

The First Records of Two Neustonic Calanoid Copepods, *Pontella securifer* and *P. sinica* (Calanoida, Pontellidae) in the South Sea, Korea

Hyeon Gyeong Jeong¹, Hae-Lip Suh¹, Yang Ho Yoon², Im Ho Choi³, and Ho Young Soh^{2*}

¹Department of Oceanography, Chonnam National University, Gwangju 500-757, Korea

²Division of Marine Technology, Chonnam National University, Yeosu 550-749, Korea

³South Sea Fisheries Research Institute, NFRDI, Yeosu 556-823, Korea

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Abstract – The neustonic calanoid copepods *Pontella securifer* Brady, 1883 and *P. sinica* Chen and Zhang, 1965 are first recorded in Korea. These species occur in high temperatures over 23 °C and in a range of salinity from 26.6 to 31.2 psu. We provide full descriptions of the two species and discuss their zoogeography.

Key words – taxonomy, neustonic copepods, Pontellidae, *Pontella*, zoogeography

1. Introduction

As the genus *Pontella* Dana, 1849 presently comprising 47 species, mostly occurs in the surface waters (0-30 cm layer) from the tropical to the warm temperate regions of the world oceans (Mulyadi 2002, 2003; Razoul *et al.*, 2008), it has been studied as a possible indicator of hydrographical features (Sherman 1963, 1964; Matsuo and Marumo 1982). In Korean waters hitherto, four species of *Pontella* have been reported by Kim (1985): *P. spinicauda* Mori, 1937, *P. chierchiae* Giesbrecht, 1889, *P. fera* Dana, 1849 and *P. latifurca* Chen and Zhang, 1965.

During a survey on the neustonic zooplankton community of the Korean waters, two *Pontella* species, *P. securifer* Brady, 1883 and *P. sinica* Chen and Zhang, 1965 are newly recognized and confirmed as new records in the region. This study aims to re-describe both species based on the samples from Korea and to discuss their zoogeographies for the first time in the region.

2. Materials and Methods

Neustonic zooplanktons were collected monthly in surface layers less than 30 cm in the South Sea of Korea from April, 2002 to March, 2003 using the David/Hempel neuston net (Hydro-Bios co. model 300; mesh size 0.3 mm) towed for 10 minutes at a speed of 2.5 knots (Fig. 1). The samples were immediately preserved in 5% neutralized formalin/seawater after capture. The genus *Pontella* species were sorted out from zooplankton samples. Specimens

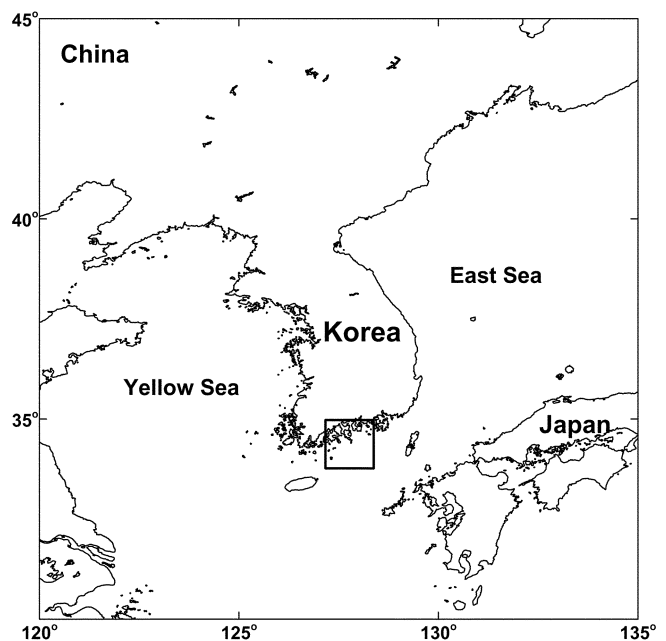


Fig. 1. Sampling areas in the South Sea of Korea.

*Corresponding author. E-mail: hysoh@chonnam.ac.kr

were dissected and mounted in CMC-10, and illustrated with an optical microscope (Nikon 80i) equipped with a drawing tube. The morphological terminology follows Huys and Boxshall (1991).

3. Description

Pontella securifer Brady, 1883
(Figs. 2-6)

Pontella securifer Brady, 1883, p. 96, pl. 45, figs. 1-9; Giesbrecht, 1892, p. 461, pl. 24, figs. 9, 37, 41, 43, pl. 40, figs. 6, 14, 21, 32, 34; Scott A., 1909, p. 160; Sewell, 1932, p. 384; Farran, 1936, p. 117; Wilson, 1950, p. 297, pl. 17, figs. 207-214, pl. 28, figs. 421-425; Tanaka, 1964, p. 259, fig. 234, a-f; Knudsen and Wolff, 1965, p. 186; Chen and Zhang, 1965, p. 102, pl. 44, figs. 1-9; Silas and Pillai, 1973, p. 822, figs. 21, 22; Zheng *et al.*, 1982, p. 75, pl. 44-1, figs. a-g, pl. 44-2, figs. h-o; Bradford-Grieve, 1999, p.200, fig. 148

