

First Record of Three *Centropages* Species (Copepoda: Calanoida: Centropagidae) in Korean Waters

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ABSTRACT

Three species of the genus *Centropages* (*C. calaninus*, *C. orsinii*, and *C. sinensis*) were newly collected from Korean waters. The Korean specimens were consistent with previous descriptions, but differ in the following characteristics: in *C. orsinii* male right antennule with spine on dorsoposterior surface of each segment XIII and XIV; distal end of segment XIX with humplike process on dorsal surface; in *C. calaninus* female long spinelike process on second exopodal segment of leg 5 of reaching 1/2 length of terminal spine on third exopodal segment; in male, first endopodal segment of leg 5 without inner seta; left second exopodal segment serrated on distal margin; and in *C. sinensis* male distal spine of left second exopodal segment of leg 5 not fused with segment. In this study, key characters for species identification also were provided.

Keywords: *Centropages*, Centropagidae, Copepoda, taxonomy, Korean fauna

INTRODUCTION

The calanoid copepod family Centropagidae consists of 15 genera (Walter and Boxshall, 2022), *Boeckella* Guerne and Richard, 1889; *Calamoecia* Brady, 1906; *Centropages* Krøyer, 1849; *Dussartopages* Huys, 2009; *Gippislandia* Bayly and Arnott, 1969; *Gladioferens* Henry, 1919; *Guernella* Giesbrecht in Giesbrecht and Schmeil, 1898; *Hemiboeckella* Sars G.O., 1912; *Isias* Boeck, 1865; *Karukinka* Menu-Marque, 2003; *Limnocalanus* Sars G.O., 1863; *Neoboeckella* Bayly, 1992; *Osphranticum* Forbes, 1882; *Parabroteas* Mrázek, 1901; and *Sinocalanus* Burckhardt, 1913. This family has morphological features of geniculate male right antennule and an asymmetric fifth leg. The family was widely distributed in freshwater, brackish water and ocean, and most of these genera inhabit freshwater environments (Boxshall and Halsey, 2004). Of these genera the genus *Centropages* is distributed in a wide range of marine environments from low to high latitudes. In particular, this genus is abundant in epipelagic plankton communities such as coastal waters (Vervoort, 1964; Bradford-Grieve, 1999; Bradford-Grieve et al., 1999; Boxshall and Halsey, 2004). Currently, 36 species of this genus

have been recorded worldwide (Razouls et al., 2005–2022). In Korean waters, the following six species of *Centropages* have hitherto been recorded: *C. abdominalis* Sato, 1913; *C. bradyi* Wheeler, 1900; *C. dorsispinatus* Thompson, 1903; *C. furcatus* (Dana, 1849); *C. gracilis* (Dana, 1849); and *C. tenuiremis* Thompson, 1903.

In this study, three species are newly described from the South Sea and estuaries of Korea in addition to key characters for species identification of genus *Centropages* from Korean waters.

MATERIALS AND METHODS

Zooplankton samples were collected from Korean waters (Fig. 1), using conical nets with mouth diameter 60 cm and 30 cm, respectively (mesh size 200 µm). Samples were preserved with 5% neutralized formaldehyde for morphological description. *Centropages calaninus*, *C. orsinii* and *C. sinensis* were sorted out and dissected under a dissecting microscope (SMZ745T; Nikon, Japan) in CMC-10 aqueous mounting medium (Masters, Wood Dale, IL, USA), mount-

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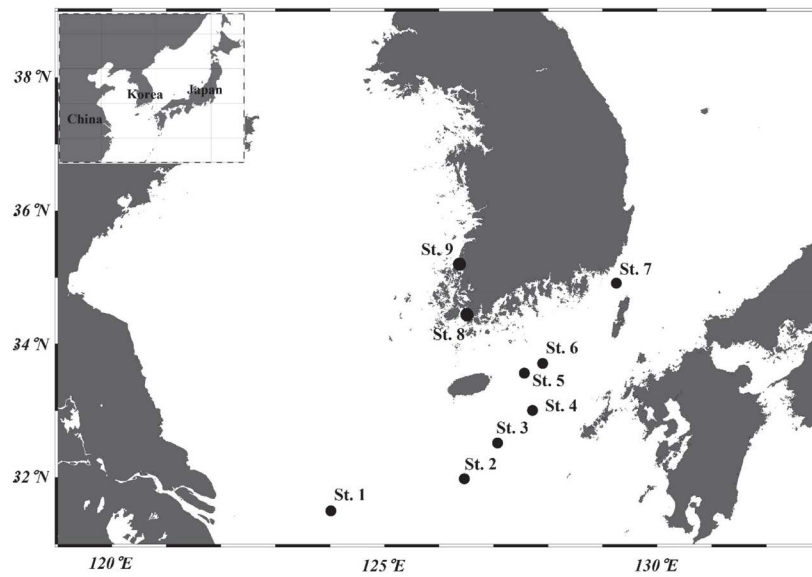


Fig. 1. Map of study area showing sampling location.

ed on slides, and then sealed with high-quality nail varnish. Drawings were generated using a differential interference contrast microscope (ECLIPSE 80i; Nikon) equipped with a drawing tube and digital pen display (Cintiq 22HD; Wacom, Kazo, Japan). Morphological terminology follows Huys and Boxshall (1991). Voucher specimens were deposited in the National Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea.

SYSTEMATIC ACCOUNTS

Order Calanoida Sars G. O., 1903
 Family Centropagidae Giesbrecht, 1893
 Genus *Centropages* Krøyer, 1849

Centropages orsinii Giesbrecht, 1889 (Figs. 2–4)

Centropages orsinii Giesbrecht, 1889: 811; 1892: 305, Taf. 17, figs. 35, 36, 41, 42, Taf. 18, figs. 2, 14, 23, Taf. 38, figs. 12, 19; Mori, 1937 (1964): 60, Pl. 29, figs. 1–7; Chen and Zhang, 1965: 76, Pl. 27, figs. 7–13; Greenwood, 1977: 63, figs. 5c, d; Mulyadi, 2004: 131, fig. 75; Phukham, 2008: 153, fig. 27; Boxshall and Jaume, 2012: 377, figs. 1–5.

Material examined. Korea: 7♀♀, 8♂♂, South Sea (St. 2), 32°0'0"N, 126°28'59.9"E, Aug 2016; 1♀ (MABIK CR00252954) dissected in 12 slides glasses, 1♂ (MABIK CR00252955) dissected in 12 slides glasses, 2♀♀, 3♂♂, East China Sea (St. 1), 31°30'0"N, 124°0'0"E, Sep 2016; 2♀♀, 1♂, South Sea (St. 4), 33°0'0"N, 127°42'0"E, Aug 2017. 25 individuals were used for length measurement.

Description. Female: Body length 1.36–1.64 mm (n = 12). Body elongated; cephalosome clearly separated from first pedigerous somite; rostrum with 2 filaments directed posteroventrally; fourth and fifth pedigerous somites fully divided; posterolateral corners of fifth pedigerous somite pointed lobe and asymmetrical (Fig. 2A, B). Urosome 3-segmented: genital double somite slightly asymmetrical, with spiniform process ventrally; caudal rami and anal segment separated; caudal rami with 6 setae (Fig. 2A–D).

Antennule symmetrical, longer than body length. 24-segmented (Fig. 2E). Fusion pattern and setal formula as follows: I-2 + ae (aesthetasc), II-IV-2 + ae, V-2 + ae, VI-2 + ae, VII-2 + ae, VIII-2 + ae, IX-2 + ae, X-2 + ae, XI-2 + ae, XII-2 + ae, 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 + ae, XXIII-1, XXIV-1 + 1, XXV-1 + ae, XXVI-XXVIII-5 + ae.

