Three new species of the genus *Stephos* Scott, 1892 (Crustacea, Copepoda, Calanoida, Stephidae) from Jeju Island, Korea

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Abstract

During general field surveys carried out recently to collect benthopelagic copepods from near the substrate of the shallow waters off Jeju Island, Korea, a few specimens of three new species of *Stephos* Scott, 1892, were collected. The new species are placed in the genus *Stephos* because of the following combination of features: absence of seta on the basal exite of maxillule, and male right leg 5 ending in an unarmed claw-like and/or mitten-like segment. *Stephos jejuensis* sp. nov. can be distinguished from its congeners by body length 0.92 mm, left side of the female genital double-somite with protruding lobes, antennule that extends beyond the distal area of the genital double-somite, and the male leg 5 terminal complex. *Stephos concavus* sp. nov. can be distinguished from its congeners by the genital double-somite with protruding lobes on both sides, and the presence of larger spinules on the distomedial margin of leg 5. *Stephos fortipes* sp. nov. can be distinguished from its congeners by its longer body length, 1.12 mm long in the female, antennules that extend to the end of the genital double-somite, and the presence of a covered row of minute spinules on the ventral surface of the genital operculum in the female. Until now, 35 species of stephids were known worldwide.

Keywords

*Stephos*, new species, benthopelagic, near bottom, Jeju Island

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Introduction

Benthopelagic copepods are of low abundance and high diversity in the benthic boundary layer (Bradford-Grieve 2004). However, they are difficult to sample on the continental slope or ocean-basin environments, which has contributed to the slow accumulation of knowledge about the benthopelagic fauna (Bradford-Grieve 2004). The benthopelagic calanoid family Stephidae Sars, 1902, consists of four valid genera by: *Stephos* Scott, 1892; *Parastephos* Sars, 1902; *Miostephos* Bowman, 1976 and *Parastephos* Sars, 1902; *Speleohvarella* Kršinić, 2005. Their species are generally smaller in body size, and include hyperbenthic forms living in anchialine and marine coastal habitats (Boxshall and Halsey 2004; Jaume et al. 2008; Kršinić 2012, 2015; Moon et al. 2015; Suárez-Morales et al. 2017). The genus *Stephos* is the most diverse, comprising 32 species (Bradford-Grieve 1999; Boxshall and Halsey 2004; Kršinić 2015; Moon et al. 2015; Suárez-Morales et al. 2017). Up to now, there have been a total of eleven species from the Australia-Western Pacific region, as follows: *S. pentacanthos* Chen & Zhang, 1965; *S. morii* Greenwood, 1978; *S. tropicus* Mori, 1942; *S. tsuyazakiensis* Tanaka, 1967, *S. pacificus* Ohtsuka & Hiromi, 1987; *S. angulatus* Bradford-Grieve, 1999; *S. robustus* Ohtsuka & Hiromi, 1987; *S. kurilensis* Kos, 1972; *S. hastatus* Bradford-Grieve, 1999; *S. geojinensis* Moon, Youn & Venmathi Maran, 2015; and *S. projectus* Moon, Youn & Venmathi Maran, 2015. Species of *Stephos* show many similarities to species of its confamilial genera but differs as follows: the male right fifth leg is 4-segmented (vs. 5-segmented in *Parastephos* and 3-segmented in *Miostephos* and *Speleohvarella*); and the male right fifth leg ends in an unarmed claw-like and/or mitten-like segment (vs. a claw being armed with spines along the concave margin in *Parastephos* and reduced in *Miostephos* and *Speleohvarella*) (Boxshall and Halsey 2004). The zoogeographical distribution of species of *Stephos* was established by Suárez-Morales et al. (2017).

During a survey of the copepod fauna of the southern coasts of Jeju Island, the largest island in Korea, a few specimens of stephids were collected from near-bottom shallow waters by vertical tows of 0.1-mm mesh conical nets at high tide in dusk hours. One of these samples contained representatives of several *Stephos* not known to the benthopelagic environment. This paper reports on three undescribed species of the genus *Stephos* that are herein described in full and compared with their known congeners around the world.

Materials and methods

Copepods were collected from the shallow waters of Jeju Island, Korea by vertical tows (0.1-mm mesh conical nets) at high tide in dusk hours (Fig. 1). For morphological examination, samples were fixed in a 5% natural formalin-seawater solution and cleared in 70% lactic acid for an hour before dissection in a drop of lactophenol on a wooden slide under the dissection microscope (Humes and Gooding 1964). Dissected body parts and appendages were examined under a compound microscope with magnification up to X1,000. Measurements were made with a stage micrometer from the head.
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To the tip of the caudal ramous, excluding the caudal setae. Drawings were made with the aid of a drawing tube equipped on the microscope. The morphological terminology follows Huys and Boxshall (1991) and Ferrari and Ivanenko (2008). An abbreviation used in the text and figures is ae, for aesthetasc. Specimens are deposited at the National Institute of Biological Resources (NIBR), Incheon, Korea.

**Taxonomy**

Order Calanoida Sars, 1901  
Family Stephidae Sars, 1902  
Genus *Stephos* Scott, 1892

*Stephos jejuensis* sp. nov.  
http://zoobank.org/94A56606-DD69-43B6-9EB0-F6ED232AF163  
Figures 2–5

**Material examined.** Holotype ♀ (NIBRIV0000840220), allotype ♂ (NIBRIV0000840219) undissected in 70% ethanol, 11 November 2012. Dissected paratypes ♀ (NIBRIV0000840221), ♂ (NIBRIV0000840222) mounted on two glass slides, 11 November 2011. All specimens collected by D. H. Cho.

**Type locality.** Near the bottom (ca. 5 m depth), Pyoseon port, Jeju Island (33°19′32″N, 126°50′42″E), Korea.

**Etymology.** The specific name of the new species *jejuensis* refers to the type locality.

**Description of female.** Body (Fig. 2A, B) robust, length 0.92 mm (mean 0.91 ± 0.03, N = 3). Prosome 5-segmented; cephalosome and first pedigerous somites completely separated; fourth and fifth pedigerous somites incompletely fused (Fig. 2A, B),
Figure 2. *Stephos jejuensis* sp. nov. Female paratype **A** habitus, dorsal view **B** habitus, lateral view **C** urosome, dorsal view **D** urosome, lateral view **E** urosome, ventral view **F** anal somite and caudal rami. Scale bars in µm.
posterior corners of fifth pedigerous somite slightly asymmetric. Rostrum represented by a rounded knob. Prosome-urosome ratio 2.61:1. Urosome 4-segmented, comprising genital double-somite, two free abdominal somites, and anal somite; length ratio of genital double-somite, first free abdominal somite, second free abdominal somite, and anal somite as 48.2: 14.2: 12.6:11.7:13.4 = 100. Genital double-somite (Fig. 2C, E) asymmetric, with protruding lobe on the anterior to posterior of the left side and a projecting lobe to distal margin, with minute spinules patched in lateral view (Fig. 2D); on the right anterior side is a swollen, common operculum bumpy-shaped ventromedially and with ear lobe on the ventrolateral margin. First and second abdominal somites with transverse hyaline frill dorsally and ventrally. Anal somite short. Caudal rami (Fig. 2F), with six setae, symmetric, 1.45 times longer than wide (44 × 31 μm); caudal setae II–VII present (seta I lacking); seta II spiniform, seta III ca. half the length of seta V, seta V longer (right longer than left) than seta IV, both plumose; dorsal seta VII short, plumose.