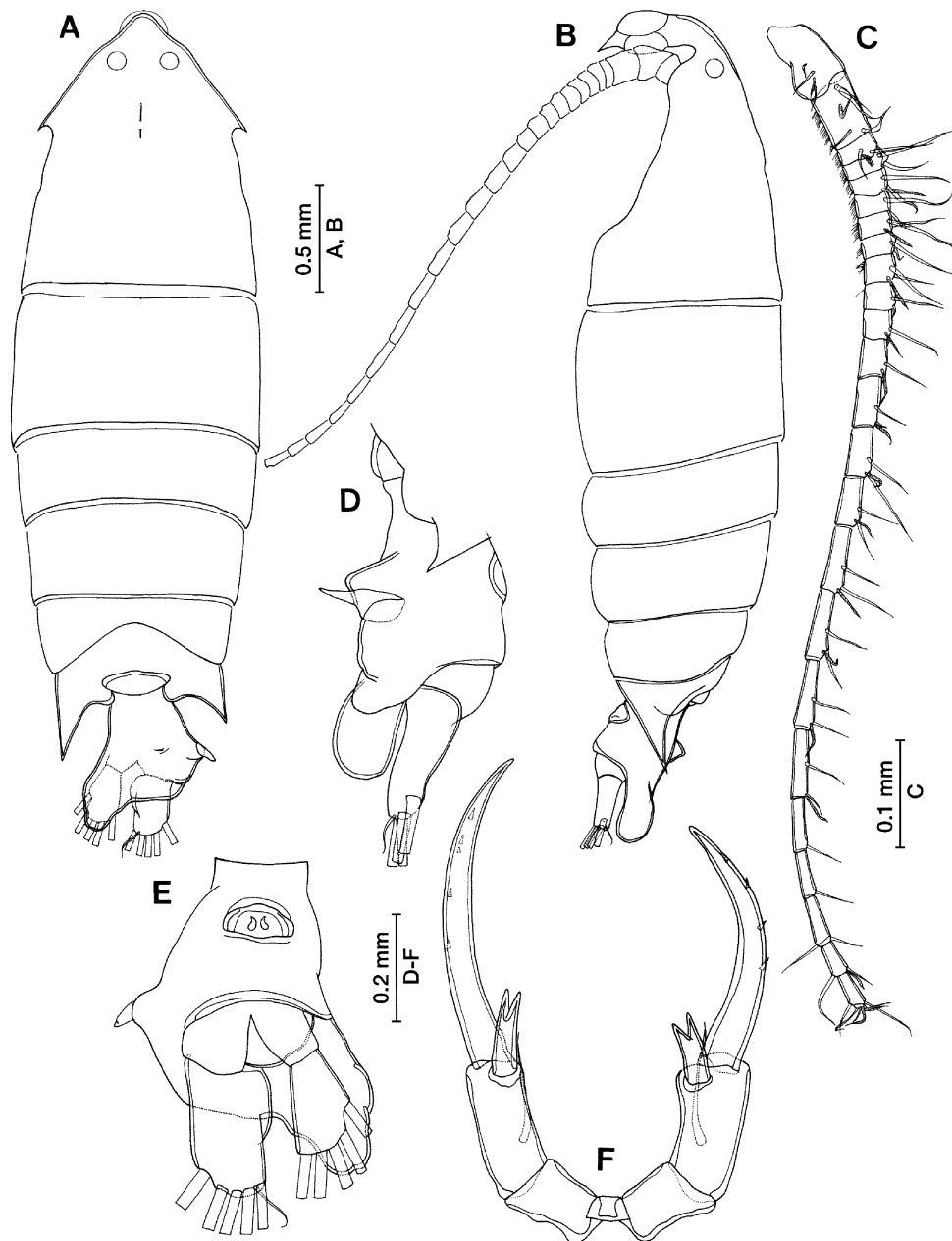


Fig. 2. *Pontella securifer* Type I, female. A. Habitus, dorsal view; B. Habitus, left lateral view; C. Antennule; D. Urosome, right lateral view; E. Urosome, ventral view; F. Fifth legs.

Pontellina (Ivellina) securifer Claus, 1893, p. 274, pl. 5, fig. 6 (cited by Silas and Pillai, 1973)

Pontella spinipes (M) Wolfenden, 1905, p. 1020

Pontella meadi (M) Chiba, 1956, p. 52 (cited by Razoul *et al.*, 2008)

Material examined

3 ♀♀ (Type I), 2 ♀♀ (Type II) and 2 ♂♂, 26 September 2002.

Type I female (Figs. 2-4)

Body length 3.73-4.07 mm (n=3). Prosome robust with lateral hooks: cephalosome and first pedigerous somite completely separated; fourth and fifth pedigerous somites fully divided; posterior corners of prosome sharply pointed, left longer than right and inner margin swelling. Cephalosome with obtusely triangular (Fig. 2A): rostrum bifurcated, thickened basally with lenses well developed (Fig. 2B). Urosome 2-segmented: genital compound somite bearing 1 sharp spine on right mediolaterally, asymmetrical and much larger than anal somite; left posterolateral process spreads over left caudal ramus; caudal rami asymmetrical, right ramus wider and longer than left one (Figs. 2D, 2E).

Antennule (Fig. 2C) symmetrical with 25-segmented: posterior margin of second to ninth segments fringed with fine hairs; ancestral segments II to IV and XXVII to XXVIII completely fused. Fusion pattern and setal formula as follows: I-3+ae (aesthetasc), II-IV-4+ae, V-2+ae, VI-2, VII-2+ae, VIII-2, IX-2+ae, X-2, XI-2+ae, XII-2, XIII-2+ae, XIV-2+ae, XV-2+ae, XVI-2+ae, XVII-2+ae, XVIII-2+ae, XIX-2+ae, XX-2+ae, XXI-2+ae, XXII-1, XXIII-1, XXIX-1+1, XXV-1+1+ae, XXVI-1+1, XXVII-XXVIII-4+ae.