Legs 1 to 4 biramous, with exopod 3-segmented: endopod 2-segmented in legs 1 to 3 and 3-segmented in leg 4; coxa with inner marginal seta; basis of leg 1 with inner marginal seta, reaching end of first endopodal segment; third exopodal segments of legs 2 and 3 with membrane on outer margin (Fig. 3). Setae and spine formula of legs 1 to 4 as follows (spines, Roman numerals; setae, Arabic numerals):

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

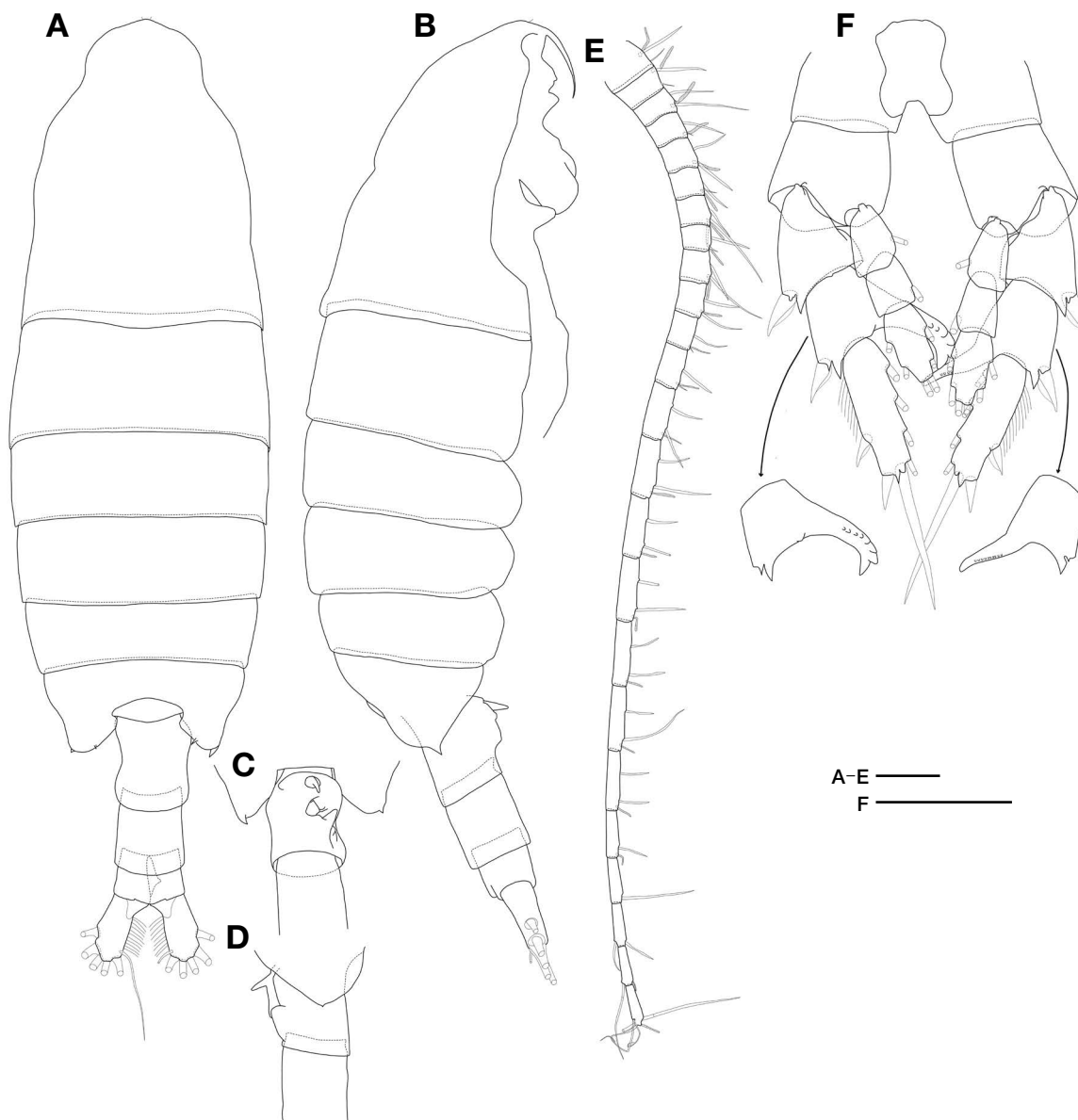


Fig. 2. *Centropages orsinii*, female: A, Habitus, dorsal; B, Habitus, right lateral; C, Genital double somite, ventral; D, Genital somite, lateral; E, Antennule; F, Leg 5. Scale bars: A-F=100 μ m.

Fifth leg slightly asymmetrical, with exopod 3-segmented (setal formula: I-0; I-0; II, I, 4) and endopod 3-segmented (setal formula: 0-1; 0-1; 2, 2, 2); inner spinelike process of second exopodal segment curved, distally bordered by small spinules, not reaching to distal end of third exopodal segment (Fig. 2F).

Male: Body length 1.28–1.44 mm (n = 13). Similar to habitus of female except urosome: posterolateral corners of fifth pedigerous somite slightly pointed and asymmetrical (Fig. 4A, B). Urosome 4-segmented, symmetrical: caudal rami and anal segment separated; caudal rami with 6 setae (Fig.

4A, B). Legs 1 to 3 same as in female.

Antennule geniculate on only right side, reaching end of caudal rami, 22-segmented (Fig. 4C). Fusion pattern and setal formula as follows: I-2 + ae, II-IV-2 + ae, V-2 + ae, VI-2 + ae, VII-2 + ae, VIII-2 + ae, IX-2 + ae, X-2 + ae, XI-2 + ae, XII-2 + ae, XIII-1 + ae, XIV-2 + ae, XV-2 + ae, XVI-2 + ae, XVII-2 + ae, XVIII-2 + ae, XIX-1 + ae, XX-1 + ae, XXI-XXIII-1 + 2ae, XXIV-1 + 1, XXV-1 + ae, XXVI-XXVIII-5 + ae. Tooth rows present on segments XIX, XX and compound segments XXI-XXIII; segment XIII and XIV with 1 spine on dorsoposterior surface; anterior margin of