**Antennule** (Fig. 3A) symmetric, extending beyond the distal area of genital double-somite; 24-segmented, apparently ancestral. Segments I–II, III–IV, X–XI, and XXVII–XXVIII are fused. Segmentation and setation pattern as follows (ancestral segment number-setae+aesthetasc): I–II-3+2ae, III–IV-4+3ae, V-2+ae, VI-2, VII-2+ae, VIII2+ae, IX-2, X–XI-4+ae, XII-1, XIII-1, XIV-2+ae, XV-1, XVI-2+ae, XVII-1, XVI-1, XIX-1, XX-1, XXI-1+ae, XXII-1, XXIII-1+ae, XXIV-1+1, XXV-1+1, XXVI-1+1, XXVII–XXVIII-5+ae. Ancestral segments I to XIV and XVI to XXV with a row of spinules on the posterior surface.

**Antenna** (Fig. 3B) biramous; coxa and basis separate, coxa with one and basis with two setae; endopod 2-segmented, proximal segment with two setae, compound distal segment bilobed with eight and seven plumose setae subterminally and terminally, respectively, outer margin ornamented with small serrated process subdistally on the medial margin; tiny spinule adjacent to serrated process; exopod 7-segmented, with intersegmental articulation between segments 2 and 3 not completely expressed, with setal formula of 1, 3, 1, 1, 1, 1, 3.

**Mandible** (Fig. 3C): well-developed coxal gnathobase, with a straight row of moderately incised teeth. Mandibular palp biramous; basis with four setae on the inner margin. Exopod 5-segmented, with setal formula of 1, 1, 1, 1, 2; endopod 2-segmented, proximal with four setae and distal segments with ten setae.

**Maxillule** (Fig. 3D): praecoxal arthrite bearing nine stout marginal spines and four elements on posterior surface, rows of tiny spinules on the posterior surface. Coxal epipodite with nine setae; coxal endite with three stiff setae. Basis with cluster of denticles on the anterior surface; proximal basal endite with four setae; distal basal endite indistinct, with five setae; no trace of basal exite. Exopod with eleven marginal setae and a row of setules along the distal portion of the medial margin. Endopod not articulated to basis, indistinctly 3-segmented, setal formula 4, 4, 7.

**Maxilla** (Fig. 3E): apparently 6-segmented, comprising coalesced praecoxa and coxa, allobasis and 3-segmented endopod. Armature of praecoxal and coxal endites
Figure 3. *Stephos jejuensis* sp. nov. Female paratype A antennule B antenna C mandible D maxillule E maxilla. Scale bars in µm.
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5,3,3,3. Basal endite with four setae, one stouter than the rest; endopodal endite with one seta on tip. Free endopod setal formula 1, 1, 3 respectively. Integument of praecoxa ornamented with patch of spinules on the posterior margin. Praecoxal and coxal endites with cluster of long spinules subdistally on the lateral surface; distal coxal endite with additional row of spinules proximally on the medial surface.

**Maxilliped** (Fig. 4A): syncoxa robust, with setal formula 1, 2, 2, 3 and oblique row of tiny spinules on the posterior distal part; basis with three setae and a row of setules on the mediolateral margin; endopod 6-segmented, with setal formula 2, 4, 4, 3, 3+1, 4.

**Legs 1–4** (Fig. 4B–E) progressively larger toward the posterior, each comprising coxa, basis, and 3-segmented exopod; endopod of leg 1 (Fig. 4B) 1-segmented, that of leg 2 (Fig. 4C) 2-segmented; endopods of P3 (Fig. 4D) and leg 4 (Fig. 4E) 3-segmented. Armature formula of legs 1–4 as follows (Roman numerals indicate spines, Arabic numeral indicates setae):

| Legs   | Coxa | Basis | Exopod | Endopod |
|--------|------|-------|--------|---------|
| Leg 1  | 0-0  | 0-1   | 0-0; 1-1; 1,1,3 | 0,2,3   |
| Leg 2  | 0-1  | 0-0   | 1-1; 1-1; 1,1,4 | 0-1; 1,2,2 |
| Legs 3 and 4 | 0-1 | 0-0 | 1-1; 1-1; 1,1,4 | 0-1; 1,2,2 |

Leg 1 (Fig. 4B) biramous, with long curved inner setae on the basis, and endopod with lobe on the outer margin, bearing a minute spinous process and a row of minute spinules on the anterior surface.

Leg 2 (Fig. 4C) biramous, endopod 2-segmented; coxa and basis unarmed; second endopodal segments with a row of spinules on the medial and distal edges, with a pointed process on the distolateral corner; exopod 3-segmented, with a row of spinules on the medio to distal margins of the distal exopodal segment.

Legs 3 (Fig. 4D) and 4 (Fig. 4E) biramous, with 3-segmented rami: coxa and basis unarmed; second and distal endopodal segments with a row of spinules on the distal edges, with a pointed process on each of the distolateral corners; exopod with a row of spinules on the medial to distal margins of the distal exopodal segment.

Leg 5 (Fig. 4F) symmetric, uniramous, 3-segmented with a proximal segment fused to intercoxal sclerite; basis separated, 2.27 times longer than wide (41 × 18 µm), widening distally with minute spinules on the anterior corner and an acute inner process, and unarmed. Distal segment with a transverse row of spinules across near the middle part and an outer seta medially.

**Description of male. Body** (Fig. 5A, B) robust, length 0.93 mm. Prosome 5-segmented; cephalosome and first pedigerous somites completely separated; fourth and fifth pedigerous somites incompletely fused (Fig. 5A). Rostrum same as in female. Prosome-uroscope ratio 2.18:1. Uroscope 5-segmented, comprising genital somite, three free abdominal somites, and anal somite; length ratio of genital somite, first to fourth free abdominal somites, and anal somite as 27.5: 19.2: 16.3: 14.5: 10.9: 11.5 = 100. Genital somite with asymmetric and protruding lobe on the left side. First to third ab-
Figure 4. *Stephos jejuensis* sp. nov. Female paratype A maxilliped B leg 1 C leg 2 D leg 3 E Leg 4 F Leg 5. Scale bars in μm.
dominal somites with transverse hyaline frill dorsally and ventrally. Anal somite shortest. Caudal rami similar to those of the female.