Antenna (Fig. 3A) biramous, endopod larger than exopod: coxa with plumose seta; basis bearing 2 distal setae; endopod 2-segmented, first endopodal segment with 2 setae distally, second endopodal segment with 9 and 7 setae on proximal and distal lobes, respectively and row of posterior spinules on distal lobe; exopod 6-segmented with setal formula 1, 4, 2, 1, 1, 3.

Mandible with large coxal gnathobase and biramous palp: gnathobase (Fig. 3B) bearing 7 teeth along its distomedial margin and dorsal seta; patch of dagger-like spinules at base of third to seventh teeth; basis of mandibular palp (Fig. 3C) elongated with 4 setae; endopod 2-segmented, setal formula 4, 8; exopod 5-segmented, setal

formula 1, 1, 1, 1, 2.

Maxillule (Fig. 3D): praecoxal endite bearing 16 stout setae, minute spinules and fine hairs near base of stout seta; coxal endite with 3 setae and epipodite bearing 9 setae; basal exite with single seta and first basal endite with 4 setae; second basal endite to second endopodal segments fused bearing 8 setae; distal endopodal segment with 5 apical setae; exopod 1-segmented with 11 setae distally.

Maxilla (Fig. 3E) uniramous: praecoxa with 2 endites, proximal bearing 5 setae, distal 3 setae; coxa with 2 endites, each with 3 setae; basis with 3 setae; endopod 4-segmented, setal formula 1, 2, 2, 2.

Maxilliped (Fig. 3F) uniramous: praecoxa and coxa completely fused, setal formula 0, 2, 3, 3; basis fringed with row of small teeth and small setula subdistally and 2 plumose setae distally; endopod 6-segmented, first and second endopodal segments partly fused, setal formula 2, 2, 1, 1, 1, 4.

Swimming legs 1 to 4 biramous and coxa bearing inner seta: leg 1 (Fig. 4A) bearing inner seta on basis, both 3-segmented rami and terminal endopodal segment ending in long and apical process; legs 2 to 4 (Figs. 4B-D) with 2-segmented endopod and 3-segmented exopod; leg 4 (Fig. 4D) having minute denticular process at base of plumose seta on basis and first exopodal segment bearing hirsute medially. Seta and spine formula as follows (spines, Roman numerals; setae, Arabic numerals):

	Coxa	Basis	Exopodal segment	Endopodal segment
Leg 1	0-1	0-1	I-1; I-1; II,I,4	0-1; 0-2; 1,2,3
Leg 2	0-1	0-0	I-1; I-1; III,I,5	0-3; 2,2,4
Leg 3	0-1	0-0	I-1; I-1; III,I,5	0-3; 2,2,4
Leg 4	0-1	1-0	I-1; I-1; III,I,5	0-3; 2,2,3

Fifth leg (Fig. 2F) biramous and asymmetrical: intercoxal sclerite and coxa divided; left leg longer than right; exopod claw-like with 4 small outer spines; endopod bifid at tip.

Type II female (Fig. 5)

Body length 3.61-3.67 mm (n=2). Rostral lens less developed than Type I (Fig. 5B). Genital compound somite with left posterolateral process extending half left caudal ramus and 1 blunt process in medial right side (Fig. 5A). Fifth leg slightly asymmetrical, left leg longer than right (Fig. 5F). Other morphological characteristics on body shape and appendages similar to type I female.

