

A new record of the species *Sinocorophium dongtanense* (Crustacea: Amphipoda: Corophiidae) from Korean waters, with comparison to *Sinocorophium homoceratum*

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A newly recorded species, *Sinocorophium dongtanense*, of the genus *Sinocorophium* was collected from shallow waters of Korea. This species was previously reported as *S. homoceratum* in Korea. However, after reanalysis of previously studied samples, this species was identified as *S. dongtanense*, which had previously been reported from the Yangtze estuary, Shanghai, China in 2014. In this study, the newly recorded species is illustrated with a diagnosis and compared to the previously misidentified species. Molecular phylogenetic studies for *Sinocorophium* species in Korea are provided. A key to the *Sinocorophium* species in Korea is also provided.

Keywords: Amphipoda, COI, Korea, *Sinocorophium dongtanense*

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INTRODUCTION

The genus *Sinocorophium* was established by Bousfield & Hoover, 1997 as a division of the large genus *Corophium*. The name is derived from the Latin prefix “Sino-”, meaning Chinese, and the generic root *Corophium*, referencing the endemism of component species in the East China Sea and adjacent regions. The twelve described species are endemic to warm temperate and subtropical shallows of the East Sea, East China Sea, and the South China Sea, the coast of Vietnam, where they burrow in soft marine and brackish substrates. Only one species, *S. alienense* occurs in the San Francisco Bay (Bousfield and Hoover, 1997).

Sinocorophium amphipods are morphologically distinct from other corophiid amphipods due to their unique characteristics, such as the peduncular article 2 of antenna 2 with a large gland cone, elongated palp article 2 of maxilliped, rounded posteroventral corner of epimeron 3 (except *S. sinensis*, Zhang, 1974), laterally inserted uropod 1, and uncoalesced urosomites (Bousfield and Hoover, 1997; Kim, 2012; Ren and Liu, 2014). Some of these species are known to inhabit U-shaped caves in the soft bottom of intertidal zone (Zhang, 1974; Ren and Liu, 2014).

Thirteen species of *Sinocorophium* amphipods have

been recorded worldwide, and four species (*S. sinensis*, *S. hangangense*, *S. jindoense*, and *S. homoceratum*) have been recorded in Korea. Among them, *S. hangangense* and *S. jindoense* are endemic to Korea (Kim, 2012; Heo and Kim, 2017).

MATERIALS AND METHODS

The specimens were collected from mud substratum of a stream in Yonggi-ri, Gochang-gun, Jeollabuk-do; and Ibam-ri, Yeonggwang-gun, Jeollanam-do, Korea using a dredge. The collected specimens were fixed in 70–80% ethanol and dissected in glycerol on Cobb’s aluminum hole slides. Drawings and measurements were performed with the aid of a drawing tube. Comparative specimens are deposited at the National Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea, and the Department of Biological Science, Dankook University (DKU), Cheonan, Korea.

DNA extraction were carried out using DNeasy Blood & Tissue Kits (QIAGEN), following the manufacturer’s instructions. The polymerase chain reaction (PCR) was used to amplify the target DNA segment of the mtCO1, using the universal CO1 primers LCO1490 5'-GGTCAAC

AAATCATAAAGATATTGG-3' and HCO2198 5'-TAAA CTTCAGGGTGACCAAAAAATCA-3' (Folmer *et al.*, 1994). The PCR thermal regime involved initial denaturing at 94°C for 5 min; five cycles at 94°C for 30 sec, 51°C for 30 sec, and 72°C for 45 sec, 35 cycles of 94°C for 30 sec, and final 1 min extension at 56°C. All sequences were aligned and analyzed using the program MEGA. Phylogenetic analysis was conducted according to Neighbor-joining method (Saitou and Nei, 1987).

SYSTEMATIC ACCOUNTS

Order Amphipoda Latreille, 1816
Family Corophiidae Leach, 1814
Genus *Sinocorophium* Bousfield and Hoover, 1997

Sinocorophium dongtanense Ren and Liu, 2014

(Figs. 1–3) 두돌기뱀옆새우 (신칭)

Sinocorophium dongtanense Ren and Liu, 2014, 96, figs. 1–3.

