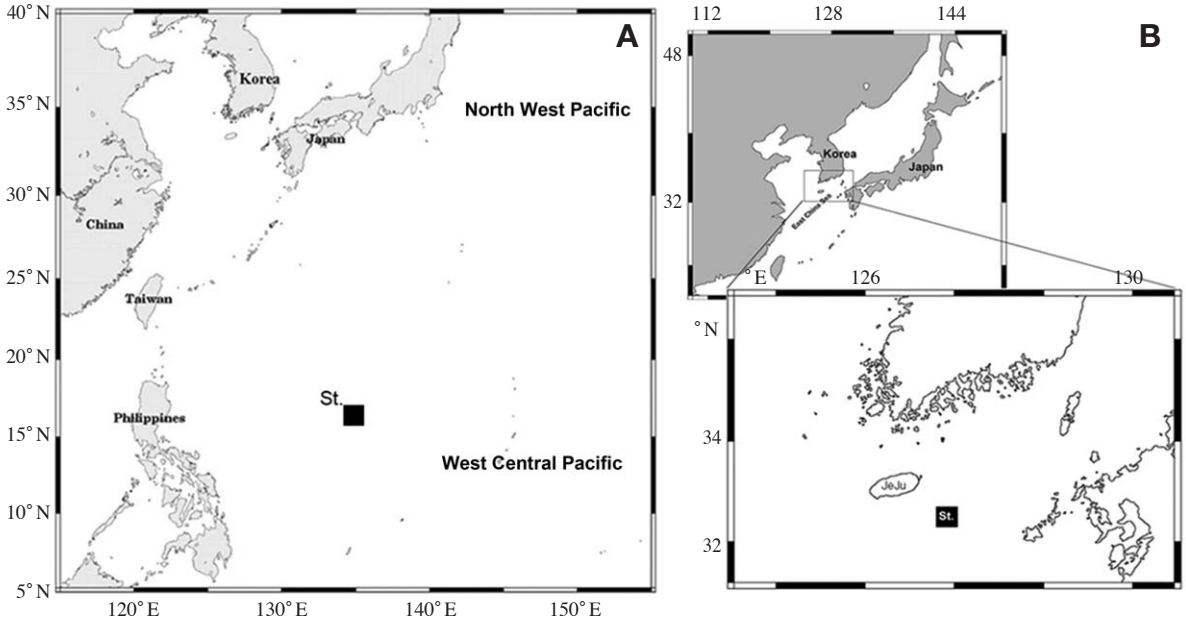

Fig. 1. Location of sampling station. A, Chuuk Islands, Micronesia (West Central Pacific); B, off southeast of Jeju Island, Korea (North West Pacific).

ed for the telescoping effect.

Females of *Farranula* were examined with a Hitachi S-3000 scanning electron microscope (Hitachi High Technologies America, Inc., USA) to observe the minute surface ornamentation in more detail. Specimens were prepared by dehydration through graded ethanol, critical point dried, mounted on stubs and sputter-coated with palladium. The descriptive terminology follows Huys and Boxshall (1991). Abbreviations used in the text and figures are as follows: ae, aesthetasc; CR, caudal rami; P1−P6, first to sixth legs; exp, exopod; enp, endopod; exp (enp)-1 (-2,-3) is used to denote the proximal (middle, distal) segment of a ramus. All type specimens were deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea.

SYSTEMATIC ACCOUNTS

Order Cyclopoida Burmeister, 1835
Family Corycaeidae Dana, 1852
Genus *Farranula* Wilson, 1932

Key to the females of *Farranula*

1. Urosome evenly tapering posteriorly, with proximal expansion both in dorsal and lateral views ····· 2
   Urosome with undulating lateral margins, with proximal expansion on dorsal surface in lateral view ····· 3
2. Eyes adhered to each other ····· 4
   Eyes located at some distance ····· 5
3. Second prosomal somite with dorsal hump ····· 6
   Second prosomal somite without dorsal hump ····· 7
4. Second urosomal somite less than 3 times length of caudal rami ····· *F. orbisa*
   Second urosomal somite more than 4 times length of caudal rami ····· *F. rostrata*
5. Anterior margin of second urosomal somite ventrally protruded; second prosomal pointed margin reaching more than 70% distance of second urosomal somite ····· *F. carinata*
   Anterior margin of second urosomal somite with ventral protrusion; second prosomal pointed margin reaching less than 40% distance of second urosomal somite ····· *F. curta*
6. Second urosomal somite less than twice length of caudal rami ····· *F. longicaudis*
   Second urosomal somite more than twice length of caudal rami ····· 8
7. Second urosomal somite sharply tapered from mid-region in lateral view ····· *F. gracilis*
   Second urosomal somite gradually tapered in lateral view ····· *F. concinna*
8. Caudal rami more than 5 times length of wide ····· *F. dahlae*
   Caudal rami less than 4 times length of wide ····· *F. gibbula*

***Farranula dahlae* n. sp. (Figs. 2−4, 5A, B)**

Corycella sp. (♂): Farran, 1911, Pl. XI, figs. 8, 9.
Corycaeus (*Corycaella*) *gibbulus*: Dahl, 1912, Taf. XV, figs. 1−3.