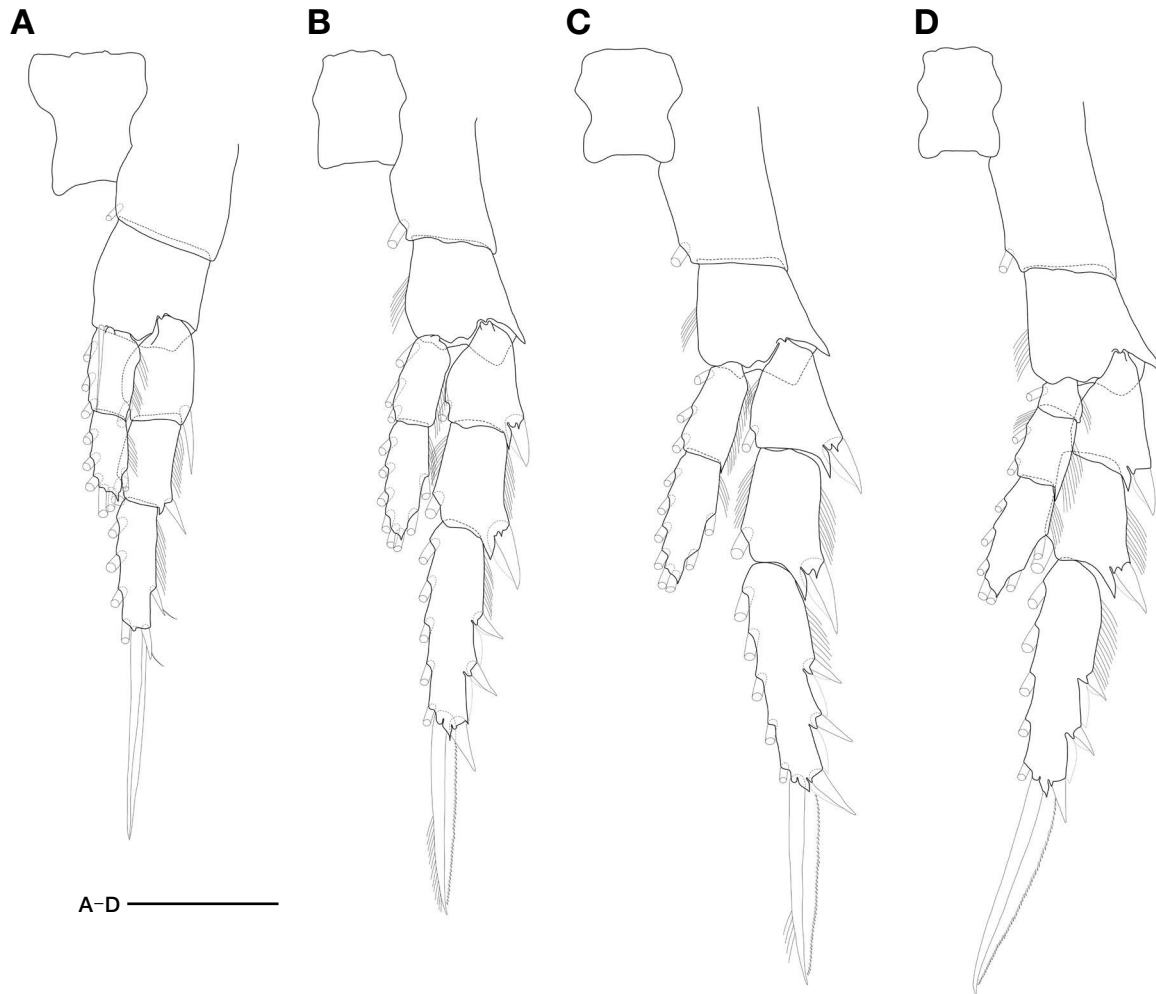


Fig. 3. *Centropages orsinii*, female: A, Leg 1; B, Leg 2; C, Leg 3; D, Leg 4. Scale bar: A-D=100 μ m.

segments XVII and XVIII with process; segment XXIII with process on distal end of anterior side; segment XIX with bumplike process on dorsoposterior surface (Fig. 4C).

Legs 1 to 3 as female, but leg 4 slightly asymmetrical: right basis of leg 4 with 2 processes on posterior surfaces (Fig. 4E).

Fifth leg asymmetrical. Left leg biramous, with endopod 3-segmented and exopod 2-segmented: first exopodal segment with outer marginal spine; second exopodal segment hirsute on anterior surface, with 2 outer marginal spines, inner pointed process and bilaterally serrated distal marginal spine fused to segment (Fig. 4D). Right leg biramous, with endopod and exopod 3-segmented: first exopodal segment with outer marginal spine; second exopodal segment with large curved process on proximally inner margin, spine on posterior surface of segment distal margin; third exopodal segment weakly-curved of distal end, with slender seta on proximally inner margin (Fig. 4D).

Distribution. *Centropages orsinii* was recorded in the Red Sea (Giesbrecht, 1892), Southwestern Pacific Ocean (Greenwood, 1977), Indonesia (Scott, 1909; Mulyadi, 2004), and China Sea (Mori, 1937; Chen and Zhang, 1965).

Remarks. The Korean specimen is consistent with previous descriptions (Giesbrecht, 1892; Mori, 1937; Chen and Zhang, 1965; Greenwood, 1977; Mulyadi, 2004), but differs in the following characteristics: (1) in female the Korean specimen with a ventral spine in genital double somite (Giesbrecht, 1892; Mulyadi, 2004), but in the description of Mori (1937) genital double somite with winglike process in periphery of gonopore; (2) in male right antennule of the Korean specimen with process on the dorsoposterior surfaces of segments XVII and XVIII and with distal end of segment XXIII (Giesbrecht, 1892), but segments XIII and XIV with each present spines on dorsoposterior surfaces; (3) distal end of segment XIX with present humplike process on dorsal surface; and (4) in

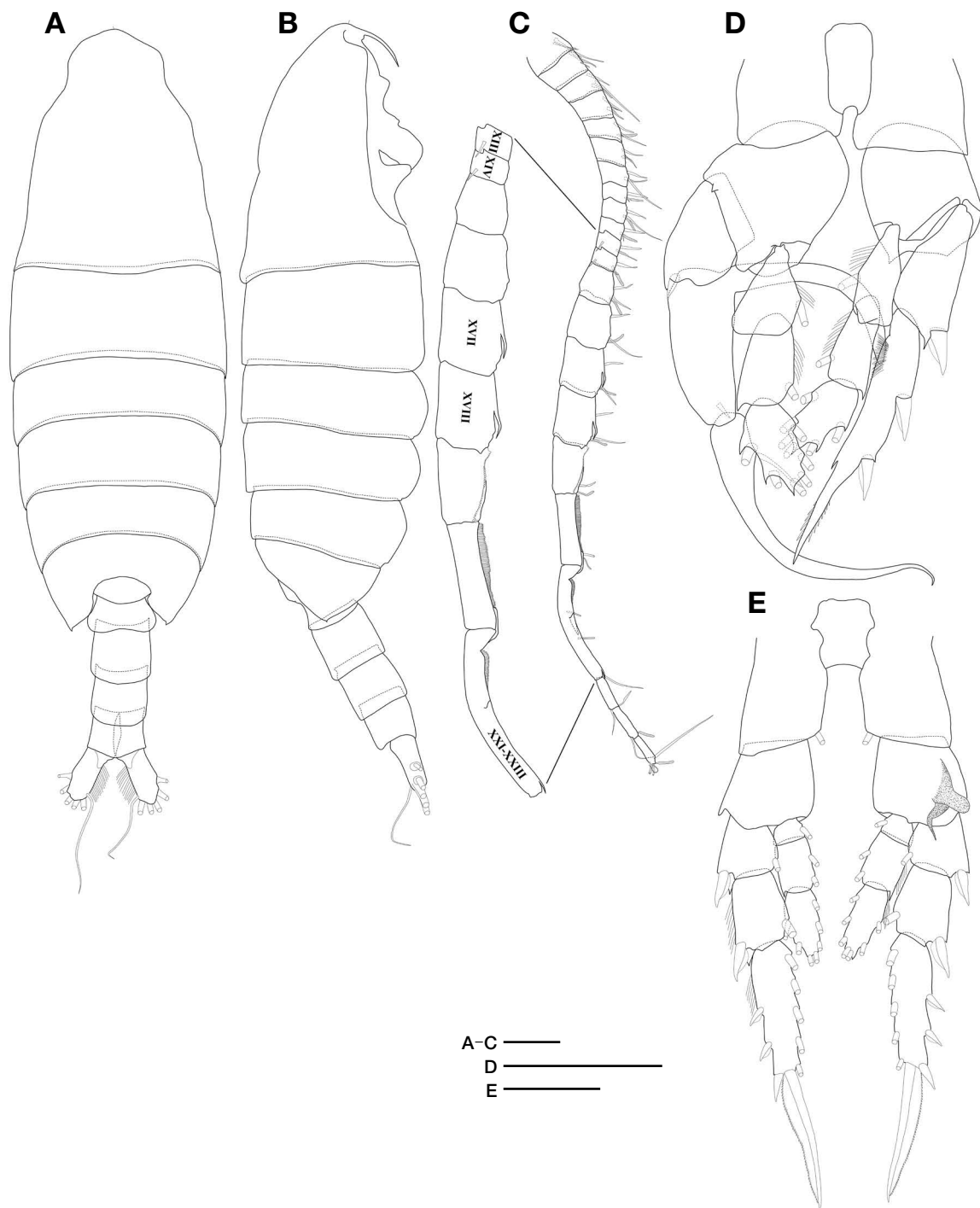


Fig. 4. *Centropages orsinii*, male: A, Habitus, dorsal; B, Habitus, right lateral; C, Right antennule; D, Leg 5; E, Leg 4. Scale bars: A-E=100 μm.

the Korean specimen leg 4 of the male with 2 processes on posterior of basis (Mulyadi, 2004), but in the description of Boxshall and Jaume (2012) with 3 processes on posterior of basis.