Sinocorophium homoceratum: Ko *et al.*, 2017, 277, figs. 2–6; Heo and Kim, 2017, 160, figs. 5, 6.

Material examined. 4♂, 37♀ Watan stream, Ibam-ri, Beopseong-myeon, Yeonggwang-gun, Jeollanam-do, Korea 35°20'15.76"N, 126°26'2.04"E, 01 April 2020; 2♂, 16♀ Jujin stream, Yonggi-ri, Simwon-myeon, Gochang-gun, Jeollabuk-do, Korea, 35°31'48.35"N, 126°35'44.12"E, 02 April 2020; 1♂, 9♀ Watan stream, Ibam-ri, Beopseong-myeon, Yeonggwang-gun, Jeollanam-do, Korea 35°20'15.76"N, 126°26'2.04"E, 31 August 2020. The specimens were collected by KES.

Description. Adult male, body (Figs. 1A, 2) depressed, 12.6 mm long (NIBRIV0000904521). Head (Fig. 2B) longer than pereonite 1; cephalic lobe produced; eye invisible in alcohol. Length ratio of pereonites 1–7 = 1.00 : 1.47 : 1.46 : 1.92 : 2.10 : 1.96 : 1.67. Coxae flat dorsoventrally, much shallower than pereonites, except coxa 1. Pleonites 1–2, posteroventral corners rounded, with plumose setae posterolaterally; pleonite 3 slightly shorter than pleonites 1 and 2 combined, with simple setae. Urosomites 1–3 separate.

Antenna 1 (Fig. 2C) much shorter than antenna 2; peduncle longer than flagellum, peduncular article 1 subrectangular, with irregularly serrulate medially in dorsal view, irregularly serrulate ventrally with 1 small robust seta ventrodistally and unequal simple setae ventrally, length ratio of peduncular articles 1–3 = 1.00 : 0.41 : 0.27; flagellum 16–20 articulate, with each article with simple short setae.

Antenna 2 (Fig. 2D) massive, peduncle stout; peduncular article 2 with 2 pointed unequal gland cones ventrodistally; peduncular article 4 characteristic in form, long and

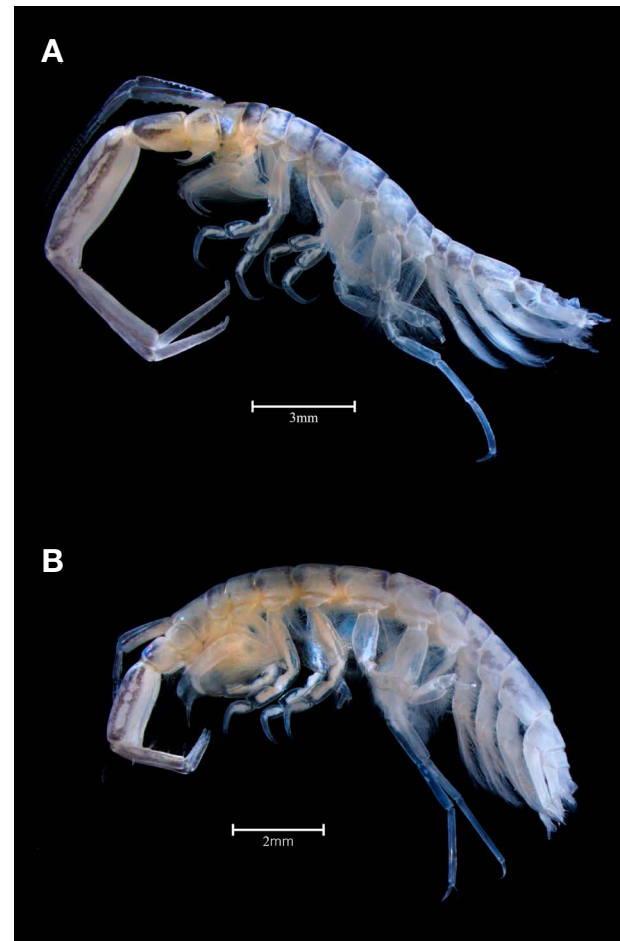


Fig. 1. *Sinocorophium dongtanense* Ren and Liu, 2014. A, adult male, 12.4 mm, habitus; B, adult female, 11.7 mm, habitus.

stout, 1.14 times as long as article 5, with 2 rows of tubercles medially, 2 strong teeth ventrodistally; peduncular article 5 cylindrical, with 2 teeth anteromedially; length ratio of peduncular articles 2–5 = 1.00 : 1.72 : 5.31 : 5.29; flagellum biarticulate, proximal one 0.62 times as long as peduncular article 5, with 6 small teeth on ventral margin, distal one short, about 0.14 times as long as proximal one, surrounded by setae apically.