Material examined. Holotype: adult female dissected and mounted on 2 glass slides, MABIKCR00218002; collection from waters adjacent to Chuuk Island, Micronesia (West Central Pacific) (16°17′054N, 134°58′200″E) on 12 June 2012.

Paratypes: two adult females and two adult males dissected and mounted on 2 glass slides, MABIKCR00218003 and 3 glass slides, MABIKCR00218004: collection from waters off Chuuk Island, Micronesia (West Central Pacific) (16°17′ 054N, 134°58′200″E).

Description of female. Body cylindrical, tapering posteriorly. Total body length in lateral view 1,011−1,031 μm (n=3). Urosome distinctly narrower than prosome.

Prosome two-segmented (Fig. 2A, B), frontal part rounded, with two large separate cuticular lenses: cephalosome completely fused with first pedigerous somite, with ventral process in lateral view, 1.6 times longer than wide, second to fourth pedigerous somites forming single compound somite with suture line between second and third pedigerous somites, prosome about 2.1 times as long as urosome including CR, 3 times as long as urosome excluding CR; third pedigerous somite dorsally covering fourth pedigerous somite, forming inverted triangular shape; fourth pedigerous somite extending almost to middle of second urosomal somite, with pointed posterolateral corners, secretory pore on inner pleural area.

Urosome (Fig. 2A, B) two-segmented: first urosomal somite bearing P5 ventrolaterally; genital compound somite and anal somite combined. Proportional lengths (%) of urosomites and caudal rami 4.4 : 59.6 : 36. Second urosomal somite (Fig. 2A, B) irregular, showing folds at anterior third in dorsal view (indicated by arrow in Fig. 2A), lateral greatest width, 1.8 times longer than maximum width at mid region, protruded with rounded hump on anteroventral margin (visible in lateral view and arrowed in Fig. 2B), bearing patch of spinules, posteroventral and lateral margins fringed with minute denticles; dorsal and ventral surfaces covered with small denticles, posterodorsal surface usually with 2 attached spermatophores (Fig. 2B); genital area located dorsolaterally, paired genital apertures at mid-region of dorsal surface, hidden behind opercula.

CR (Figs. 2A, C, 5A, B) cylindrical, 0.6 times as long as second urosomal somite, 5.2 times longer than width at base. Each ramus with triangular process located near insertion