Centropages calaninus (Dana, 1849) (Figs. 5–7)
Cyclopsina calanina Dana, 1849: 25.
Hemicalanus calaninus Dana, 1852: 1105, Pl. 78.
Centropages calaninus Giesbrecht, 1892: 305, Taf. 17, figs.

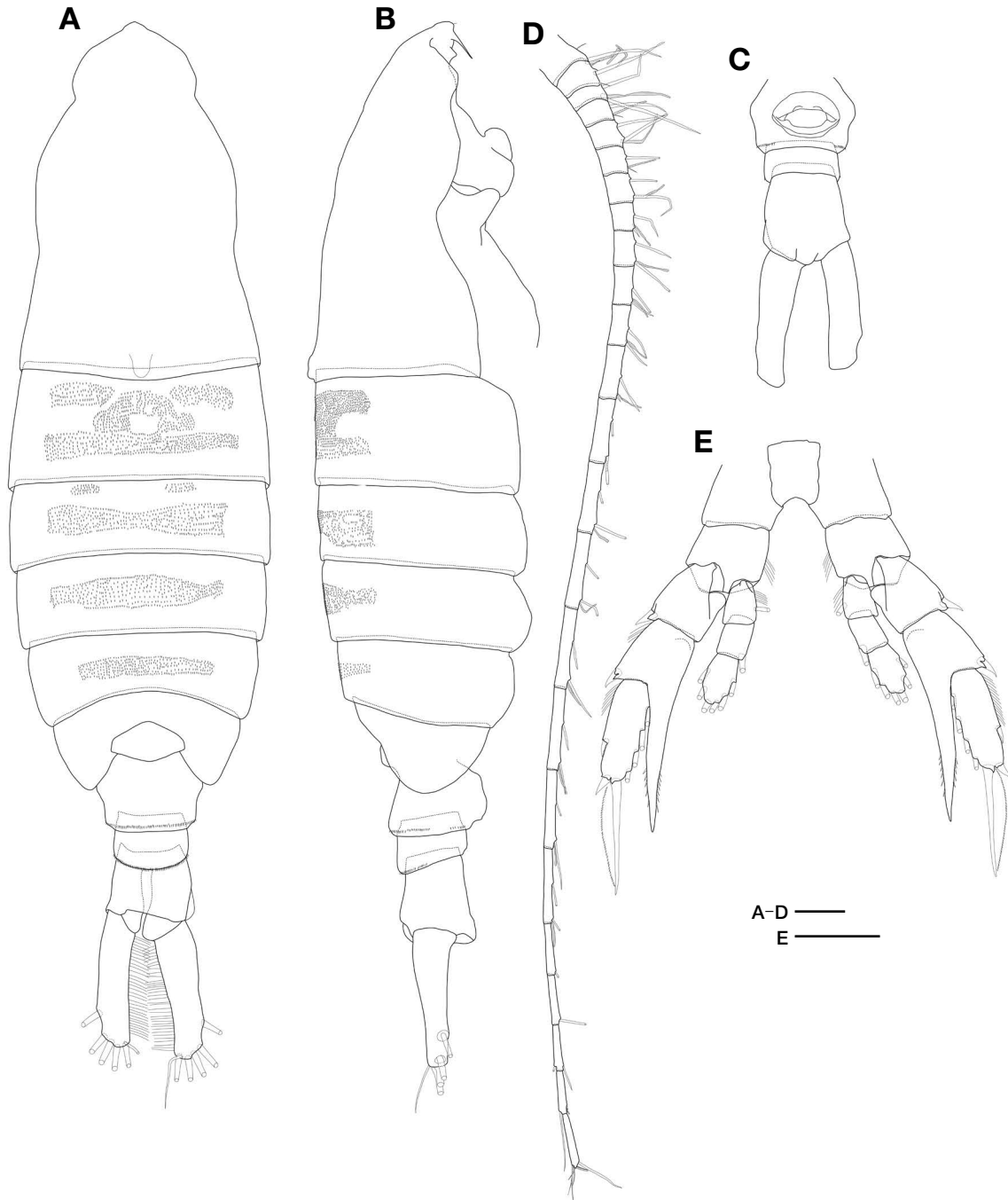


Fig. 5. *Centropages calaninus*, female: A, Habitus, dorsal; B, Habitus, right lateral; C, Urosome, ventral; D, Antennule; E, Leg 5. Scale bars: A-E=100 μ m.

27, 28, 43, Taf. 18, fig. 11, Taf. 38, fig. 1; Mori, 1937 (1964): 61, Pl. 30, fig. 4-7; Brodsky, 1962: 130, fig. 31; Grice, 1962: 220, Pl. 23, figs. 13-18; Chen and Zhang, 1965: 75, Pl. 27, figs. 1-6; Bradford-Grieve et al., 1999: 884, 951, fig. 7.339; Conway et al., 2003: 115; Mulyadi, 2004: 127, fig. 72.

Material examined. Korea: 1 ♀, South Sea (St. 7), 34° 53'53.9"N, 129°15'24.1"E, Oct 2016; 3 ♀♀, South Sea (St. 3), 32°30'0"N, 127°5'6"E, Feb 2021; 2 ♀♀, 2 ♂♂, South Sea (St. 6), 33°41'24"N, 127°53'24"E, Apr 2021; 1 ♀ (MABIK CR00252952) dissected in 12 slides glasses, 1 ♂ (MABIK CR00252953) dissected in 12 slides glasses, 1 ♀, South Sea