Gnathopod 1 (Fig. 2E) transverse; coxa elongate anteriorly, with 3 long plumose setae distally, anterior margin with 5–8 unequal setae; basis with 1–3 long simple setae posterodistally; ischium subrectangular, with long plumose setae ventrodistally; merus short, with plumose setae ventrodistally; carpus with 2–3 simple setae midanteriorly, distal corner with a transverse row of simple setae, posterior margin with 2 rows of plumose setae; propodus subrectangular, palm lined with rows of bifid spinules; dactylus falcate, nearly fitting to palm; length ratio of 2–7 articles = 1.00 : 0.26 : 0.27 : 1.02 : 0.64 : 0.22.

Gnathopod 2 (Fig. 2F) simple; coxa small; basis with

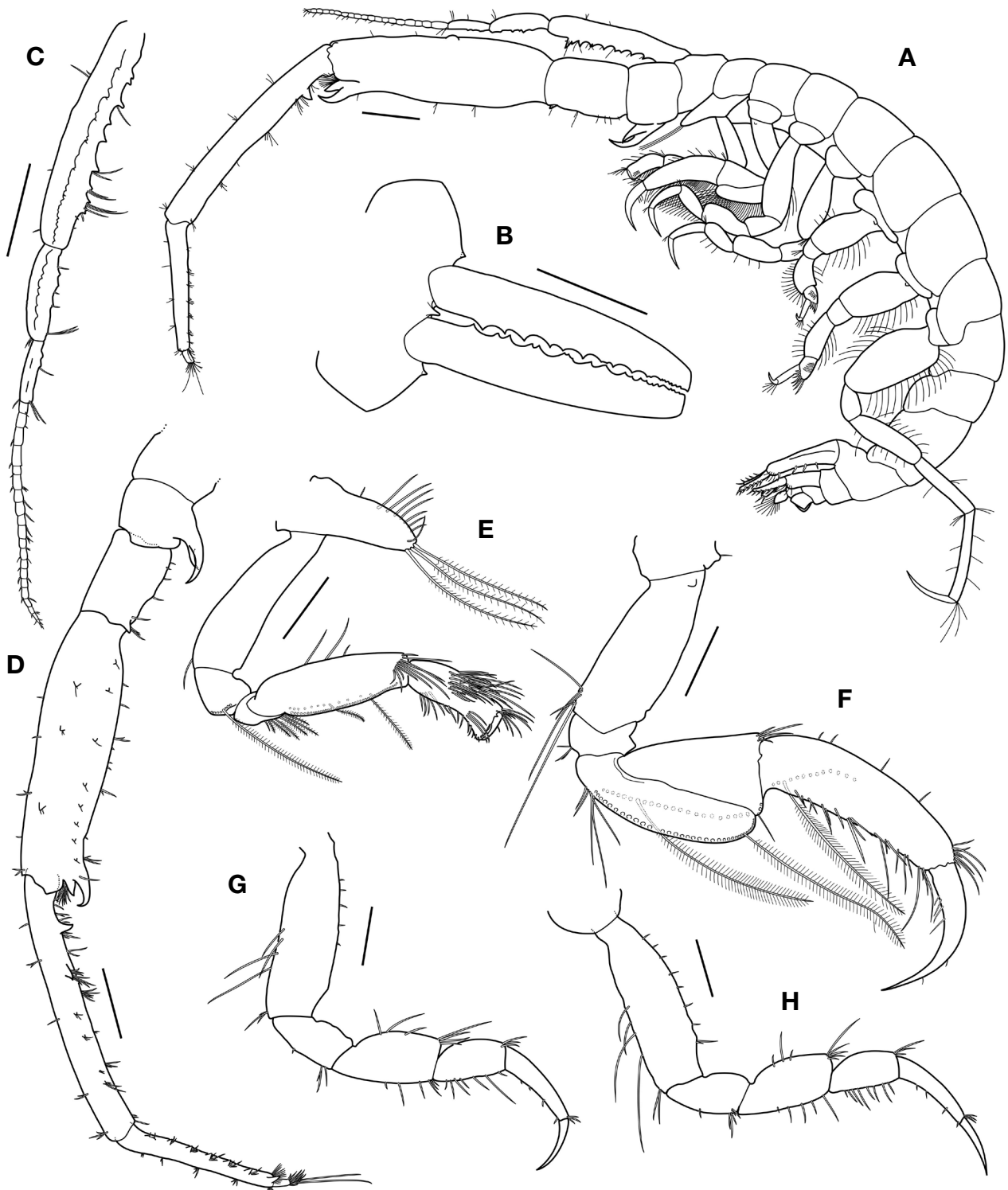


Fig. 2. *Sinocorophium dongtanense* Ren and Liu, 2014. Adult male, 12.36 mm: A, habitus; B, head (dorsal view); C, antenna 1 (medial view); D, antenna 2 (medial view); E, gnathopod 1; F, gnathopod 2; G, pereopod 3; H, pereopod 4. Scale bars: A–D = 1.0 mm, E–H = 2.0 mm.

3–5 long simple setae posterodistally; merus convexly curved posteriorly, with 2 rows of long plumose setae

along posterior margin and medial portion; carpus isosceles triangle in shape, with several simple and plumose

setae posterodistally; propodus both margins with simple setae, proximal half of medial region with a curved row of plumose setae; dactylus long and falcate; length ratio of 2–7 articles = 1.00 : 0.15 : 0.96 : 0.81 : 1.25 : 0.83.

Pereopod 3 (Fig. 2G) simple; basis subrectangular; merus slightly widening distally; propodus thin and long, 0.73 times as long as merus; dactylus slender and falcate; length ratio of 2–7 articles = 1.00 : 0.35 : 0.52 : 0.40 : 0.48 : 0.35.

Pereopod 4 (Fig. 2H) similar to pereopod 3, but basis slightly more setose.