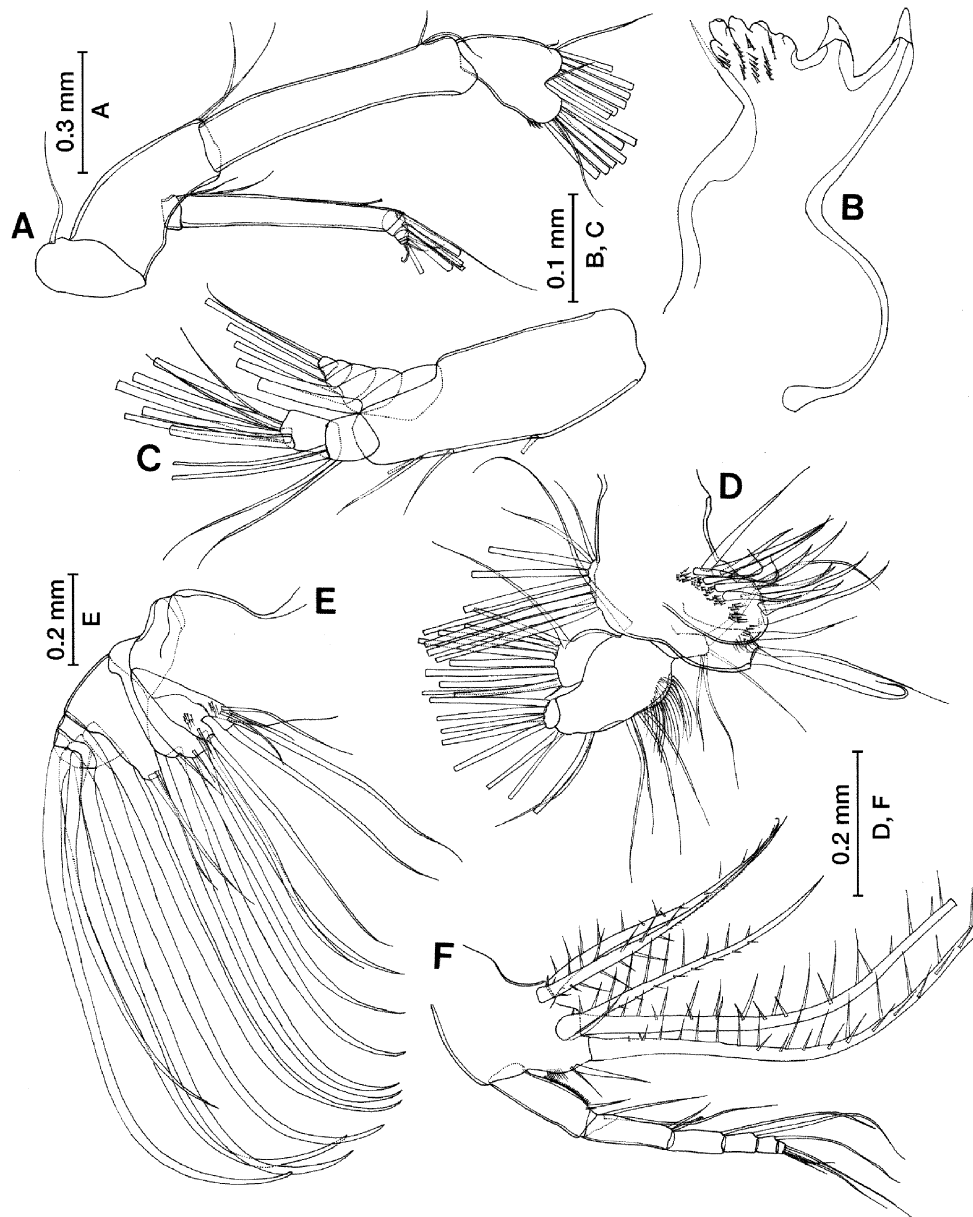


Fig. 3. *Pontella securifer* Type I, female. A. Antenna; B. Mandibular gnathobasic cutting edge; C. Mandibular palp; D. Maxillule; E. Maxilla; F. Maxilliped.

Male (Fig. 6)

Body length 3.2-3.51 mm (n=2). Prosome robust (Fig. 6A): posterior corners of prosome slightly symmetrical, with acute triangular process. Rostrum anterior and posterior sides with 2 well-developed lenses (Fig. 6B). Urosome 5-segmented: genital segment swelling on the left side; caudal rami elongate and symmetrical.

Antennule (Fig. 6C) geniculate on right side only, left one resembling that of female, indistinctly 14-segmented. Fusion pattern and setal formula as follows: I-3+ae, II-IV-4+ae, V-

VI-4+ae, VII-IX-6+2ae, X-XI-4+2ae, XII-XIV-6+2ae, XV-XVI-4+2ae, XVII-2+ae, XVIII-2+ae, XIX-1+p (process)+ae, XX-1+p+ae, XXI-XXIII-2+3p+ae, XXIV-XXVI-6+ae, XXVII-XXVIII-4+ae. Segment XIX with 1 large toothed plate having triangular denticles; fused segments XXI to XXIII with 1 falcate spur distally and 2 toothed plates medially which proximal plate with protruded and coarsely toothed and distal one with lamelliform teeth.

Fifth leg (Fig. 6D) uniramous, asymmetrical and bearing single plumose seta on basis: right first exopodal segment