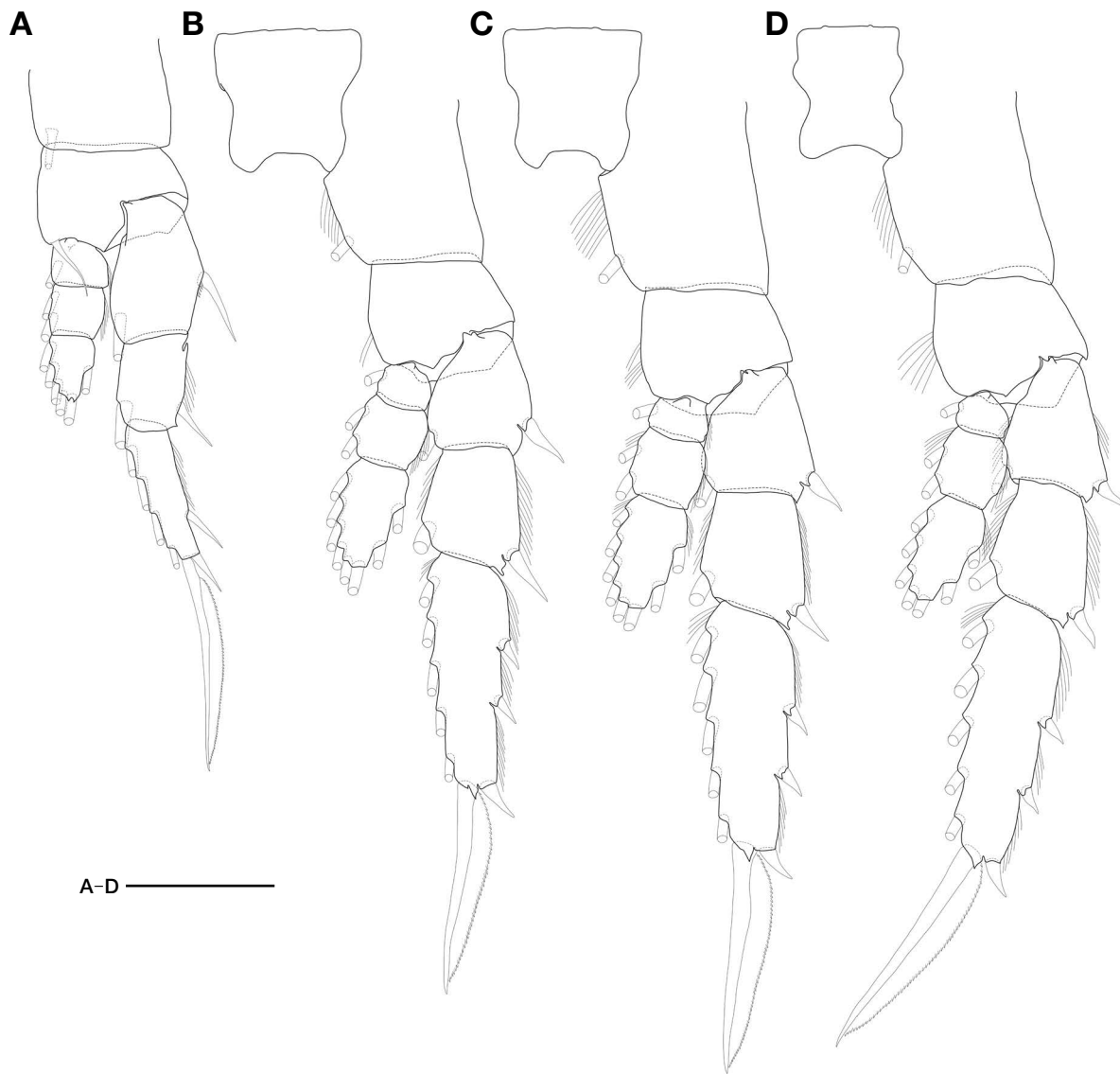


Fig. 6. *Centropages calaninus*, female: A, Leg 1; B, Leg 2; C, Leg 3; D, Leg 4. Scale bar: A-D=100 μ m.

(St. 5), 33°33'36"N, 127°34'0.12"E, Nov 2021. 11 individuals were used for length measurement.

Description. Female: Body length 1.87–2.08 mm (n = 8). Body elongated; cephalosome clearly separated from first pedigerous somite; rostrum with pair of frontal filaments; fourth and fifth pedigerous somites fully divided; posterolateral corners of fifth pedigerous somite rounded and symmetrical. Cephalosome and first to fourth pedigerous somites partially adorned with fine spines on dorsal surface (Fig. 5A, B). Urosome 3-segmented; genital double somite swollen at middle, small spinules row on posterior margin and extends to ventrolaterally; second urosomite, small spinules row on posterior margin; anal segment with small knob on ventral

surface near posterior margin; caudal rami asymmetrical, right ramus longer and thicker than left one; caudal rami with 6 setae (Fig. 5A–C).

Antennule symmetrical, longer than body length; 24-segmented (Fig. 5D). Fusion pattern and setal formula as follows: I-2 + ae, II-IV-3 + ae, V-2 + ae, VI-2 + ae, VII-2 + ae, VIII-2 + ae, IX-2 + ae, X-2 + ae, XI-2 + ae, XII-2 + ae, 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, XXIV-1 + 1, XXV-1 + 1 + ae, XXVI-XXVIII-6 + ae.

Legs 1 to 4 biramous, with exopod and endopod 3-segmented; coxa with 1 inner marginal seta; basis of leg 1 with

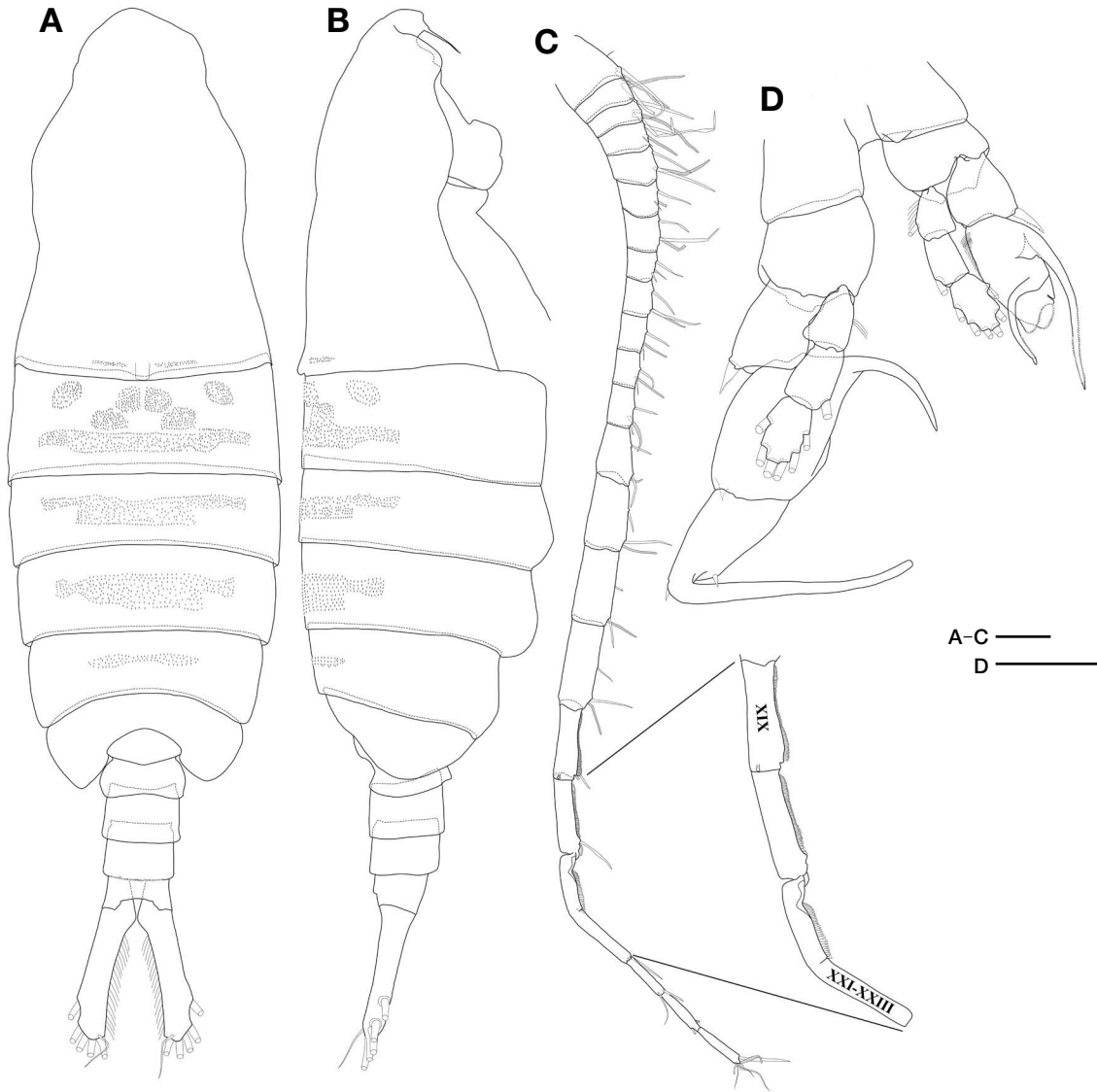


Fig. 7. *Centropages calaninus*, male: A, Habitus, dorsal; B, Habitus, right lateral; C, Right antennule; D, Leg 5. Scale bars: A-D=100 μ m.