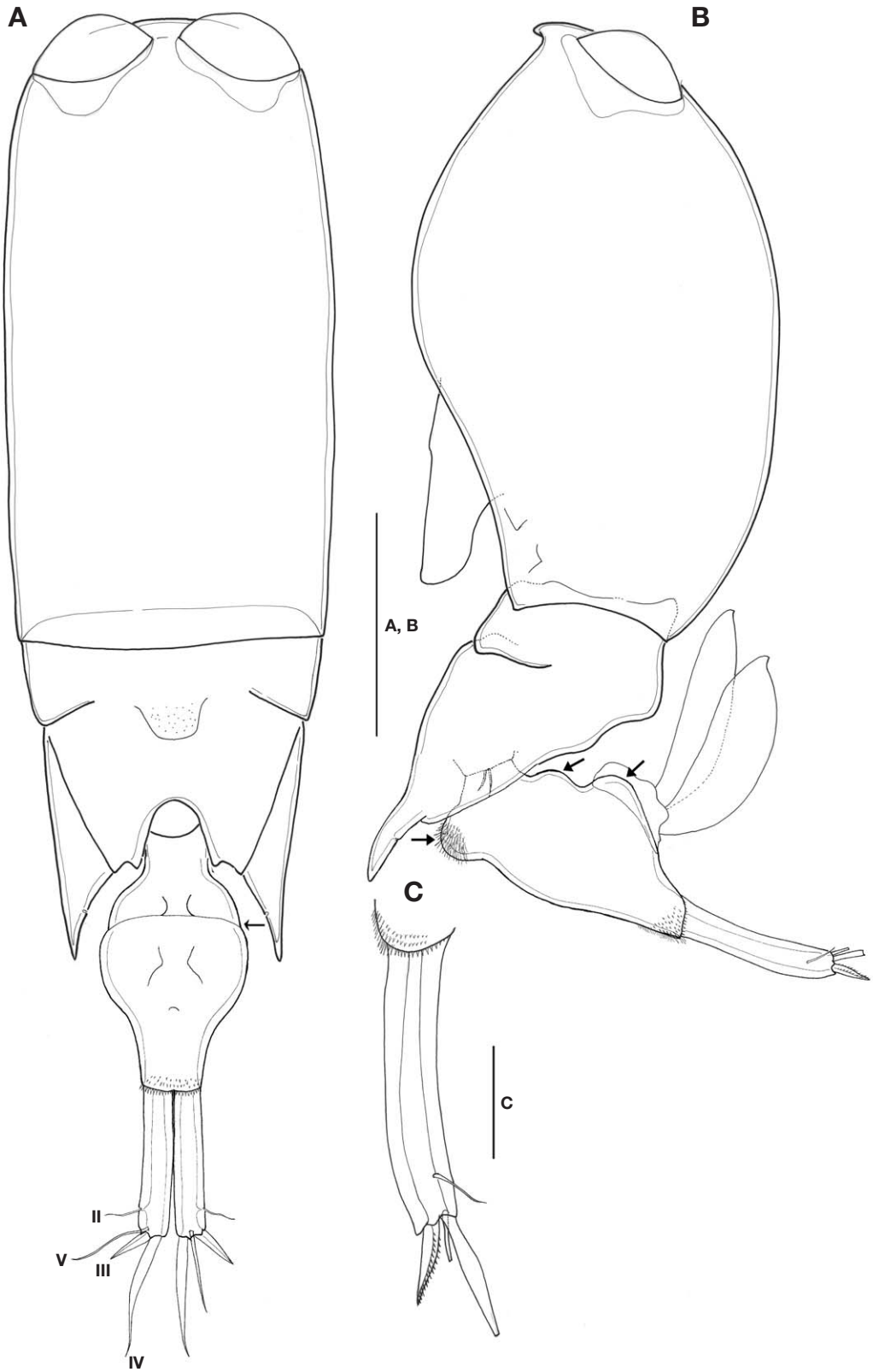

Fig. 2. *Farranula dahlae* n. sp. female (holotype). A, Habitus, dorsal view; B, Habitus, lateral view; C, Caudal rami, caudal setae numbered using Roman numerals. Scale bars: A, B=200 μm, C=50 μm.

and armed with four setae (arrowed in Fig. 5B): slender anterolateral seta II, bipinnate posterolateral seta III short and robust, inner terminal seta IV longest, and dorsal seta V 1.7 times longer than seta III. Entire surface ornamented with small denticles (Fig. 5A).

Antennule (Fig. 3A) short, 6-segmented. Armature formula 1-[2], 2-[8], 3-[2+ae], 4-[3+ae], 5-[2+ae], 6-[5+(1+ae)]. Proportional lengths (%) 20.7 : 8.8 : 13.2 : 29.4 : 14.7 : 13.2.

Antenna (Fig. 3B) 4-segmented with coxa and basis fused. Coxobasis 1.9 times longer than width at base, with strong seta at distal margin. Endopod three-segmented: first endopodal segment robust, 4.7 times longer than remainder of endopodal segments, 3.7 times longer than width at base, bearing bipinnate seta on inner proximal margin, about 0.9 times as long as coxobasal seta; inner distal margin with long spine-like process, outer lateral margin ornamented with row of denticles, naked seta on distolateral margin; second endopodal segment shortest, bearing three elements: curved stout spine arising from outer distal margin, with lateral branch; slender, pinnate spine located near base and reaching almost one-third of distal spine; short curved spine arising from inner margin; outer distal spine 2.3 times longer than branched spine; third endopodal segment cylindrical, as long as wide, and armed with three elements: one stout terminal spine, short spine arising from inner margin, strong seta on outer margin; terminal spine equal to outer spine on second endopodal segment in length. Length ratio of terminal spine to outer spine on third exopodal segment 1.4 : 1.

Mandible (Fig. 3C) with two elements on gnathobase: one spine and one blade; spine broad and robust, with three naked slender setules on medial area and two basal setules; blade forming spiniform processes, surrounded by patch of spinules around base.

Maxillule (Fig. 3D) reduced, praecoxal arthrite bearing four articulated spinous elements: innermost element (A) separated from other elements, trifurcate, slightly longer than element B; element B stout, distally trifurcate, as long as element C, distal margin of element C serrated, and element D shortest.

Maxilla (Fig. 3E) two-segmented, allobasis shorter than syncoxa: syncoxa unarmed; allobasis produced distally into strong spine, with four naked setae proximally, inner margin bearing three spines of different lengths: medial one naked, ventral one split into two branches, and dorsal one longest, unipinnate innermost spine.

Maxilliped (Fig. 3F) three-segmented: syncoxa unarmed; basis robust and expanded, 2.2 times longer than width at base, with two elements along inner margin: proximal element short, located at base of distal element; distal element with three spinules along inner margin, located at anterior two-thirds distance of inner margin, 0.38 times as long as basis; endopodal segment drawn out into long curved claw, unornamented and much shorter than basis, accessory armature consisting of long slender, unipinnate seta on inner proximal margin, and short unilaterally pectinate spine laterally on outer proximal margin.

Swimming legs 1–3 (Fig. 3G–I) comprising coxa, basis and three-segmented rami; intercoxal sclerite well developed; basis of P1 and P3 with naked outer seta and round process between insertions of enp and exp, and exopods distinctly longer than endopods.

Exopods of P1 to P3: inner margin of first and second segments with long setules, first segments of P1 to P3 without spine, and relative length ratio of terminal spine to distal outer spine of P1 to P3 different: P1 smallest (2.2 : 1), P2 (2.6 : 1), and P3 largest (3.2 : 1), terminal spines longer than distal segments, in P1 1.2 times longer, in P2 about 1.5 times longer, and in P3 2.3 times longer.