Pereopod 5 (Fig. 3A) much shorter and different structure than pereopod 4, coxa narrowing posteriorly; basis slightly widened anteriorly, anteromarginally with several setae, posterior margin with 8 plumose setae; merus widening distally, both margins with plumose setae; carpus subtriangular, with 2 oblique rows of 5 proximal and 10 distal robust setae respectively; propodus subequal in length to merus; dactylus short. length ratio of 2–7 articles = 1.00 : 0.30 : 0.60 : 0.28 : 0.28 : 0.15.

Pereopod 6 (Fig. 3B) similar to pereopod 5, but longer; basis with a row of plumose setae posteriorly; merus anterior margin with a row of unequal plumose setae; carpus subtriangular, with 2 oblique rows of 5 proximal and 8 distal robust setae respectively; propodus slender; dactylus short; length ratio of 2–7 articles = 1.00 : 0.22 : 0.69 : 0.31 : 0.34 : 0.17.

Pereopod 7 (Fig. 3C) elongate, greatly longer than others; basis elongate-ovate, 0.46 times wider than long, densely setose along both margins with long plumose setae; length ratio of 2–7 articles = 1.0 : 0.30 : 0.66 : 0.62 : 0.84 : 0.38.

Urosomites 1–3 (Fig. 3D) separate; urosomite 1 longest, widest and slightly curved dorsally; uropods 1–3 arising laterally.

Uropod 1 (Fig. 3D) extending beyond end of uropod 2; peduncle much longer than rami, 1.85 times as long as outer ramus, lateral margin with 13 short setae, medial

margin with 4 robust setae; outer rami 1.30 times longer than inner.

Uropod 2 (Fig. 3D), peduncle slightly longer than rami, with apicodistal robust seta and cluster of setae laterally; rami subequal in length.

Uropod 3 (Fig. 3D) uniramous, peduncle subtrapezoidal, subequal to ramus; ramus ovate, margins surrounded by simple setae.

Telson (Fig. 3D) fleshy, thickened, truncate distally, with 2 rounded lobe dorsolaterally.