1 inner marginal seta, beyond distal end of first endopodal segment; second exopodal segment of leg 1 with small notch on outer margin (Fig. 6). Setae and spine formula of legs 1 to 4 as follows:

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

Fifth leg symmetrical, with exopod 3-segmented (setal formula: I-0; I-0; II, I, 4) and endopod 3-segmented (se-

tal formula: 0-1; 0-1; 2, 2, 2); first exopodal segment with notch on proximal inner margin; inner spinelike process of second exopodal segment with small spinules, exceed the distal end of third exopodal segment (Fig. 5E).

Male: Body length 1.84–1.95 mm (n = 3). Similar to habitus of female except urosome; posterolateral corners of fifth pedigerous somite rounded and symmetrical (Fig. 7A, B). Urosome 4-segmented, symmetrical; caudal rami and anal segment separated; caudal rami with 6 setae (Fig. 7A, B). Legs 1 to 4 same as in female.

Antennule geniculate on only right side, longer than body length, 22-segmented (Fig. 7C). Fusion pattern and setal formula as follows: I-2 + ae, II-IV-3 + ae, V-2 + ae, VI-2 + ae,

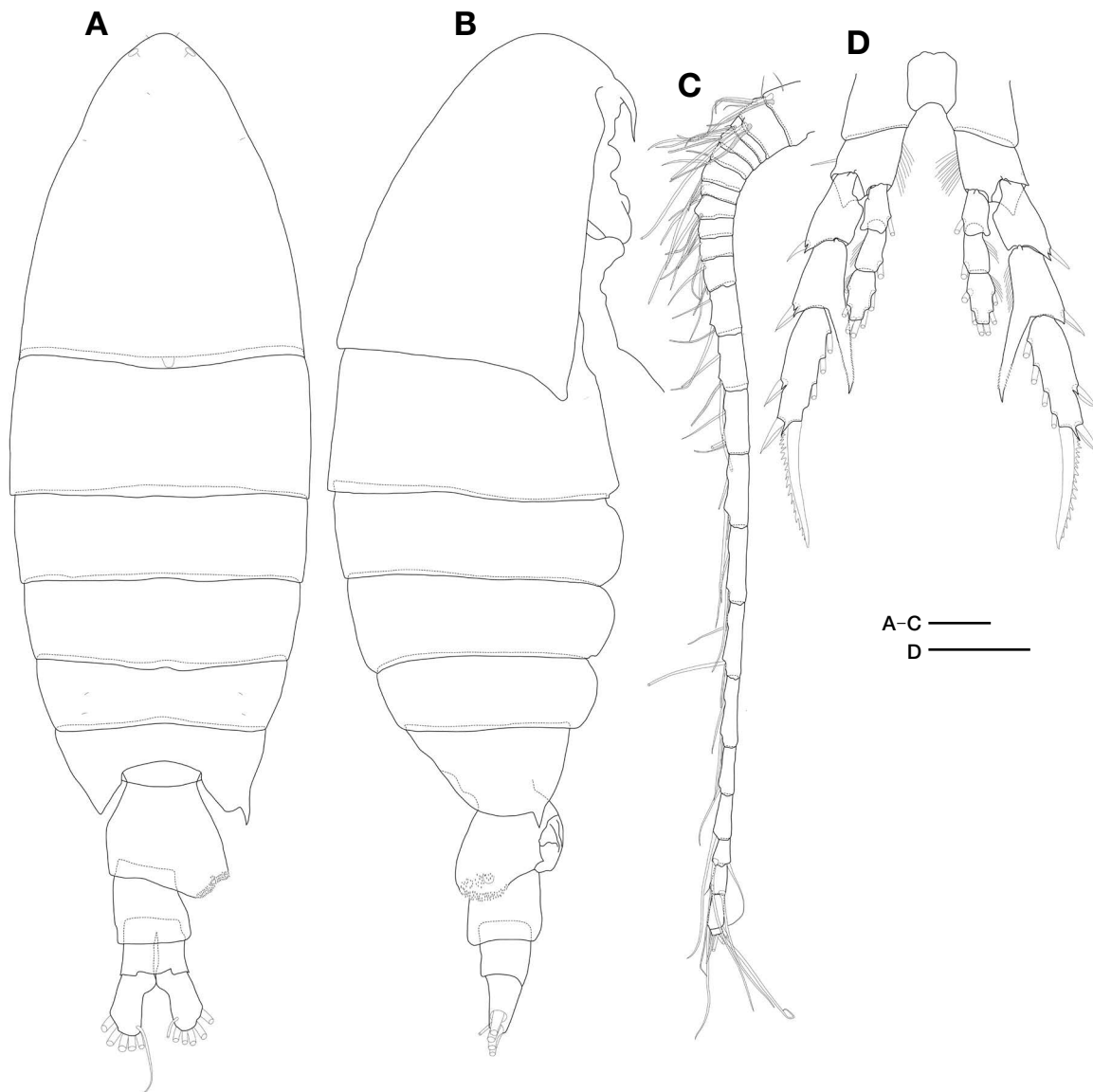


Fig. 8. *Centropages sinensis*, female: A, Habitus, dorsal; B, Habitus, right lateral; C, Antennule; D, Leg 5. Scale bars: A-D=100 μ m.

VII-2 + ae, VIII-2 + ae, IX-2 + ae, X-2 + ae, XI-2 + ae, XII-2 + ae, XIII-2 + ae, XIV-2 + ae, XV-2 + ae, XVI-2 + ae, XVII-2 + ae, XVIII-2 + ae, XIX-1 + ae, XX-1 + ae, XXI-XXIII-1 + ae, XXIV-1 + 1, XXV-1 + 1 + ae, XXVI-XXVIII-6 + ae. Tooth rows present on segments XIX, XX and XXI; segment XIX with bumplike process on dorsoposterior surface (Fig. 7C).

Fifth leg asymmetrical. Left leg biramous, with endopod 3-segmented and exopod 2-segmented; first exopodal segment with outer marginal spine; second exopodal segment with outer marginal process and outer marginal curved process; serrated on distal margin (Fig. 7D). Right leg bira-

mous, with endopod 3-segmented and exopod 3-segmented; first endopodal segment without inner marginal seta; first exopodal segment with outer marginal spine; second exopodal segment with large curved process on proximally inner margin; spine on posterior surface of segment distal margin; third exopodal segment sharply bent inwards, with inner marginal spine and outer marginal spine (Fig. 7D).

Distribution. *Centropages calaninus* was recorded in the Pacific Ocean (Mori, 1937; Grice, 1962), Northern Pacific Ocean (Brodsky, 1962), Southwestern Indian Ocean (Conway et al., 2003) and Indonesia (Scott, 1909; Mulyadi, 2004).