P4 (Fig. 3J) with narrow, transversely extended, intercoxal sclerite; coxa unarmed; basis with outer basal seta arising from posterior surface, fringed with row of setules along inner margin; exp well developed, three-segmented, bearing spinules along inner margin of first segment, proportional length ratio of each segment 37 : 18.5 : 44.5, distal segment 1.8 times as long as terminal spine; enp absent. Armature formula of P1 to P4 as follows (Roman numerals indicate spines, and Arabic ones, setae):

Leg	Coxa	Basis	Exopod	Endopod
P1	0-0	1-0	0-0;0-1;I,I,4	0-1; 0-1;0,2,3
P2	0-0	0-0	0-0; 0-1; I,I,5	0-1; 0-2; 0,1,3
P3	0-0	1-0	0-0; 0-1; I,I,5	0-1; 0-2; 0,1,1
P4	0-0	1-0	0-0; 0-1; I,6	Absent

P5 (Fig. 2B) consisting of two unequal simple setae located ventrolaterally.

P6 (Fig. 2A, B) represented by operculum closing off each genital aperture (arrowed in Fig. 2B).

Male. Total body length in lateral view 958–986 μm (n=3). Urosome distinctly narrower than prosome (Fig. 4A, B).

Prosome two-segmented, two large contiguous cuticular lenses located at a distance from each other on frontal part: prosomal length about 1.2 times as long as urosome including caudal rami, 1.6 times as long as urosome length excluding CR (Fig. 4A, B); fourth pedigerous somite with extended and pointed posterolateral corners, extended to 26% of second urosomal somite (Fig. 4A, B).

Second urosomal somite (Fig. 4A, B): anterior margin rounded, 2.5 times longer than maximum width (at anterior two-fifths), posterior part abruptly narrowed (indicated by arrows in Fig. 4A), and rear margin about 0.32 times as long as rest of second urosomal somite (marked in Fig. 4A), and 1.5

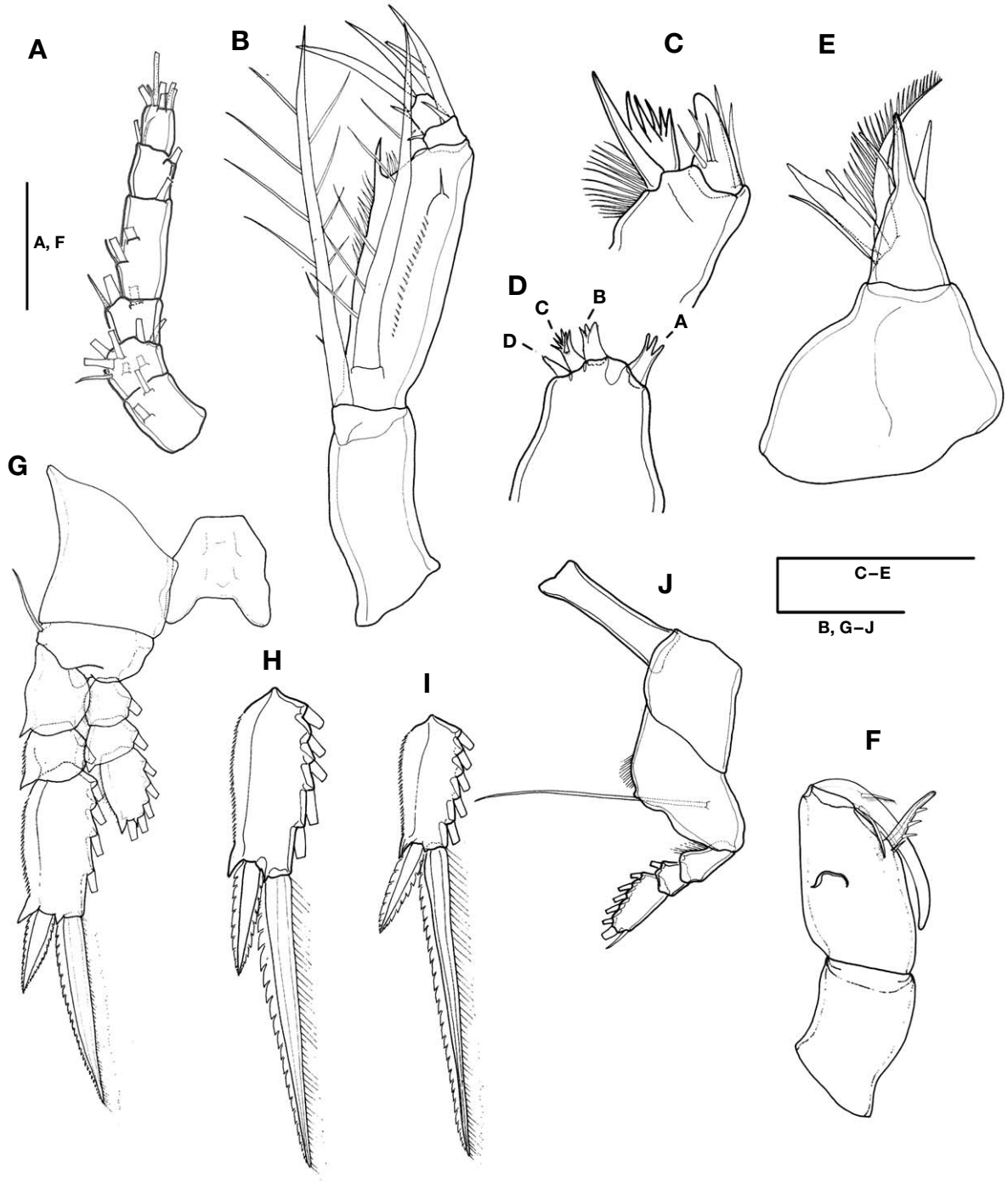

Fig. 3. *Farranula dahlae* n. sp. female (holotype). A, Antennule; B, Antenna; C, Mandible; D, Maxillule, individual setae designated using capital letters; E, Maxilla; F, Maxilliped; G, P1; H, P2, exp-3; I, P3, exp-3; J, P4. Scale bars: A–J=50 μm.

times longer than caudal ramus.