Adult female, similar to male, body (Fig. 3E) 11.6 mm long. Head (Fig. 3F) similar to that of male, but rostrum wider and longer, beyond cephalic lobe.

Antenna 1 (Fig. 3G) similar to that of male, but more setose, smooth; peduncular article 1 rectangular, with unequal simple setae ventrally and a robust seta posterodistally, without rows of teeth; length ratio of peduncular articles 1–3 = 1.00 : 0.53 : 0.36; flagellum 13–16 articulate, each article with simple short setae.

Antenna 2 (Fig. 3H) similar in shape, but stouter and shorter than that of male, especially peduncular articles 3 and 4; length ratio of peduncular articles 2–5 = 1.00 : 1.41 : 3.15 : 2.63; flagellum biarticulate, proximal one 0.51 times as long as peduncular article 5, distal one short, 0.22 times as long as proximal one.

Molecular data. CO1 gene sequences (GenBank accession numbers OQ996608, OQ998653, OQ998654, OR048101, OR048102) were obtained from five *S. dongtanense* specimens. The sequences were aligned and compared with sequences from *S. hangangense* (OQ943924, OQ970180), *S. jindoense* (OQ991265, OQ992550), and *S. sinensis* (OQ991369, OQ991370) (Table 1). Intra-specific variation of the CO1 gene sequence of *S. dongtanense* ranged between 0 and 1.2%, while inter-specific variation ranged from a low of 22.8% (*S. hangangense* and *S. jindoense*) to a high of 26.7% (*S. dongtanense* and *S. jindoense*).

Table 1. Sampling localities information of *Sinocorophium* species from Korea and GenBank access numbers.

No.	Date	Locality	Latitude, longitude	Species	GenBank Accession No.
1	2017.09.12	Yonggi-ri, Simwon-myeon, Gochang-gun, JB	35°31'48"N, 126°35'44"E	<i>S. dongtanense</i>	OQ996608
2	2017.09.12	Yonggi-ri, Simwon-myeon, Gochang-gun, JB	35°31'48"N, 126°35'44"E	<i>S. dongtanense</i>	OQ998653
3	2017.09.12	Yongsan-ri, Buan-myeon, Gochang-gun, JB	35°30'33"N, 126°36'02"E	<i>S. dongtanense</i>	OQ998654
4	2020.04.01	Ibam-ri, Beopseong-myeon, Yeonggwang-gun, JN	35°20'15"N, 126°26'02"E	<i>S. dongtanense</i>	OR048101
5	2020.08.31	Ibam-ri, Beopseong-myeon, Yeonggwang-gun, JN	35°20'15"N, 126°26'02"E	<i>S. dongtanense</i>	OR048102
6	2018.04.18	Baekpo-ri, Hyeonsan-myeon, Haenam-gun, JN	34°25'27"N, 126°30'42"E	<i>S. hangangense</i>	OQ943924
7	2018.04.18	Baekpo-ri, Hyeonsan-myeon, Haenam-gun, JN	34°25'27"N, 126°30'42"E	<i>S. hangangense</i>	OQ970180
8	2017.04.10	Daechon-dong, Boryeong-si, CN	36°21'01"N, 126°34'52"E	<i>S. jindoense</i>	OQ991265
9	2017.04.10	Daechon-dong, Boryeong-si, CN	36°21'01"N, 126°34'52"E	<i>S. jindoense</i>	OQ992550
10	2022.04.20	Seopo-myeon, Sacheon-si, KN	35°00'45"N, 128°00'24"E	<i>S. sinensis</i>	OQ991369
11	2022.06.04	Sinsido-ri, Okdo-myeon, Gunsan-si, JB	35°49'07"N, 126°26'57"E	<i>S. sinensis</i>	OQ991370