Remarks. *Centropages calaninus* is distinguished with other

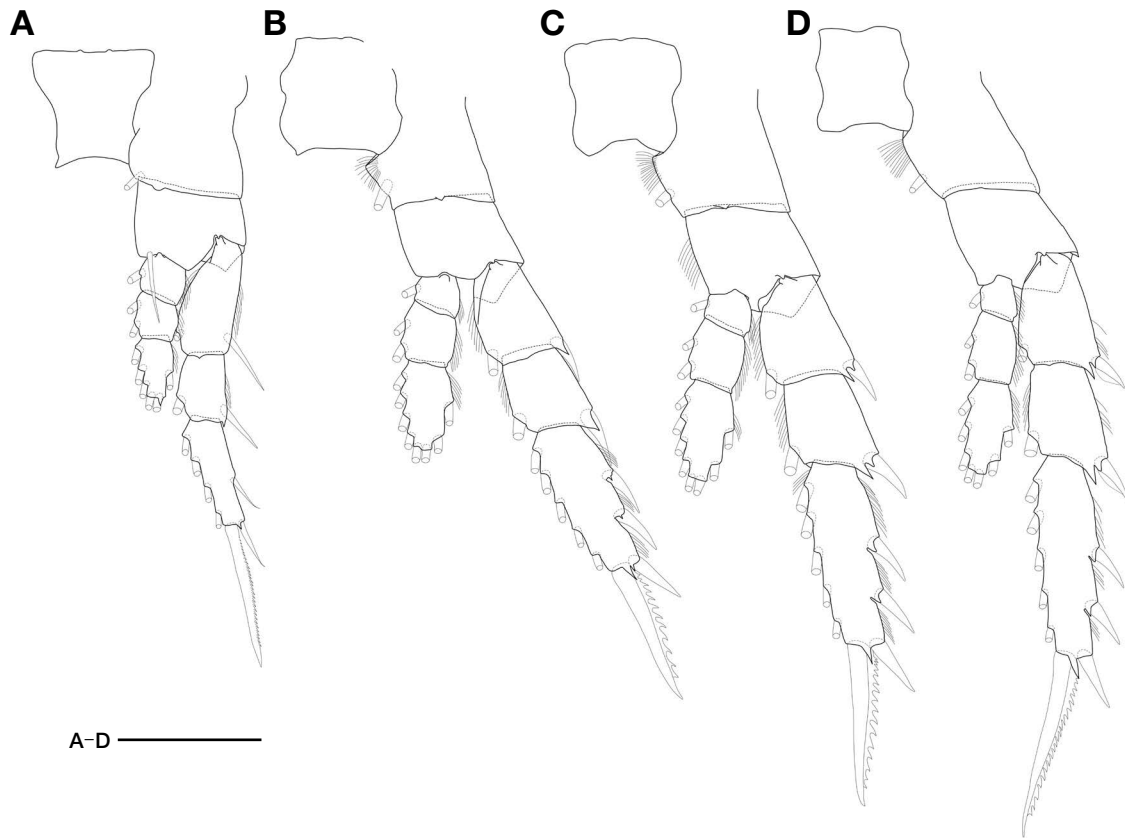


Fig. 9. *Centropages sinensis*, female: A, Leg 1; B, Leg 2; C, Leg 3; D, Leg 4. Scale bar: A-D=100 μ m.

Centropages species in the following characteristics: in the female, anal segment with a ventral knob, and second exopodal segment of leg 5 with a long spinelike process; in the male process of right third exopodal segment sharply bent inwards in leg 5. The Korean specimens differ in the following characteristics: (1) in females, Mulyadi (2004)'s description with second urosomite surrounded by small spines, but in Korean specimens second urosomite with small spinules row only on posterior margin; (2) in the previous records (Giesbrecht, 1892; Mori, 1937; Brodsky, 1962; Grice, 1962; Mulyadi, 2004), the long spine-like process of leg 5 second exopodal segment exceeding half the length of terminal spine on third exopodal segment, but in the Korean specimens that reaching 1/2; and (3) in male, first endopodal segment of leg 5 without inner seta (Brodsky, 1962) and left second exopodal segment serrated on distal margin.

***Centropages sinensis* Chen and Zhang, 1965**

(Figs. 8–10)

Centropages sinensis Chen and Zhang, 1965: 126, Pl. 26, figs. 1–7; Mulyadi, 2004: 133, fig. 76.

Material examined. Korea: 7♀♀, 1♂♂, Jeollanam-do: Haenam-gun, Hyeonsan-myeon, Baekpo-ri (St. 8), 34°25'30"N, 126°30'40.7"E, Jun 2021; 1♀ (MABIK CR00252956) dissected in 12 slides glasses, 1♂♂ (MABIK CR00252957) dissected in 12 slides glasses, 12♀♀, 18♂♂, Jeollanam-do: Yeonggwang-gun, Yeomsan-myeon, Oksil-ri (St. 9), 35°11'53"N, 126°22'5"E, Jun 2021. 40 individuals were used for length measurement.

Description. Female: Body length 1.44–1.66 mm (n = 20). Body plump in prosome, widest at first pedigerous; cephalosome clearly separated from first pedigerous somite; rostrum with pair of frontal filaments; fourth and fifth pedigerous somites fully divided; right posterolateral corners of fifth pedigerous somite pointed and asymmetrical (Fig. 8A, B). Urosome 3-segmented; genital double somite asymmetrical, right side swollen provided with numerous fine denticles; caudal rami asymmetrical, left ramus slightly longer than right ramus; caudal rami with 6 setae (Fig. 8A, B).

Antennule symmetrical, extending beyond end of second urosomite, 23-segmented (Fig. 8C). Fusion pattern and setal formula as follows: I-2 + ae, II-V-4 + 2ae, VI-2 + ae, VII-2 + ae, VIII-1 + ae, IX-2 + ae, X-2 + ae, XI-2 + ae, XII-