CR 6.8 times longer than width at base (Fig. 4A, K), about 0.38 times as long as second urosomal somite. Armature of rami similar to that of female. Dorsal seta V slightly longer than seta III.

Antennule (Fig. 4C) short, 6-segmented; armature formula as in female; proportional lengths (%) 23 : 14.7 : 11.5 : 24.6 : 16.4 : 9.8.

Antenna (Fig. 4D, D′) sexually dimorphic, four-segmented, with coxa and basis fused and endopod three-segmented; co-

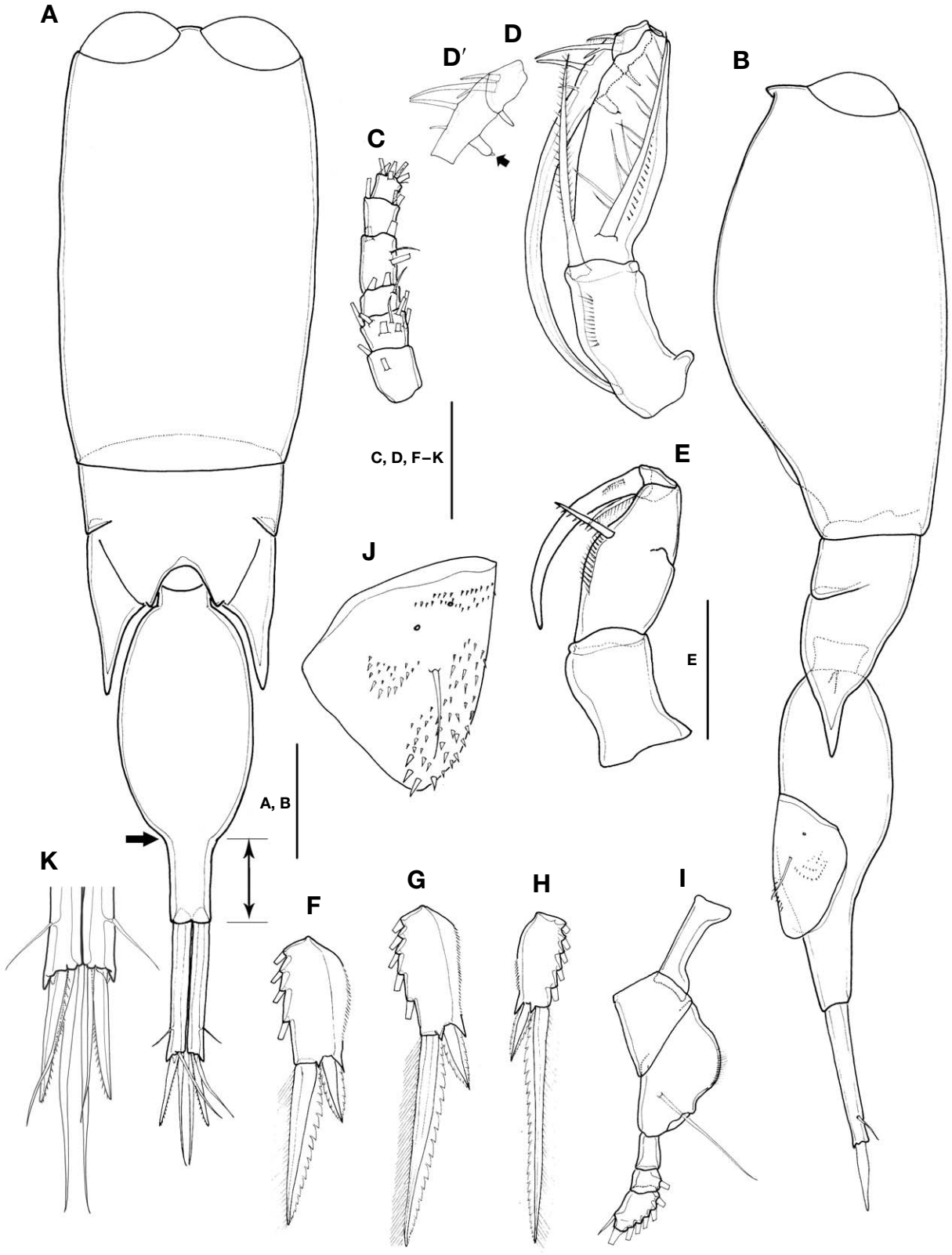

Fig. 4. *Farranula dahlae* n. sp. male (paratype). A, Habitus, dorsal view; B, Habitus, lateral view; C, Antennule; D, Antenna; D′, Second endopodal segment and proximal part of third endopodal segment of antenna; E, Maxilliped; F, P1, exp-3; G, P2, exp-3; H, P3, exp-3; I, P4; J, P6, genital flap; K, caudal setae. Scale bars: A, B=100 μm, C–K=50 μm.