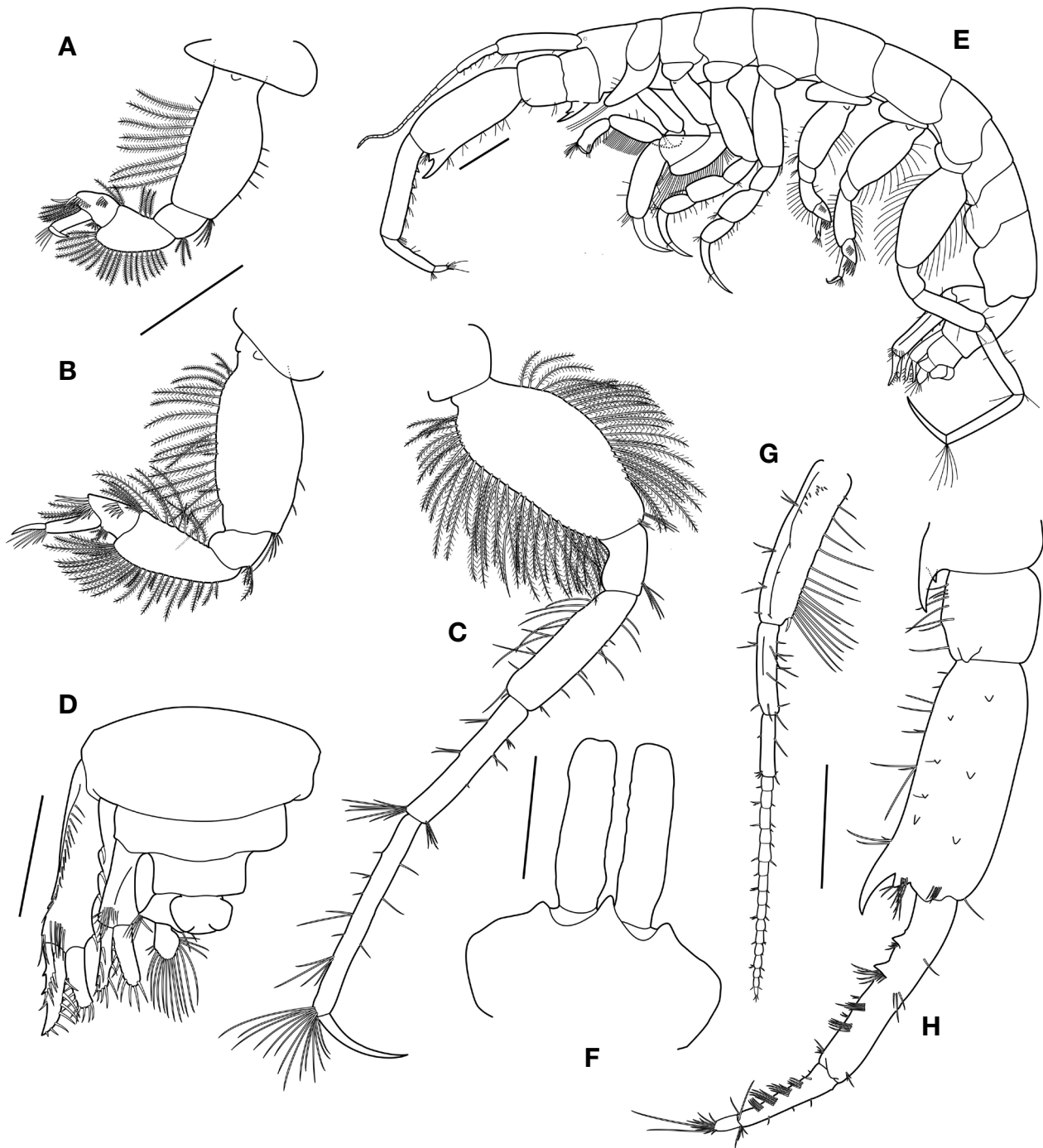


Fig. 3. *Sinocorophium dongtanense* Ren and Liu, 2014. A, pereopod 5; B, pereopod 6; C, pereopod 7; D, urosomites. Adult female, 11.71 mm; E, habitus; F, head (dorsal view); G, antenna 1 (medial view); H, antenna 2 (left, medial view). Scale bars: A-H = 1.0 mm.

ense) (Fig. 5, Table 2).