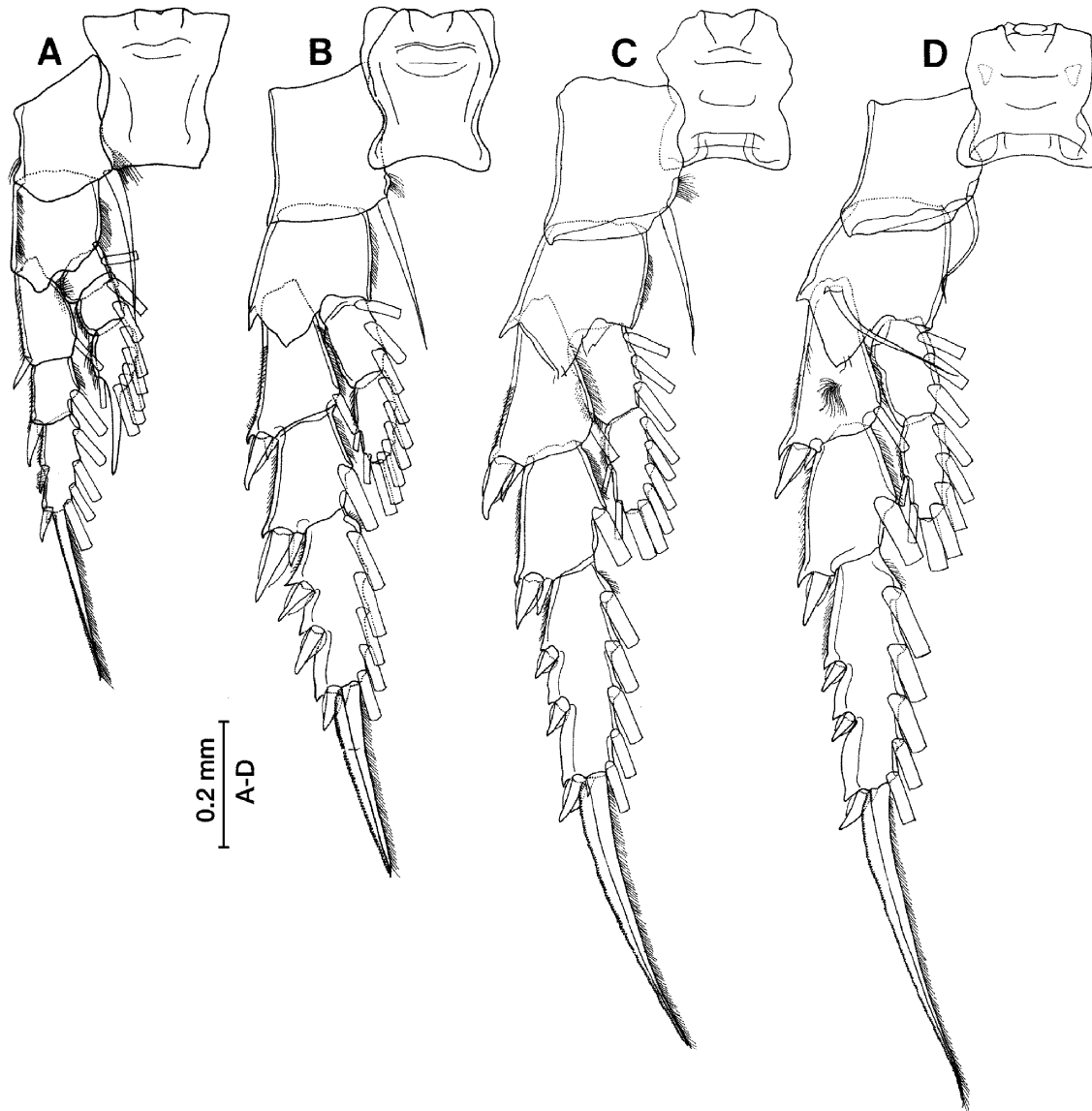


Fig. 4. *Pontella securifer* Type I, female. A. Left leg 1; B. Left leg 2; C. Left leg 3; D. Left leg 4.

with short spine proximally, 1 curved thumb-like process, 1 conical process with transversely acute spine and 1 papilla-shaped process more distally; second exopodal segment with 4 spines along inner surface and anterior swelling; left first exopodal segment with 1 outer process at distal end and 1 medial seta; second exopodal segment bulb-shaped with 2 spines and hirsute medially; apex with 2 spines which one having membrane around the edge, and 1 short process.

Remarks

In the female of *Pontella securifer* originally described from Mid-Pacific Ocean some meaningful morphological

variations were found in the genital compound somite (Brady 1883; Wilson 1950; Chen and Zhang 1965). However, Wilson (1950) suggested that *P. securifer* is a single species because the male has no inclination toward variation. Zheng *et al.* (1982) divided females from the East China Sea into two types by characteristic features in their habitus, genital compound somite and fifth leg: type I 1) having almost symmetrical corners of last pedigerous somite, 2) genital compound somite with an acute process on right mediolaterally and large rounded process on left posterodistally, and 3) asymmetrical fifth leg; type II 1) bearing asymmetrical corners of last pedigerous somite, 2)

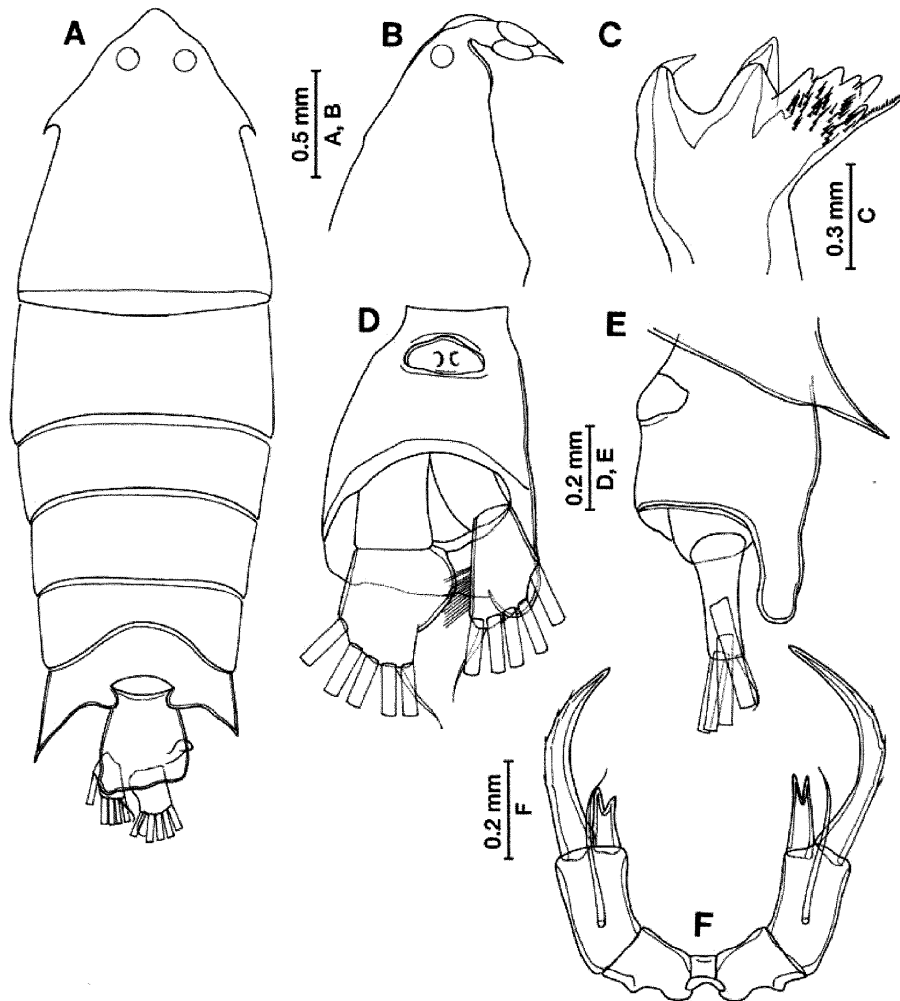


Fig. 5. *Pontella securifer* Type II, female. A. Habitus, dorsal view; B. Head, right lateral view; C. Mandibular gnathobasic cutting edge; D. Urosome, ventral view; E. Urosome, left lateral view; F. Fifth legs.