Antennule (Fig. 5C) symmetric, extending beyond the distal area of the genital double-somite; 24-segmented, apparently ancestral; segments I–II, III–IV, X–XI, and XXVII–XXVIII are fused. Segmentation and setation pattern as follows (ancestral segment number-setae+aesthetasc): I–II-3+2ea, III–IV-4+3ae, V-2+ae, VI-2, VII-2+ae, VIII2+ae, IX-2, X–XI-4+ae, XII-1, XIII-1, XIV-2+ae, XV-1, XVI-2+ae, XVII-1, XVI–II-1, XIX-1, XX-1, XXI-1+ae, XXII-1, XXIII-1+ae, XXIV-1+1, XXV-1+1, XXVI-1+1, XXVII–XXVIII-5+ae. Ancestral segments I–XIV and XVI–XXV with row of spinules on the posterior surface.

Antenna, mandible, maxillule, maxilla, maxilliped and legs 1–4 similar to those of the female.

Leg 5 (Fig. 5D–F), strongly asymmetric, slender on both sides, developed as a grasping organ on the left. Right leg 4-segmented; coxa and basis are short, unarmed, but thickened proximally; terminal segment comprising a single longer process (see arrowed in Fig. 5F), outwardly directed, curved medially, and acute at its tip. Left leg 5-segmented (see Fig. 5E); proximal segment ca. as long as right proximal segment; second segment with rounded outgrowth on medial margin; third segment elongated, unarmed; fourth segment narrow, shorter than third segment; terminal segment complex, with 5 terminal (long) and 5 subterminal (short) lamella spines.

Variations. Within this new species, there was a minor variation in the number of spinules on the genital double-somite and on the surfaces of legs 1–4 in both sexes.

Remarks. The genital double-somite in most species of Stephos has been found to be symmetric and/or slightly asymmetric in shape. The feature of an asymmetric genital somite in S. jejuensis sp. nov. is shared with five of its congeners, S. lamellatus Sars, 1902; S. tsuyazakiensis Tanaka, 1966; S. exumensis Fosshagen, 1970; S. kurilensis Kos, 1972; and S. robustus Ohtsuka & Hiromi, 1987. Of these, S. jejuensis has a projecting lobe on the distal margin in the lateral side of the genital double-somite; however, the other five species do not have this feature. Stephos jejuensis has been group IV.

In addition, S. jejuensis expresses by two diagnostic features: the fifth pedigerous somite is slightly asymmetric; and a projecting lobe in the lateral side of the genital double-somite. These features are shared by only one other species: S. jejuensis can be distinguished from S. maculosus (Bradford-Grieve 1999) by the following features in the female: the body length is 0.92 mm (vs. 0.62 mm in S. maculosus); dorsally the left side of the genital double-somite has anterior and posterior protruding lobes (vs. without protruding lobe in S. maculosus); the antennule extends beyond the distal area of the genital double-somite (vs. not beyond the distal area in S. maculosus); and the distal segment is less than four times longer than the second segment of leg 5 (vs. more than four times in S. maculosus). In the male: the body length is 0.93 mm (vs. 0.54 mm in S. maculosus); the antennule extends beyond the distal area of the genital double-somite (vs. beyond the anterior margin of the caudal rami in S. maculosus); on the leg 5 fourth
Figure 5. *Stephos jejuensis* sp. nov. Male paratype A habitus, dorsal view B habitus, lateral view C antennule D–F leg 5. Scale bars in µm.
segment of the male is narrow (vs. with a finger-like lobe on the medial expansion in *S. maculosus*); and the leg 5 terminal segment complex consists of five terminal (long) and five subterminal (short) lamella spines (vs. not complex, only with three lamella spines in *S. maculosus*).

*Stephos concavus* sp. nov.
http://zoobank.org/812ECEFE-53ED-4675-90C9-D631F3D40F0C
Figures 6–8

**Material examined.** *Holotype* ♀ (NIBRIV0000293109) dissected on two glass slides collected by D. H. Cho, 9 May 2012.

**Type locality.** Near the bottom (ca. 4 m depth), Wimi port, Jeju Island (approximately 33°16'13"N, 126°39'43"E), Korea.

**Description of female.** *Body* (Fig. 6A, B) robust, length 0.93 mm. Prosome 5-segmented; cephalosome and first pedigerous somites completely separated; fourth and fifth pedigerous somites incompletely fused (Fig. 6A), posterior corners of prosome slightly asymmetric. Rostrum represented by a rounded knob. Prosome-uropode ratio 2.25:1. Urosome 4-segmented, comprising genital double-somite, two free abdominal somites, and anal somite; length ratio of genital double-somite, first free abdominal somite, second free abdominal somite, and anal somite as 43.0:18.9:18.1:9.4:10.7 = 100. Genital double-somite (Fig. 6C–E) slightly asymmetric, with protruding lobe on the anterior to medial part of both sides and with a row of spinules in lateral view (Fig. 6C, D); common operculum located ventromedially slightly round (Fig. 6E) and with spermatophore and coupler in dorsal view (Fig. 6C). First and second abdominal somites (Fig. 6C), with transverse hyaline frill dorsally and ventrally. Anal somite shortest. Caudal rami with six setae, symmetric, 1.75 times longer than wide (49 × 28 µm); caudal setae II–VII present (seta I lacking); seta II spiniform, seta III ca. half the length of seta V, seta V longer (right longer than left) than seta IV, both plumose; dorsal seta VII short, plumose.

**Antennule** (Fig. 7A) symmetric, extending beyond distal area of genital double-somite; 24-segmented, apparently ancestral, segments I–II, III–IV, X–XI, and XXVII–XXVIII are fused. Segmentation and setation pattern as follows (ancestral segment number-setae+aesthetasc): I–II-3+2ae, III–IV-4+3ae, V-2+ae, VI-2, VII-2+ae, VIII2+ae, IX-2, X–XI-4+ae, XII-1, XIII-1, XIV-2+ae, XV-1, XVI-2+ae, XVII-1, XVI-1, XX-1, XXI-2+ae, XXII-1, XXIII-1+ae, XXIV-1+1+ae, XXV-1+1, XXVI-1+1, XXVII–XXVIII-5+ae. Ancestral segments I–XIV and XVI–XXV with row of spinules on posterior surface.