Remarks. It seems that there has been a mistake in the identification of specimens previously recorded as *S. homoceratum* (Yu, 1938) in Korea (Heo and Kim, 2017; Ko *et al.*, 2017). Upon rechecking the sample descriptions and specimens used in previous studies (Fig. 4), it was found

that these specimens had the characteristics of *S. dongtanense* Ren and Liu, 2014, which is morphologically similar to *S. homoceratum*, but has distinct differences, such as two rows of teeth on the medial surface of peduncular article 4 of antenna 2. To confirm this, the COI molecular sequences of both previously identified and newly identi-

Table 2. The genetic distance in the Genus *Sinocorophium* species based on mtDNA COI sequences

No.	Species	1	2	3	4	5	6	7	8	9	10	11
1	<i>Sinocorophium dongtanense</i>											
2	<i>Sinocorophium dongtanense</i>	0.000										
3	<i>Sinocorophium dongtanense</i>	0.000	0.000									
4	<i>Sinocorophium dongtanense</i>	0.012	0.012	0.012								
5	<i>Sinocorophium dongtanense</i>	0.005	0.005	0.005	0.011							
6	<i>Sinocorophium hangangense</i>	0.239	0.239	0.238	0.239	0.241						
7	<i>Sinocorophium hangangense</i>	0.237	0.237	0.236	0.237	0.239	0.011					
8	<i>Sinocorophium jindoense</i>	0.262	0.262	0.262	0.257	0.266	0.230	0.230				
9	<i>Sinocorophium jindoense</i>	0.262	0.262	0.262	0.258	0.267	0.228	0.228	0.009			
10	<i>Sinocorophium sinensis</i>	0.234	0.234	0.233	0.233	0.233	0.242	0.243	0.237	0.244		
11	<i>Sinocorophium sinensis</i>	0.236	0.236	0.235	0.235	0.235	0.249	0.249	0.241	0.248	0.011	

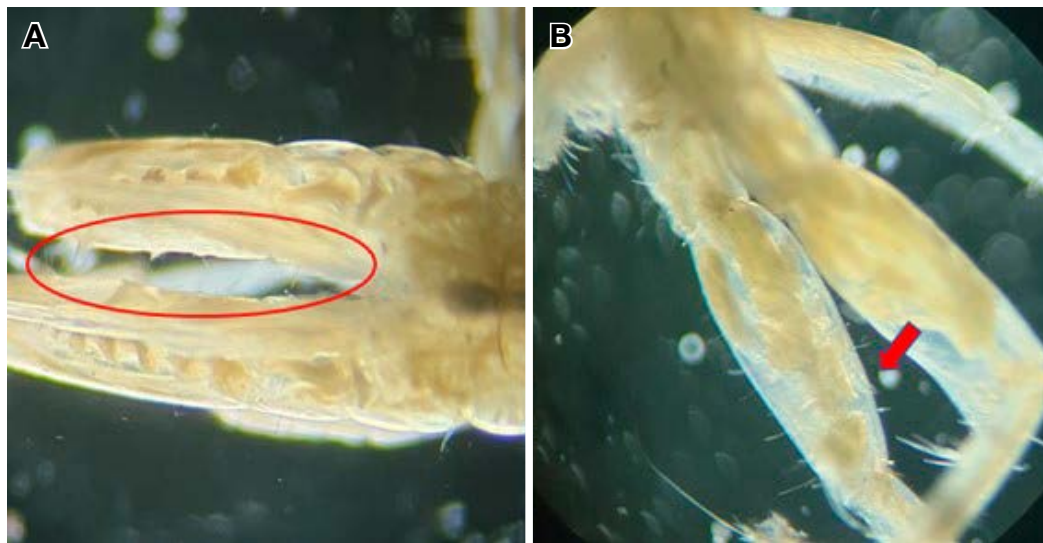


Fig. 4. *Sinocorophium homoceratum*, peduncular article 4 of antenna 2 (MABIK CR00240676) from MABIK, analyzed by Ko et al., 2017. A, dorsal view; B, medial view.

fied samples of *S. dongtanense* and other *Sinocorophium* species in Korea were compared and analyzed, along with related genus data from the NCBI (Fig. 5). The new specimens accord with the original description given by Ren and Liu, 2014, with some slight differences in certain characteristics, such as the length of antenna 1 in males and the number of teeth on peduncular article 4 of antenna 2 in females. Through this study, there are four species of the genus *Sinocorophium* in Korean waters.

Habitat. The new recorded species is found in brackish estuary with a water temperature of 15.38°C, salinity of 6.45 PSU, and pH 6.9. Sediment is composed of gravel and sand.