genital compound somite with small process on right mediolaterally and left posterodistally, respectively, and 3) almost symmetrical fifth leg. Females occurring in the South Sea of Korea generally also have two types as in Zheng *et al.* (1982). However, there is a little difference between Korean and Chinese individuals: last pedigerous somite of type I from Korean waters is asymmetrical while that of Chinese waters almost symmetrical; fifth leg of type II from Korean waters is asymmetrical while that of Chinese waters almost symmetrical. Although these differences might be in a species level, we retain two types as in Zheng *et al.*'s suggestion (1982), in that male of only single type is found. However, it is necessary to reexamine by such methods as molecular analysis to verify its taxonomic position in addition to morphological differences. Meanwhile, type I is identical with illustrations of *P. securifer* provided

by Tanaka (1964) and Brady (1883) and type II is similar to figures of Giesbrecht (1892).

Since *Pontella securifer* has been recorded in warm surface waters from the Atlantic, Pacific and Indian Oceans between 35°N and 50°S (Fig. 8), it has been known as an euneustonic species (Sherman 1963; Matsuo and Marumo 1982). On the other hand, in Korean waters, *P. securifer* is a very rare species since its highest abundance is low: less than 50 indiv.100 m⁻³, even in the optimal temperature of above 23 °C for its occurrence (Fig. 9). It was absent during low temperature periods.

Pontella sinica Chen and Zhang, 1965`
(Fig. 7)

Pontella sinica Chen and Zhang, 1965, p. 104, pl. 45,

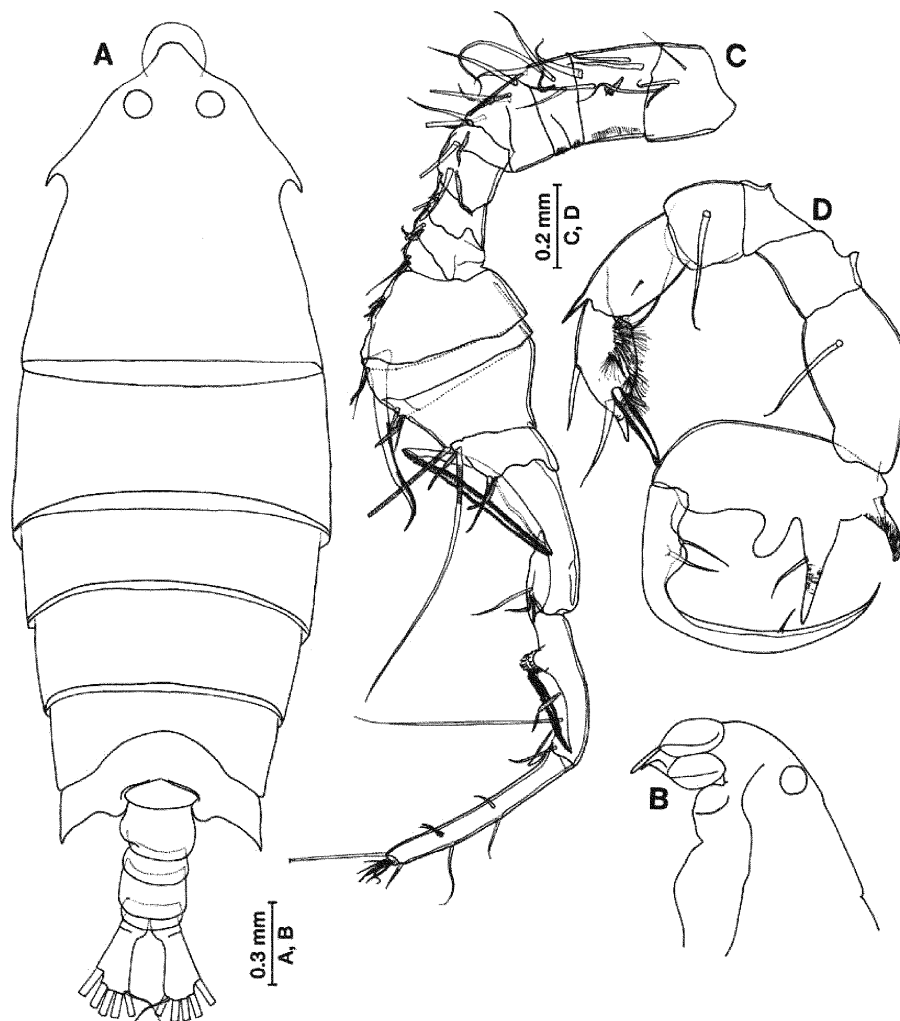


Fig. 6. *Pontella securifer*, male. A. Habitus, dorsal view; B. Head, left lateral view; C. Right antennule; D. Fifth legs.

figs. 8-11; Zheng *et al.*, 1982, p. 84, pl. 48, figs. a-j

Pontella princeps Sewell, 1932, p. 382, fig. 127, a-d;
Mulyadi, 2000, p. 191, fig. 12

Pontella sewelli Heinrich, 1987, p. 932, figs. 1, 2

Material examined

1 ♂, 26 September 2002.