**Antenna** (Fig. 7B) biramous; coxa and basis separate, coxa with one and basis with two setae; endopod 2-segmented, proximal segment with two setae, compound distal segment bilobed with eight and seven plumose setae subterminally and terminally,
respectively, outer margin ornamented with a small serrated process subdistally on medial margin; tiny spinule adjacent to serrated process; exopod 7-segmented, with intersegmental articulation between segments 2 and 3 not completely expressed, with setal formula of 1, 3, 1, 1, 1, 1, 3.

Figure 6. Stephos concavus sp. nov. Female holotype A habitus, dorsal view B habitus, lateral view C urosome, dorsal view D urosome, lateral view E genital double-somite, ventral F leg 5. Scale bars in µm.
Mandible (Fig. 7C): well-developed coxal gnathobase, with a straight row of moderately incised teeth and patched spinules on the anterior and posterior corners. Mandibular palp biramous; basis with four setae on inner margin. Exopod 5-segmented, with setal formula of 1, 1, 1, 1, 2; endopod 2-segmented, proximal with 4 setae and distal segments with 10 setae.
Maxillule (Fig. 8A): praecoxal arthrite bearing nine stout marginal spines and four elements on posterior surface, rows of tiny spinules on the posterior surface. Coxal epipodite with nine setae; coxal endite with three stiff setae. Basis with cluster of denticles on the anterior surface; proximal basal endite with four setae; distal basal endite indistinct, with five setae; no trace of basal exite. Exopod with eleven marginal setae; with row of setules along the distal portion of the medial margin. Endopod not articulated to basis, indistinctly 3-segmented, setal formula 4, 4, 7.

Maxilla (Fig. 8B): apparently 6-segmented, comprising coalesced praecoxa and coxa, allobasis, and 3-segmented endopod. Armature of praecoxal and coxal endites 5, 3, 3, respectively. Basal endite with four setae, one stouter than the rest; endopodal endite with one seta on tip. Free endopod setal formula 1, 1, 3, respectively. Integument of praecoxa ornamented with a patch of spinules on the posterior margin. Praecoxal and coxal endites with a cluster of long spinules subdistally on the lateral surface; distal coxal endite with an additional row of spinules proximally on the medial surface.

Maxilliped (Fig. 8C): syncoxa robust, with setal formula 1, 2, 2, 3 and an oblique row of tiny spinules on the anterior distal part; basis with three setae and patched setules on the mediolateral margin; endopod 6-segmented, with setal formula 2, 4, 4, 3, 3+1, 4.

Legs 1–4 (Fig. 8D–G) progressively larger towards the posterior, each comprising coxa, basis, and 3-segmented exopod; endopod of leg 1 (Fig. 8D) 1-segmented, that of leg 2 (Fig. 8E) 2-segmented; endopods of leg 3 (Fig. 8F) and P4 (Fig. 8G) 3-segmented. Armature formula of legs 1–4 as follows in S. jejuensis sp. nov.

Leg 1 (Fig. 8D) biramous, with long curved inner setae on the basis, and endopod with lobe on the outer margin, bearing a minute spinous process and a row of minute spinules on the dorsal surface.

Leg 2 (Fig. 8E) biramous, endopod 2-segmented; coxa and basis unarmed; second endopodal segments with a row of spinules on medial and distal edges, with pointed process on the distolateral corner; exopod 3-segmented, with a row of spinules on the medio to distal margins of the distal exopodal segment.

Legs 3 (Fig. 8F) and 4 (Fig. 8G) biramous, with 3-segmented rami: coxa and basis unarmed; second and distal endopodal segments with a row of spinules on the distal edges, with a pointed process on each distolateral corner; exopod with row of spinules on the medio to distal margins of the distal exopodal segment, except for a row of spinules on the posterior surface of leg 4 basis.

Leg 5 (Fig. 6F) symmetric, uniramous, 3-segmented with a proximal segment fused to intercoxal sclerite; basis separated, 2.53 times longer than wide (38 × 15 µm) and unarmed. Distal segment constricted slightly at ca. mid-length with five large spinules and a large seta medially and with two rows of teeth on both lateral each sides as figured.

Male. Not collected.

Remarks. The new species Stephos concavus sp. nov. is easily recognized by its four diagnostic features in the female: the genital double-somite with a protruding lobe on
Figure 8. *Stephos concavus* sp. nov. Female holotype A maxillule B maxilla C maxilliped D leg 1 E leg 2 F leg 3 G leg 4. Scale bars in µm.
the anterior to medial part of both lateral sides; the presence of seven large rows of spinules on the left side of the genital double-somite; the basis of leg 5 is separated, 2.53 times longer than wide; and the presence of large spinules mediodistally on distal segment of leg 5.

The new species closely resembles *S. cryptospinosus* (Zagami et al. 2000), but it differs in the following features in the female: the body length is 0.93 mm (vs. 0.86 mm in *S. cryptospinosus*); the presence of seven spinules on the left side of the genital double-somite (vs. absence in *S. cryptospinosus*); the antennule extends beyond the distal end of the genital double-somite (vs. beyond the posterior margin of the prosome in *S. cryptospinosus*); the presence of large spinules on the mediodistal margin of leg 5 distal segment (vs. absence in *S. cryptospinosus*); and the terminal segment with teeth on both sides and large spinules mediodistally on both fifth legs (vs. absence in *S. cryptospinosus*).

*Stephos concavus* differs from another congener *S. longipes* (Giesbrecht, 1902) in the following features of the female: the genital double-somite with protruding lobe on the anterior to medial part of both sides (vs. triangular lobe on the medial part of both sides in *S. longipes*); the presence of a row of spinules on the left side of the genital double-somite (vs. absence in *S. longipes*); the absence of a row of minute spinules on the dorsodistal surface of the genital double-somite (vs. presence in *S. longipes*); the leg 5 distal segment is tapering and stout (vs. tapering and not stout in *S. longipes*); and the teeth on the outer margin of both sides (vs. finely serrated fringe on the outer margin in *S. longipes*).

*Stephos fortipes* sp. nov.
http://zoobank.org/C726634A-9A85-4966-B9B1-B63AA83DA929
Figures 9–11

**Material examined.** *Holotype* ♀ (NIBRIV0000293110) dissected on a glass slide collected by D. H. Cho, 9 May 2012.

**Type locality.** Near the bottom (ca. 4 m depth), Wimi port, Jeju Island (approximately 33°16′13″N, 126°39′43″E), Korea.

**Etymology.** The specific name *fortipes* is the combination of Latin words *fortis* (strong) and *pes* (leg), alluding to the strong feature of the female fifth leg.