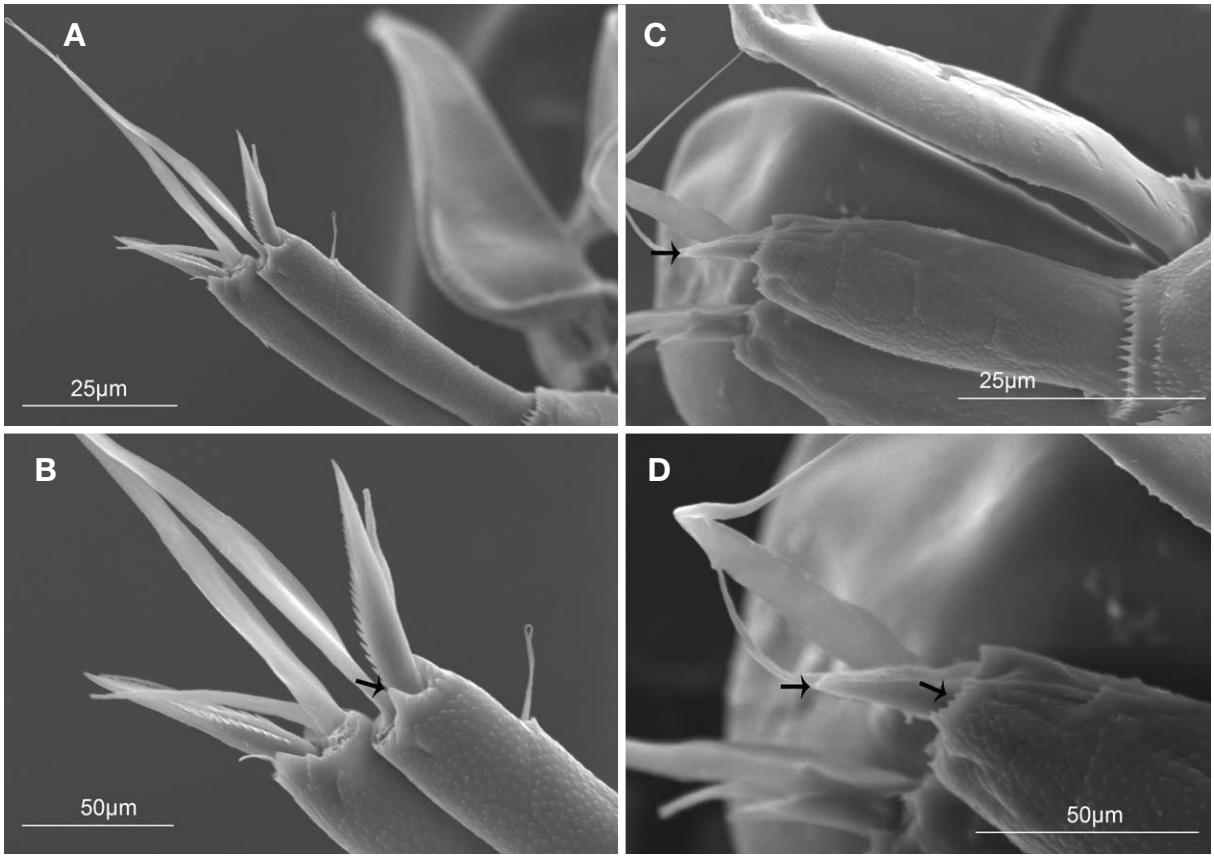

Fig. 5. Scanning electron microscope photographs. *Farranula dahlae* n. sp. female: A, Caudal rami (CR); B, Caudal setae, arrow indicating triangular process near insertion of caudal seta III. *Farranula gibbula*, female: C, CR; D, Caudal setae and distal margin of CR, arrows indicating tip of caudal seta III and distal serration near insertion of caudal seta III. Scale bars: A, C=25 μm, B, D=50 μm.

xobasis 1.6 times longer than width at base, with long bipinnate strong seta on inner distal margin, slightly shorter than length of first endopodal segment, fringed with row of spinules along inner margin; first endopodal segment about 3 times as long as width at base, bearing bipinnate seta on ventral proximal margin, almost as long as coxobasal seta, outer lateral margin ornamented with row of denticles; second endopodal segment short, bearing three elements: stout spine arising from outer distal margin, with lateral branch, short plumose spine located near stout spine, and short blunt spine arising from inner distal margin; third endopodal segment drawn out into long claw, armed with four elements: short spine arising from proximal inner margin, tipped with minute process (arrowed in Fig. 4D′); long naked seta and two slender, naked setae inserted on outer proximal margin.

Mandible, maxillule, and maxilla similar to those of female.