Male

Body length 4.99 mm (n=1). Prosome robust with prominent lateral hooks (Fig. 7A): posterior corners of prosome sharply pointed. Dorsal eye lenses more conspicuous and rostral lens well-developed (Fig. 7B). Urosome 5-segmented: genital segment slightly asymmetrical with lobe on left medially; caudal rami symmetrical.

Right antennule (Fig. 7C) geniculate, indistinctly 15-segmented. Fusion pattern and setal formula as follows: I-3+ae, II-IV-4+ae, V-2+ae, VI-2+ae, VII-IX-6+2ae, X-XI-4+2ae, XII-XIV-6+3ae, XV-XVI-4+2ae, XVII-2+p+ae, XVIII-2+ae, XIX-1+p+ae, XX-1+2p+ae, XXI-XXIII-2+3p+ae, XXIV-XXVI-6+ae, XXVII-XXVIII-4+ae. Segment XVI with elongated spine, segment XVII with triangular process, fused segments XIX and XX each with 1 large toothed plate, the latter with 1 bluntly rounded process, and fused segments XXI to XXIII with 2 smaller toothed plates, proximal plate coarse and denticulated, distal one with villiform, and with 1 falcate process distally.

Fifth leg (Fig. 7D) with 2 setae on each basis: right first exopodal segment with thumb-like process curved inwards, bluntly rounded process along inner margin and 1 seta at

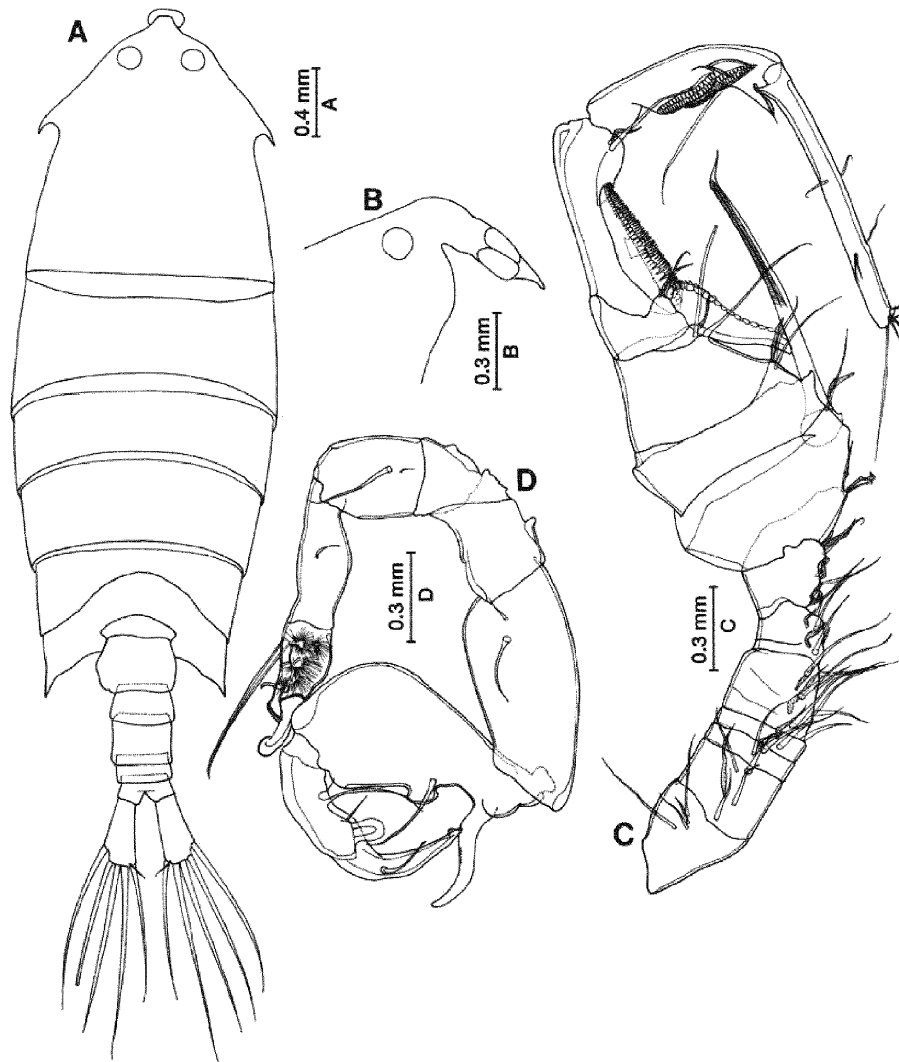


Fig. 7. *Pontella sinica*, male. A. Habitus, dorsal view; B. Head, right lateral view; C. Right antennule; D. Fifth legs.

base; second exopodal segment elongated with 4 setae and 1 plate-form process; first exopodal segment of left leg bearing 1 seta medially; second exopodal segment with 1 elongated spine, 1 seta and hirsute mediolaterally; apex bearing 2 spines longer spine with spatulate and crenulated margin, shorter one truncate distally and 1 spine at base.

Female not found in present study.