**Description of female.** *Body* (Fig. 9A, B) robust, length 1.12 mm. Prosome five-segmented; cephalosome and first pedigerous somites completely separated; fourth and fifth pedigerous somites incompletely fused (Fig. 9A), posterior corners of prosome slightly asymmetric. Rostrum represented by a rounded knob. Prosome-urosome ratio 2.45:1. Urosoome 4-segmented, comprising a genital double-somite, two free abdominal somites, and anal somite; length ratio of genital double-somite, first free abdominal somite, second free abdominal somite, and anal somite as 39.1: 18.7: 17.1:15.1:10.0 = 100. Genital double-somite (Fig. 9C, E) slightly asymmetric with a differing groups
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Figure 9. *Stephos fortipes* sp. nov. Female paratype A habitus, dorsal view B habitus, lateral view C urosome, dorsal view D urosome, lateral view E genital double-somite, ventral view F caudal rami, dorsal view. Scale bars in µm.
of minute spinules on each side, anterior to mid-length; on the left side is a group of minute spinules that tend to be obscured by detritus and difficult to observe, patches and rows of fine spinules on the right side; genital double-somite not produced ventrally, operculum slightly round, with rows of spinules on the ventral surface. First and second abdominal somites (Fig. 9C), with transverse hyaline frill dorsally and ventrally. Anal somite shortest. Caudal rami (Fig. 9F), with six setae, symmetric, 1.19 times longer than wide (56 × 47 µm), with minute spinules on the dorsal surface; caudal setae II to VII present (seta I lacking); seta II spiniform, seta III ca. half the length of seta V, seta V longer (right longer than left) than seta IV, both plumose; dorsal seta VII short, plumose.

**Antennule** (Fig. 10A) symmetric, extending near to distal area of genital double-somite; 24-segmented, apparently ancestral, segments I–II, III–IV, X–XI, and XXVII–XXVIII are fused. Segmentation and setation pattern as follows (ancestral segment number-setae+aesthetasc): I–II-3+ae, III–IV-4+3ae, V-2+ae, VI-2, VII-2+ae, VIII2+ae, IX-2, X-XI-4+ae, XII-1, XIII-1, XIV-2+ae, XV-1, XVI-2+ae, XVII-1, XVIII-1, XIX-1, XX-1, XXI-1+ae, XXII-1, XXIII-1, XXIV-1+1, XXV-1+1, XXVI-1+1, XXVII–XXVIII-5+ae. Ancestral segments I–XIV and XVI–XXV with a row of spinules on the posterior surface.

**Antenna** (Fig. 10B) biramous; coxa and basis separate, coxa with one and basis with two setae; endopod 2-segmented, proximal segment with two setae, compound distal segment bilobed with eight and seven plumose setae subterminally and terminally, respectively, outer margin ornamented with a small serrated process subdistally on the medial margin; tiny spinule adjacent to the serrated process; exopod 7-segmented, with intersegmental articulation between segments 2 and 3 not completely expressed, with setal formula of 1, 3, 1, 1, 1, 1, 3.

**Mandible** (Fig. 10C): well-developed coxal gnathobase, with a straight row of moderately incised teeth, ornamented with spinule rows on the medioventral part. Mandibular palp biramous; basis with four setae on inner margin. Exopod 5-segmented, with setal formula of 1, 1, 1, 1, 2; endopod 2-segmented, proximal with four setae and distal segments with ten setae.

**Maxillule** (Fig. 10D): praecoxa and coxa incompletely fused; praecoxal arthrite with ten marginal spines plus four stiff setae on posterior surface, rows of tiny spinules on posterior surface. Coxal epipodite with nine setae; coxal endite with three stiff setae. Basis with cluster of denticles on the anterior surface; proximal basal endite with four setae; distal basal endite indistinct, with five setae; no trace of basal exite. Exopod with eleven marginal setae. A row of setules along the distal portion of the medial margin. Endopod not articulated to basis, indistinctly 3-segmented, setal formula 4, 4, 7.

**Maxilla** (Fig. 10E): apparently 6-segmented, comprising coalesced praecoxa and coxa, allobasis, and 3-segmented endopod. Armature of praecoxal and coxal endites 5,3,3,3, respectively. Basal endite with four setae, one stouter than the rest; endopodal endite with one seta on tip. Free endopod setal formula 1, 1, 3, respectively. Integument of praecoxa ornamented with patch of spinules on the posterior margin. Prae-
Figure 10. *Stephos fortipes* sp. nov. Female paratype A antennule B antenna C mandible D maxillule E maxilla F maxilliped. Scale bars in µm.
coxal and coxal endites with a cluster of long spinules subdistally on the lateral surface; distal coxal endite with an additional row of spinules proximally on the medial surface.

**Maxilliped (Fig. 10F):** syncoxa robust, with setal formula 1, 2, 2, 3 and an oblique row of tiny spinules on the posterior distal part; basis with three setae and a row of setules on the mediolateral margin; endopod six-segmented, with setal formula 2, 4, 4, 3, 3+1, 4.

**Legs 1–4** (Fig. 11A–D), progressively larger towards posterior, each comprising coxa, basis, and 3-segmented exopod; endopod of leg 1 (Fig. 11A) 1-segmented, that of leg 2 (Fig. 11B) 2-segmented; endopods of leg 3 (Fig. 11C) and P4 (Fig. 11D) 3-segmented. Armature formula of legs 1–4 as in *S. jejuensis* sp. nov.

Leg 1 (Fig. 11A) biramous, coxa with hairs and spinules on the inner and posterior surfaces; basis with a row of spinules on the inner distal corner and long, curved inner setae, and endopod with a lobe on the outer margin, bearing a minute spinous process; second and distal exopodal segments with patched minute spinules; second and terminal exopodal segment with a row of spinules on the posterior margin.

Leg 2 (Fig. 11B) biramous, endopod 2-segmented; coxa with hairs on the inner margin, row of spinules on the posterior surface; basis unarmed; each first and second endopodal with row of spinules on the medial and distal edge, with pointed process on distolateral corner; exopod 3-segmented, with a row of spinules on the medio to distal margins of distal exopodal segment.

Legs 3 (Fig. 11C) and 4 (Fig. 11D) biramous, with 3-segmented rami: coxa with hairs on the inner margin and a row of spinules on the anterior surface; first to distal endopodal segments with a row of spinules on distal edges, with pointed process on each distolateral corner; exopod with a row of spinules on the medio to distal margins of distal exopodal segment.

Leg 5 (Fig. 11E) symmetric, uniramous, 3-segmented with proximal segment fused to intercoxal sclerite; basis separated from the single, tapering terminal segment. Second segment (basis) 1.38 times longer than wide (44 × 32 µm), with an antero-medial patch of minute spinules on the anterior surface. Distal segment constricted slightly at ca. mid-length with seven large spinules and inner stout spine and with two rows of denticles along the tapering portion.