Maxilliped (Fig. 4E) sexually dimorphic, four-segmented, comprising syncoxa, basis and two-segmented endopod (subchela); syncoxa without surface ornamentation, unarmed; basis robust, oval, particularly swollen in proximal half, inner margin with spiniform seta ornamented with several tough spinules along inner margin, with row of fine spinules between proximal third and seta, twice as long as width at base, and 2.3 times longer than sea on basis. Subchela comprising unarmed proximal endopodal segment and distal endopodal segment drawn out into long curved claw, with accessory armature consisted of minute, unipinnate spine on outer proximal margin, and long unipinnate spine delimited basally from inner proximal corner of claw.

P1-3 (Fig. 4F−H) segmentation and armature similar to those of female, except for length ratios of terminal spine to distal outer spine of P1 (1.3 : 1), P2 (3 : 1), and P3 (3.9 : 1).

P4 (Fig. 4I) similar to that of female, except proportional length ratio of each segment 37.7 : 23.1 : 39.2, and length ratio of distal segment to terminal spine smaller (1.5 : 1) than that of female (1.8 : 1).

P5 (Fig. 4B) similar to that of female.

P6 (Fig. 4B, J) represented by genital flap closing off each genital aperture, armed with long seta, surface ornamented with unique pattern of denticles and two small secretory pores:

inner part covered with small denticles to anterior third from distal margin, outer margin ornamented with denticles arranged in semicircle in mid region; distal margin with comparatively large denticles.

Etymology. The species named in honor of Dr. M. Dahl (Germany), in recognition of her many contributions to the taxonomy of the Corycaeidae.

Remarks. Farran (1911) eastablished a new genus *Corycella*, characterized by a posteriorly directed ventral cephalothoracic process, and designated *Corycella gibbulus* (Giesbrecht, 1891, as *Corycaeus gibbulus*) as the type species of the genus. The genus *Corycella* was replaced by *Farranula* by Wilson (1932), who noticed the generic name *Corycella* Farran, 1911 had already been occupied by *Corycella* Legar, 1892, a genus of Protozoa.

Most taxonomic records of *Farranula* have been limited to body size, gross features such as dorsal and lateral habitus, and sometimes details of the antenna in some cases. Farran (1911) questioned the traditional identification method relying on size alone, and he compared the proportional lengths of abdomen and caudal rami of *Farranula* males. As a result, he recorded the male of Cleve (1904)'s *F. gibbula* (as *Corycaeus gibbula*) as a new species (as *Corycella* sp.) (Farran, 1911, Pl. XI, figs. 8, 9). Besides, Farran (1911) mentioned that the caudal seta III (as middle furcal seta) of *F. gibbula* were strong and length to the width of the caudal ramus is equal. Later, Dahl (1912) provided descriptions of large and small types of *F. gibbula* (as *Corycaeus* [*Corycella*] *gibbulus*), of which the male of the larger type was in good agreement with new species of Farran (1911).

Farranula dahlae corresponds closely to large from of *F. gibbula* described by Dahl (1912, Taf. XV, figs. 1−3) from the Indo-Pacific, but distinctly differs from the original description (Giesbrecht, 1891) of *F. gibbula* and from other species within *Farranula* in the following morphological characteristics: in the female, 1) the total body length is longest (average 1,022 μm) of all species of *Farranula*; 2) the length ratio of the second urosomal somite to the caudal ramus is small (1.6 : 1) and similar to that of *F. longicaudis* (1.4 : 1), but the female of *F. longicaudis* can be differentiated by the shape of the second urosomal somite which lacks a ventral hump and the two dorsal protrusion; 3) the length to width ratio of the caudal ramus is much larger (5.2 : 1) than that of *F. gibbula* (3.5 : 1) and is the second-longest in the genus after that of *F. longicaudis* (6.4 : 1); 4) in the shape of the second urosomal somite, where the ventral hump and the second dorsal protrusion are much more rmarked, compared to other species of *Farranula*; and in males; 5) the narrow posterior part of the second urosomal somite is one-third as long as the somite.

F. dahlae can easily be differentiated from Korean specimens of *F. gibbula* by the much longer and more slender caudal rami and a combination of following characteristics (Table 1): in both sexes, 1) the total body length is much longer (female, 1,022 μm vs. 925 μm; male, 972 μm vs. 865 μm); 2) the length to width ratio of the caudal ramus much larger (female, 5.2 : 1 vs. 3.5 : 1; male, 6.8 : 1 vs. 5.4 : 1); 3) the length ratio of caudal setae III to V is much smaller (female, 1 : 1.7 vs. 1 : 3; males, 1 : 1.1 vs. 1 : 1.2); 4) the length ratio of seta on the basis to basis of the maxilliped is smaller (female, 1 : 2.6 vs. 1 : 2.9; male, 1 : 1.23 vs. 1 : 3.1); 5) the spine lengths of P1-3 exp-3 differ from each other; 6) the length ratio of the distal segment to the terminal spine of P4 are smaller (female, 1.8 : 1 vs. 2.1 : 1; male, 1.5 : 1 vs. 2 : 1); in the female, 7) the lateral margin of the fourth pedigerous somite is extended to the mid-region of the second urosomal

Table 1. Morphological differences between *Farranula dahlae* n. sp. and *F. gibbula*