Remarks

In male *P. sinica* most resemble *P. princeps* Dana, 1849, but are distinguished by the morphology of the right fifth legs: in *P. sinica*, first exopodal segment ending in slender digitiform process curving inward and with 1 process along inner margin, whereas in *P. princeps* having stout and

straight thumb-like process and 2 processes; second exopodal segment in the former species long and narrow with a plate-form process in the middle, but in the latter short and wide without any process. Among the previous descriptions, the same characteristics are seen in figures of *P. princeps* described from Andaman Sea (Sewell 1932) and Java Sea (Mulyadi 2000) and *P. sewelli* from Indian Ocean (Heinrich 1987), indicating that these specimens are *P. sinica*.

Chen and Zhang (1965) originally described *Pontella sinica* based on 2 females off Zhejiang (30°30'N, 123°15'E) and subsequently recorded both sexes from Fujian neritic waters by Zheng *et al.* (1982). In the South Sea, Korea, it appears in the subsurface layer (10-30 cm) only during

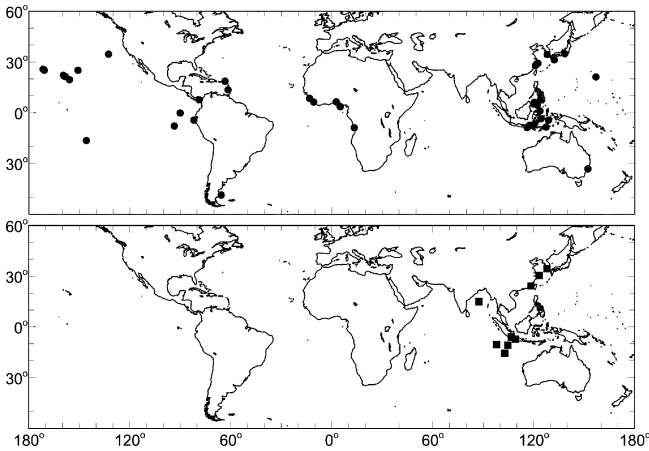


Fig. 8. Distribution of *Pontella securifer* (●) and *P. sinica* (■) based on previous records and on the present study. References are: Scott A. (1909), Wilson (1950), Tanaka (1964), Chen and Zhang (1965), Knudsen and Wolff (1965), Bradford-Grieve (1999) in *securifer*; Sewell (1932), Chen and Zhang (1965), Zheng *et al.* (1982), Heinrich (1987), Mulyadi (2000) in *sinica*.

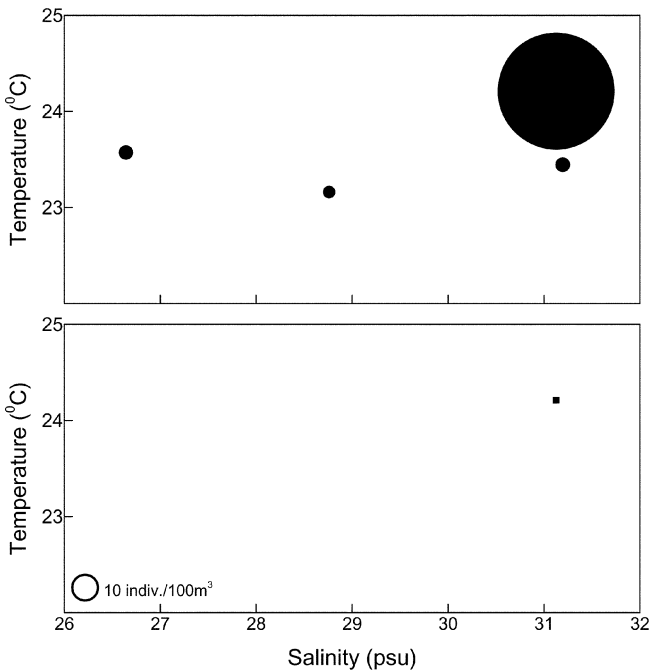


Fig. 9. Temperature-Salinity-Plankton diagram corresponding to *Pontella securifer* (●) and *P. sinica* (■).

September (24°C, 31 psu) (Figs. 8, 9).

Key to species of *Pontella* in Korean waters

- 1. Urosome 2 to 3 segmented.....2 (Female)
 Urosome 5-segmented.....7 (Male)
- 2. Posterior corners of prosome bifurcated.....*P. chierchiaie*

- Posterior corners of prosome with acute lobes.....3
- 3. Urosome 3-segmented.....4
 Urosome 2-segmented.....5
- 4. Genital double somite with processes on each side
 *P. spinicauda*
 Genital double somite with large process on right side
 *P. sinica*
- 5. Caudal rami almost symmetrical.....*P. fera*
 Caudal rami distinctly asymmetrical.....6
- 6. Genital compound somite without any process
 *P. latifurca*
 Genital compound somite with process.....*P. securifer*
- 7. Posterior corners of prosome rounded.....8
 Posterior corners of prosome with acute lobes.....9
- 8. Distal segment of right fifth leg bifurcated at apex
 *P. fera*
 Distal segment of right fifth leg elongated, dilated distally
 *P. chierchiaie*
- 9. Distal segment of right fifth leg with process
 *P. sinica*
 Distal segment of right fifth leg without process.....10
- 10. Distal segment of right fifth leg with anterior swelling
 *P. securifer*
 Distal segment of right fifth leg without swelling.....11
- 11. First segment of right fifth leg with three processes
 *P. latifurca*
 First segment of right fifth leg with two processes
 *P. spinicauda*

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