**Male.** Not collected.

**Variations.** Within this new species, there was a minor variation in the number of spinules on the genital double-somite and on the surfaces of legs 1–4 in the female.

**Remarks.** The new species closely resembles its congeners *S. angulatus* Bradford-Grieve, 1999, *S. hastatus*, and *S. pacificus* Ohtsuka & Hiromi, 1987; however, it differs in the following characteristics in the female: the antennule extends to the end of the genital double-somite (vs. first abdominal segment end in *S. angulatus*, and fifth pedigerous end in *S. hastatus* and *S. pacificus*); the operculum is slightly round (vs. triangular in three species); and the stout and present large row of spinules on the terminal tapering part of leg 5 (vs. not stout and absent in three species).
Figure 11. *Stephos fortipes* sp. nov. Female paratype A leg 1 B leg 2 C leg 3 D leg 4 E leg 5, dorsal view. Scale bars in μm.
Discussion

The benthopelagic copepod fauna of the Korean peninsula was previously surveyed (Soh et al. 2013; Moon et al. 2014, 2015). They recorded five species: *Sarsarietelus orientalis*, Soh et al., 2013, offshore of Yogji and Maemul Island, southern Korea; *Stephos geojinensis* from the Geojin fishery port in eastern Korea; *S. pacificus* from the shallow waters of Jangeong beach in southern Korea; and *Bobolina ganghwensis*, Moon & Soh, 2014, from Ganghwa Island in western Korea. The morphological characteristics of the genus *Stephos*, and a key to identifying the species were provided by Boxshall and Halsey (2004). Taxonomic analysis of closely related species of *Stephos* is based on the subtle morphological characters by Bradford-Grieve (1999) and Suárez-Morales et al. (2017). Bradford-Grieve (1999) categorized the species of the genus by analyzing the fourth segments of the male left fifth leg into four types. In this study, seven species in the Australian-Western Pacific region belong to “group IV”, where the fourth segment of the male left fifth leg is narrow, as follows: *S. angulatus* Bradford-Grieve, 1999; *S. geojinensis* Moon, Youn, & Venmathi Maran, 2015; *S. jejuensis* sp. nov., *S. morii* Greenwood, 1977; *S. pacificus* Ohtsuka & Hiromi, 1987; *S. pentacanthos* Chen & Zhang, 1965; and *S. tsuyazakiensis* Tanaka, 1967 (Table 1). The zoogeographic analysis presented based on the structural patterns of the female fifth leg by Suárez-Morales et al. (2017), grouped the 29 species of *Stephos* together. The three new species described here belong to “group A”, where lateral setae are present and segments are apically elongate. This primitive “group A” is the most widespread, present in the most diverse regions (Suárez-Morales et al. 2017).

Most species of *Stephos* are frequently found in hyperbenthic and epibenthic habitats of tropical to polar regions (Boxshall and Halsey 2004; Jaume et al. 2008; Kršinić 2015; Moon et al. 2015; Suárez-Morales et al. 2017), and are occasionally recorded in anchialine caves (Boxshall et al. 1990; Riera et al. 1991; Carola and Razouls 1996; Jaume et al. 2008; Suárez-Morales et al. 2017). However, in this study, the three new species were collected at night using a plankton net in shallow waters. Other stephids have also occurred in plankton samples collected at night in coastal waters (Kos 1972; Ohtsuka and Hiromi 1987; Costanzo et al. 2000; Zagami et al. 2000; Moon et al. 2015). These facts suggest that benthopelagic calanoids could undertake daily vertical migrations (Zagami et al. 2000; Moon et al. 2015) and also diel feeding rhythm, reproduction, molting, dispersal, and niche diversification (Allredge and King 1980).

The stephids comparisons of morphological features between the three new species of Korean fauna and the all species of genus *Stephos* are based on both sexes in the World. *Stephos* shares many of the characteristics of *Miostephos* Bowman, 1976, but differs in that the right fifth leg in female is 4-segmented and the male right fifth leg ends in an unarmed claw and/or mitten-like segment in *Stephos* (Boxshall and Halsey 2004; Kršinić 2015). According to Suárez-Morales et al. (2017), the structure of the female fifth leg is of great significance in the taxonomy of stephids. These characteristics were used in the keys to species of *Stephos* by Suárez-Morales et al. (2017). Here the following combination of features are used in order to separate
### Table 1. Comparison of morphological characteristics of *Stephos* spp.

| Character | *Stephos angulatus* Bradford-Grieve, 1999 | *Stephos antarcticum* Wolfenden, 1908 | *Stephos arcticus* Sars, 1909 | *Stephos boettgerschnackei* Kršinić, 2012 | *Stephos canariensis* Boxshall, Stock & Sanchez, 1990 | *Stephos concavus* sp. nov. | *Stephos cryptospinosus* Zagani, Campolimi & Costanzo, 2000 |
|-----------|-------------------------------------------|--------------------------------------|-------------------------------|---------------------------------------------|---------------------------------------------|---------------------------------|-----------------------------------------------|
| **Female** |                                           |                                      |                               |                                             |                                             |                                 |                                 |
| Body length (mm) | 0.82           | 1.85–2.0                     | 1.20                         | 0.89–0.93                          | 0.64–0.69                          | 0.93                                 | 0.86                                    |
| Posterolateral corners | symmetrical | slightly asymmetrical | slightly asymmetrical | asymmetrical | asymmetrical | asymmetrical | symmetrical | symmetrical |
| Shape of genital double–somite | asymmetrical | symmetrical, lateral sweling on both side | asymmetrical, lateral sweling on left side | symmetrical | slightly asymmetrical | asymmetrical, convex on posterior corner | symmetrical | symmetrical |
| Operculum shape of genital double–somite | triangular | –                           | –                            | –                           | rounded                            | –                           | rounded | rounded |
| Ornamentation of genital double–somite | fringe of fine spines on left side | long spines on both side | –                            | –                           | –                                   | left side with 7 row spines | –                           | –                           |
| Antennule extention | distal margin of first abdominal segment | distal margin of second abdominal segment | distal margin of fifth pedigerous somite | distal margin of caudal rami | distal margin of fifth pedigerous somite | distal margin of genital double–somite | distal margin of fifth pedigerous somite | |
| Row of spinules on basis of fifth legs | absent | absent | absent | absent | present | absent | present | present |
| Shape of third segment of fifth legs | tapering | tapering | conical | tapering | tapering, short | tapering, short | tapering, short | tapering, short |
| Large spinules of third segment of fifth legs | absent | absent | absent | absent | present | present | absent | absent |
| Outer seta on third segment of fifth legs | present | absent | present | present | present | present | present | present |
| Terminal distal part of the segment of fifth legs | curved, distal portion bordered by coarse teeth | curved, strongly serrate process apically | scarcely denticles on distal half of lateral margin | scattered denticles both side | scattered denticles both side | scattered denticles both side | finely serrated fringe on outer margin | |
| **Male** |                                           |                                      |                               |                                             |                                             |                                 |                                 |
| Body length (mm) | 0.703        | 1.75                        | 1.05                         | 0.82–0.9 | 0.59–0.64 | –                           | 0.78                                    |
| Posterolateral corners | symmetrical | asymmetrical | –                            | asymmetrical | symmetrical | symmetrical | symmetrical | symmetrical |
| Shape of genital somite | asymmetrical, with genital aperture on the left | symmetrical | asymmetrical | symmetrical | symmetrical | symmetrical | symmetrical | symmetrical |
| Antennule extention | distal margin of fifth pedigerous end | second abdominal segment end | distal margin of fifth pedigerous end | end of caudal rami | about to posterior border of genital somite | – | approximately to posterior margin of genital somite | |
| Type of left segment of P5 | left segment 4 narrow, segment 5 bifurcate without leaf–like elements | left segment 4 swollen, segment 5 with leaf–like elements | left segment 4 swollen, segment 5 with leaf–like elements | left segment 4 swollen, segment 5 with leaf–like elements | left segment 4 swollen, segment 5 with leaf–like elements | left segment 4 swollen, segment 5 with leaf–like elements | |
### Table 1. Continued.