Distribution. China, Korea (Yellow Sea).

Key to the Korean species of genus *Sinocorophium* (modified from Heo and Kim, 2017)

1. Antenna 2 sexually dimorphic; gnathopod 1, palm steeply oblique to transverse; pereopods 3, 4, meri subequal to carpi..... *S. sinensis* (Zhang, 1974)
 - Antenna 2 sexually subsimilar; gnathopod 1, palm gently convex; pereopods 3, 4, meri longer than carpi..... 2
2. Antenna 2, peduncular article 4 with 2 large ventrodiscal teeth..... *S. dongtanense* Ren and Liu, 2014
 - Antenna 2, peduncular article 4 with 1 large ventrodiscal tooth..... 3
3. Uropod 1, lateral margin of peduncle with setae; uropod 3, ramus longer than peduncle.....
 - *S. hangangense* Kim, 2012

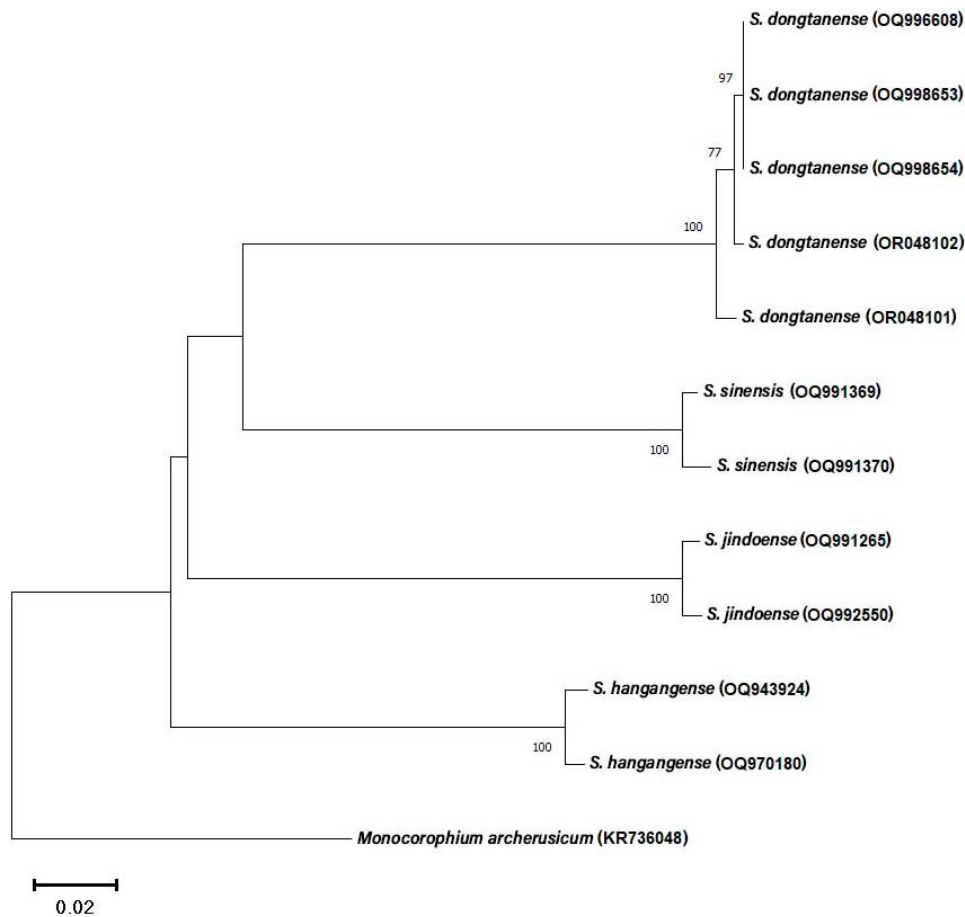


Fig. 5. Neighbor-Joining (NJ) tree of mtDNA COI sequences from four Korean *Sinocorophium* species based on maximum likelihood (ML) genetic distances.

– Uropod 1, lateral margin of peduncle with robust setae;
uropod 3, ramus subequal or shorter than peduncle
..... *S. jindoense* Heo and Kim, 2017

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