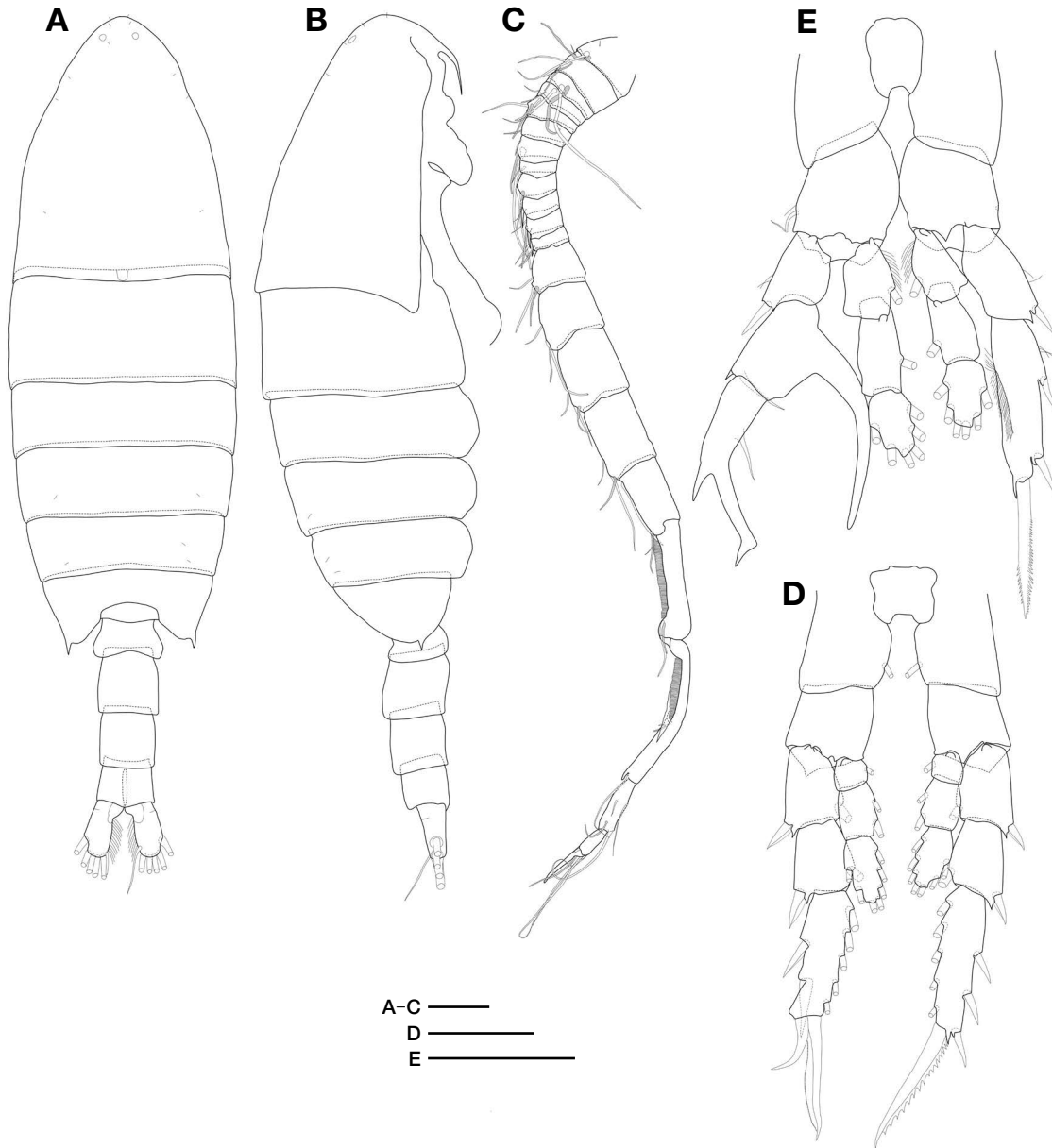


Fig. 10. *Centropages sinensis*, male: A, Habitus, dorsal; B, Habitus, right lateral; C, Right antennule; D, Leg 4; E, Leg 5. Scale bars: A-E=100 μ m.

2 + ae, 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, XXIV-1 + 1, XXV-1 + 1 + ae, XXVI-XXVIII-6 + ae.

Legs 1 to 4, setae and spine formula of legs similar to *C. calaninus*.

Fifth leg asymmetrical; exopod with 3-segmented (setal formula: I-0; I-0; II, I, 4) and endopod 3-segmented (setal formula: 0-1; 0-1; 2, 2, 2); inner spinelike process of second exopodal segment with small spinules, extending beyond

1/2 of third exopodal segment (Fig. 8D).

Male: Body length 1.32–1.44 mm (n = 20). Similar to habitus of female except urosome; posterolateral corners of fifth pedigerous somite pointed and symmetrical (Fig. 10A, B). Urosome 4-segmented, symmetrical; caudal rami and anal segment separated; caudal rami with 6 setae (Fig. 10A, B). Legs 1 to 4 same as in female.

Antennule geniculate on only right side, longer than body length; 21-segmented (Fig. 10C). Fusion pattern and setal formula as follows: I-2 + ae, II-IV-3 + ae, V-1 + ae,

VI-2 + ae, VII-2 + ae, VIII-1 + ae, IX-2 + ae, X-1 + ae, XI-2 + ae, XII-1, XIII-1 + ae, XIV-1 + ae, XV-2 + ae, XVI-2 + ae, XVII-2 + ae, XVIII-2 + ae, XIX-1 + ae, XX-1 + ae, XXI-XXIII-2 + ae, XXIV-XXV-3 + ae, XXVI-XXVIII-5 + ae. Tooth rows present on segments XX and XXI, both side of geniculation; segment XXIII with process on distal end of anterior side (Fig. 10C).

Fourth leg slightly asymmetrical; distal outer marginal spine of right third exopodal segment hook-like and curved outward; outer marginal denticles of distal spine smaller than left side (Fig. 10D).

Fifth leg asymmetrical; basis with outer marginal seta. Left leg biramous, with endopod 3-segmented and exopod 2-segmented; first exopodal segment with outer marginal spine; second exopodal segment hirsute on anterior surface, with 2 outer marginal spines and bilaterally serrated distal marginal spine (Fig. 10E). Right leg biramous, with endopod and exopod 3-segmented; first exopodal segment with outer marginal spine; second exopodal segment with spinelike process on outer, large curved process on proximally inner margin and long spine on posterior surface of segment distal margin; third exopodal segment with outermid margin spinelike process, distal curved outwards and inner marginal spine (Fig. 10E).

Distribution. *Centropages sinensis* was recorded only in the China Sea (Chen and Zhang, 1965) and Indonesia (Mulyadi, 2004).

Remarks. Since *Centropages sinensis* was first reported in the coastal of Hangzhou Bay and the Zhoushan Islands in China during summer and autumn (Chen and Zhang, 1965), it was collected from Tegal, Central Java in Indonesia (Mulyadi, 2004). Korean specimens were the third record. *Centropages tenuiremis* is a common species in coastal waters of Korea, but *C. sinensis* was only collected from certain estuaries. The Korean specimen agrees well with previous records: (1) in males and females, an outer marginal seta in basis of leg 5; (2) female genital double somite asymmetric; and (3) in males outer marginal spine of right third exopodal segment of leg 4 curved. However, the Korean specimens differ in the following characteristics: (1) the number of antennule segments in females and males one less than in previous records; (2) in males, distal spine of the left second exopodal segment in leg 5 not fused with segment, different from Mulyadi (2004)'s record.

Key to species of genus *Centropages* in Korean waters

- 1. Median posterodorsal hook-like process on cephalosome absent 2
- 1a. Median posterodorsal hook-like process on cephalosome present *C. dorsispinatus*

- 2. Caudal rami without peculiar, short, truncated, peg-shaped projection between two outer setae 3
- 2a. Caudal rami with peculiar, short, truncated, peg-shaped projection between two outer setae *C. bradyi*
- 3. Antennule symmetrical 4 (Female)
- 3a. Antennule asymmetrical 9 (Male)
- 4. Posterolateral corners of fifth pedigerous somite rounded 8
- 4a. Posterolateral corners of fifth pedigerous somite pointed 5
- 4b. Posterolateral corners of fifth pedigerous somite pointed, with 1 accessory spine on inner side *C. furcatus*
- 5. Posterolateral corners of fifth pedigerous somite asymmetrical 6
- 5a. Posterolateral corners of fifth pedigerous somite symmetrical *C. tenuiremis*
- 6. Endopod 3-segmented in legs 1 to 3 7
- 6a. Endopod 2-segmented in legs 1 to 3 *C. orsinii*
- 7. Caudal rami short *C. sinensis*
- 7a. Caudal rami long *C. abdominalis*
- 8. Caudal ramus asymmetrical *C. calaninus*
- 8a. Caudal ramus symmetrical *C. gracilis*
- 9. Posterolateral corners of fifth pedigerous somite rounded 13
- 9a. Posterolateral corners of fifth pedigerous somite pointed 10
- 9b. Posterolateral corners of fifth pedigerous somite pointed, with 1 accessory spine on inner side *C. furcatus*
- 10. Posterolateral corners of fifth pedigerous somite symmetrical 11
- 10a. Posterolateral corners of fifth pedigerous somite asymmetrical 12
- 11. Third exopodal segment of fifth leg curved of distal end *C. orsinii*
- 11a. Third exopodal segment of fifth leg not curved of distal end *C. tenuiremis*
- 12. Caudal rami short *C. sinensis*
- 12a. Caudal rami long *C. abdominalis*
- 13. Third exopodal segment of fifth leg sharply bent inwards *C. calaninus*
- 13a. Third exopodal segment of fifth leg not sharply bent inwards *C. gracilis*

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CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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