| Character                                                                 | Stephos deichmannae Fleming, 1957 | Stephos exumensis Fossahagen, 1970 | Stephos fernandez Sierra-Morales, Gutiérrez-Aguirre, Cervantes-Martínez & Illife, 2017 | Stephos fortipes sp. nov. | Stephos fultoni Scott T. & Scott A., 1898 | Stephos geojinensis Moon et al., 2015 | Stephos grieseae Kršinić, 2015 |
|--------------------------------------------------------------------------|----------------------------------|------------------------------------|---------------------------------------------------------------------------------|--------------------------|-------------------------------------|-----------------------------------|---------------------------------|
| **Female**                                                               |                                  |                                    |                                                                                 |                          |                                     |                                   |                                 |
| Body length (mm)                                                         | 0.62–0.73                        | 0.73                               | 0.47                                                                           | 1.12                     | 1.00                                | 0.88                              | 0.60–0.67                       |
| Posterolateral corners                                                  | asymmetrical                     | asymmetrical                       | symmetrical                                                                     | symmetrical              | symmetrical                         | symmetrical                       | symmetrical                      |
| Shape of genital double–somite                                          | asymmetrical                     | asymmetrical, protruding lobe on left side | symmetrical                                                                     | symmetrical              | symmetrical, protruding lobe on both side | symmetrical                       |                                 |
| Operculum shape of genital double–somite                                | –                                | –                                  | rounded                                                                        | rounded                  | –                                   | rounded                           | rounded                         |
| Ornamentation of genital double–somite                                   | present                          | present                            | row of minute spinules on ventral surface                                     | present                  | –                                   | –                                 | –                              |
| Antennule extension                                                      | –                                | –                                  | posterior margin of preanal somite                                             | distal margin of genital double–somite | –                                   | –                                 | –                              |
| Row of spinules on basis of fifth legs                                   | present                          | present                            | absent                                                                         | present                  | present                             | absent                            | present                        |
| Shape of third segment of fifth legs                                    | tapering                         | tapering                           | cylindrical                                                                     | tapering, stout          | asymmetrical, right leg longer than left | tapering, elongated              | tapering, elongated              |
| Large spinules of third segment of fifth legs                            | absent                           | present                            | absent                                                                         | present (spine)          | absent                              | present                           | present                        |
| Outer seta on third segment of fifth legs                                | absent                           | absent                             | absent                                                                         | present (spine)          | absent                              | present                           | present                        |
| Terminal distal part of the segment of fifth legs                        | row of spinules on distal half of lateral margin | finely serrated fringe on outer margin | spiniform bipinnated apical process                                           | distal potion bordered by fringe teeth | coarsely serrated spine incorporated distally | single small spine on anterior surface |                                 |
| **Male**                                                                 |                                    |                                    |                                                                                 |                          |                                     |                                   |                                 |
| Body length (mm)                                                         | 0.61–0.66                        | –                                  | 0.49                                                                           | –                        | 1                                   | 0.819                             | 0.55–0.62                      |
| Posterolateral corners                                                  | asymmetrical                     | –                                  | symmetrical                                                                     | –                        | symmetrical                         | symmetrical                       | symmetrical                      |
| Shape of genital somite                                                  | asymmetrical                     | –                                  | symmetrical                                                                     | –                        | symmetrical, with lateral lobe at each side | slightly asymmetrical     |                                 |
| Antennule extension                                                      | –                                | –                                  | beyond distal margin of second urosomite                                        | –                        | distal margin of second urosomite   | distal margin of third urosomite |                                 |
| Type of left segment of P5                                               | left segment 4 swollen            | –                                  | left segment 4 narrow, segment 5 bufurcate without leaf–like elements         | –                        | left segment 4 swollen              | left segment 4 narrow             | left segment 4 narrow           |
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| Table 1. Continued. |
|----------------------|
| **Character**        | **Stephos cyaneus (Giesbrecht, 1893)** | **Stephos hnemae Kuroda, 1999** | **Stephos hyouiki Kuroda, 1994** | **Stephos laevis Giesbrecht, 1902** |
| Body length (mm)     | 0.9–1.0 | 0.72–0.80 | 0.6–0.7 | 0.6–0.7 |
| Posteralateral corners | symmetrical | asymmetrical | asymmetrical | asymmetrical |
| Shape of genital double–somatic | symmetrical | asymmetrical, round | asymmetrical | asymmetrical |
| Ornamentation of genital double–somatic | row of spinules, distal margin | spinules on ventral surface | spinules on ventral surface | spinules on ventral surface |
| Antennule extension | absent | present | present | absent |
| Row of spinules on basis of third segment of third legs | absent | tapering, curved | tapering | absent |
| Shape of third segment of third legs | tapering, curved | tapering | tapering | tapering |
| Large spinules of third segment of third legs | present | present | present | present |
| Outer seta on third segment of third legs | absent | present | present | present |
| Terminal distal part of third segment of third legs | strongly serrate | strongly serrate | strongly serrate | strongly serrate |