Character/type form (F/M)	*F. dahlae*		*F. gibbula* (Korean water)	
	Female	Male	Female	Male
Mean body length (μm)	1,022	972	925	865
Length ratio of PR to UR (+CR)	2.1 : 1	1.6 : 1	2.8 : 1	1.3 : 1
SUS				
Length to maximum width ratio	1.8 : 1	2.5 : 1	1.9 : 1	2.3 : 1
Length ratio of SUS to CR	1.3 : 1	2.6 : 1	2.2 : 1	2.5 : 1
CR				
Length to width ratio	5.2 : 1	6.8 : 1	3.5 : 1	5.4 : 1
Caudal setae III to V length ratio	1 : 1.7	1 : 1.1	1 : 3	1 : 1.2
Maxilliped				
Length of element on basis to basis	1 : 2.6	1 : 2.3	1 : 2.9	1 : 3.1
P1/P2/P3exp-3				
Distal segment to terminal spine	1 : 1.2/1 : 1.5/1 : 2.3	1 : 1.3/1 : 1.6/1 : 2.3	1 : 1.1/1 : 1.6/1 : 2.1	1 : 1.2/1 : 1.6/1 : 2.1
Terminal spine to distal outer spine	2.2 : 1/2.6 : 1/3.2 : 1	1.3 : 1/3 : 1/3.9	2.2 : 1/2.7 : 1/3.2 : 1	2.1 : 1/2.3 : 1/3.4 : 1
P4exp				
Terminal spine to distal segment	1.8 : 1	1.5 : 1	2.1 : 1	2 : 1

PR, prosome; UR, urosome; CR, caudal rami; SUS, second urosomal somite.

Table 2. A comparison of morphological characteristics of *Farranula dahlae* n. sp. and *F. gibbula* in published literature.

Character/ type form (F/M)	*F. dahlae*		*F. gibbula*				
	Present study (West Pacific)	Previous literature Dahl (1912) (Indian Ocean)	Present study (East China Sea)	Chen et al. (1974)	Zheng et al. (1982)	Tanaka (1957)	Giesbrecht (1893)
Mean body length (μm)	1,022	1,025	925	885	925	925	925
CR to SUS length ratio	1 : 1.6	1 : 1.6	1 : 2.3	1 : 2.2	1 : 2.3	1 : 2.3	1 : 2.2.

CR, caudal rami; SUS, second urosomal somite.

somite in *F. dahlae*, but to 63% in *F. gibbula*; and in the male, 8) the length ratio of the narrow posterior part of the second urosomal somite to the remainder of the somite is larger (3.1 : 1), compared to that of *F. gibbula* (2.5 : 1). In addition, inner distal seta of the second endopodal segment of maxilliped of *F. dahlae* male has a terminal process, which is absent in *F. gibbula*.

In this study, we discovered that the entire surface of the caudal rami of females of both species are ornamented with small denticles and the distal margin has a unique shape: the distal margin of the caudal rami of *F. dahlae* has somewhat strong triangular protrusions, while that of *F. gibbula* is gently angled with small serrations.

The similar morphologies of the second urosomal somite of *Farranula* females have frequently led to mistakes in identification, as in *F. dahlae* and *F. gibbula*: the dorso-anterior margins of *F. concinna*, *F. gracilis*, and *F. longicaudis* are sub-rectangular; while those of *F. orbisa*, *F. curta*, and *F. carinata* are rounded. To overcome this identification confusion, Wi and Soh (2013b) compared the length and width proportions of body segments of seven species of *Farranula* (*F. gibbula*, *F. concinna*, *F. carinata*, *F. rostrata*, *F. gracilis*, and *F. longicaudis*), which showed the length ratios of the second urosomal somite to the caudal ramus are largest for *F. rostrata* (5.3 : 1) and smallest for *F. longicaudis* (1.4 : 1). In particular, the projection on the second prosomal somite and the relatively long caudal rami of *F. longicaudis* female are similar to *F. gibbula*. However, the second urosomal somite of *F. longicaudis* without a ventral hump and dorsal protrusions differed from that of *F. gibbula*. Subsequently, morphological comparison between *F. orbisa*, *F. carinata*, *F. curta*, and *F. rostrata* performed by Wi and Soh (2013a) revealed the length to width ratio of caudal rami of four species differed (see Table 2). Additionally, *F. longicaudis* described by Giesbrecht (1893) and *F. gracilis* females described by Dahl (1912) also showed different length to width ratio of caudal rami (6.6 : 1 and 4 : 1). These results showed that data on the relative length to second uorosmal somite, the proportions of the caudal setae, and the surface ornamentation of caudal rami are necessary for accurate identification of *Farranula*.

In order to test for geographical variation, females of *F. dahlae* from Chuuk Island (West Central Pacific) and the large form of *F. gibbula* described by Dahl (1912) were compared with females of *F. gibbula* (Giesbrecht, 1891) from the North West Pacific and *F. gibbula* described by Giesbrecht (1893 [“1892”]), with respect to the body length and the length ratio of the caudal ramus to the second urosomal somite (Table 2). The records of *F. gibbula* showed very similar size range, which, while clearly different from *F. dahlae*, indicated little variation of *F. gibbula* among different regions.

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