**Male**

| Character | **Stephos cyaneus (Giesbrecht, 1893)** | **Stephos hnemae Kuroda, 1999** | **Stephos hyouiki Kuroda, 1994** | **Stephos laevis Giesbrecht, 1902** |
|-----------|--------------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Body length (mm) | 0.94 | 1.00 | 1.24 | 1.00 |
| Posteralateral corners | symmetrical | asymmetrical, round | asymmetrical | asymmetrical |
| Shape of genital somite | symmetrical | asymmetrical | asymmetrical, with protruding lobe | asymmetrical |
| Ornamentation of genital somite | row of spinules, distal margin | spinules on ventral surface | spinules on ventral surface | spinules on ventral surface |
| Antennule extension | distal margin of second urosomite | tapering, curved | tapering, curved | tapering, curved |
| Left leg of P5 | left leg 4 swollen, segment 5 with egg-like elements | left leg segment 4 swollen | left leg segment 4 swollen | left leg 4 swollen, segment 5 with egg-like elements |

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**Type of left segment of P5**

- *Stephos cyaneus* | left leg 4 swollen, segment 5 with egg-like elements
- *Stephos hnemae* | left leg segment 4 swollen
- *Stephos hyouiki* | left leg segment 4 swollen
- *Stephos laevis* | left leg segment 4 swollen
| Character                          | *Stephos maurus* Andronov, 1974 | *Stephos margarifii Riera, Vives & Gili, 1991 | *Stephos marsaleensis* Costanzo, Campomai & Zagami, 2000 | *Stephos minor* Scott T., 1892 | *Stephos morii* Greenwood, 1978 | *Stephos pacificus* Ohtsuka and Hiromi, 1987 | *Stephos pentacanthos* Chen and Zhang, 1965 |
|----------------------------------|----------------------------------|-----------------------------------------------|-------------------------------------------------|-------------------------------|---------------------------------|-------------------------------------------|---------------------------------|
| **Female**                       |                                  |                                               |                                                 |                               |                                 |                                           |                                 |
| Body length (mm)                 | 0.86                             | 0.77–0.80                                     | 0.76                                            | 0.73                          | –                               | 0.73                                      | –                               |
| Posterolateral corners           | slightly asymmetrical            | symmetrical                                   | Slightly symmetrical                            | slightly asymmetrical         | –                               | symmetrical                               | –                               |
| Shape of genital double–somite   | symmetrical                      | symmetrical                                   | symmetrical                                     | symmetrical                   | –                               | symmetrical                               | –                               |
| Operculum shape of genital double–somite | –                              | –                                             | –                                                | –                             | –                               | –                                         | –                               |
| Ornamentation of genital double–somite | absent                         | –                                             | Row of minute spinules dorsolaterally           | –                             | –                               | row of minute spinules on both side   | –                               |
| Antennule extension              | distal margin of caudal rami     | distal margin of second urosomite             | Posterior margin of first urosomite             | beyond of genital double–somite | –                               | fifth pedigerous end                     | –                               |
| Row of spinules on basis of fifth legs | absent                        | absent                                        | absent                                          | absent                        | –                               | present                                   | –                               |
| Shape of third segment of fifth legs | tapering, curved                | tapering, stouted                              | asymmetrical                                    | tapering, stouted             | –                               | tapering                                   | –                               |
| Large spinules of third segment of fifth legs | absent                     | absent                                        | present                                         | absent                        | –                               | absent                                    | –                               |
| Outer seta on third segment of fifth legs | absent                      | present                                       | present                                         | absent                        | –                               | absent                                    | –                               |
| Terminal distal part of the segment of fifth legs | strongly serrate process apically | strongly serrate process with patch of spinules on proximal anterior surface | scarcely denticuls on distal half of lateral margin | – | striated hyaline | – | –                               |
| **Male**                         |                                  |                                               |                                                 |                               |                                 |                                           |                                 |
| Body length (mm)                 | 0.54                             | 0.74                                          | 0.73                                            | 0.6                           | 0.85                            | 0.62                                      | 0.75                            |
| Posterolateral corners           | slightly asymmetrical            | asymmetrical                                   | symmetrical                                     | asymmetrical                 | asymmetrical                   | slightly asymmetrical, asymmetrical, produced | –                               |
| Shape of genital somite          | symmetrical                      | asymmetrical                                   | symmetrical                                     | symmetrical, more             | asymmetrical, more              | asymmetrical with protruding        | –                               |
| Antennule extension              | distal margin of fourth urosomite | –                                             | Posterior margin of second urosomite           | end of last pedigerous somite | distal margin of third urosomite | distal margin of fifth pedigerous somite | distal margin of second urosomite |
| Type of left segment of P5       | left leg segment 4 swollen       | left leg segment 4 swollen                     | left segment 4 narrow                           | left segment 4 narrow         | left segment 4 narrow            | left segment 4 narrow                  | left segment 4 narrow             |
Table 1. Continued.

| Character                        | Stephos projectus | Stephos robustus Ohtsuka and Hiromi, 1987 | Stephos rustadi Strømøøen, 1969 | Stephos scotti Sars, 1902 | Stephos tropicus Mori, 1942 | Stephos tropazakiensis Tanaka, 1967 | Stephos vivesi Jaume, Boxshall & Gràcia, 2008 |
|----------------------------------|-------------------|------------------------------------------|---------------------------------|--------------------------|-------------------------------|----------------------------------------|---------------------------------|
| **Female**                       |                   |                                          |                                 |                          |                               |                                        |                                 |
| Body length (mm)                 | 1.51              | 1.01                                     | 0.68                            | 0.95                     | 0.82                          | 0.78                                   | 0.45                            |
| Posterior lateral corners        | asymmetrical      | asymmetrical                             | symmetrical                     | asymmetrical             | symmetrical                   | asymmetrical                          | asymmetrical                    |
| Shape of genital double–somite   | asymmetrical, elongated | asymmetrical, lateral swelling on both sides | asymmetrical, lateral swelling on both sides | symmetrical | symmetrical | swelling on the left side | symmetrical |
| Operculum shape of genital double–somite | bumpy            | fringed                                  | absent                          | absent                   | absent                        | paired genital opercular plates       |                                 |
| Ornamentation of genital double–somite | patch spinules on dorsal surface | row of spinules on anterior margin | -                              | absent                   | -                            | row of spinules on ventrolateral spinules | row of spinules on dorso-lateral margin |
| Antennule extension              | distal margin of fifth pedigerous somite | distal margin of fifth pedigerous somite | beyond of fifth pedigerous somite | distal margin of second urosomite | -                            | distal margin of genital segment | beyond posterior margin of fifth pedigerous somite |
| Row of spinules on basis of fifth legs | absent           | present                                  | absent                          | absent                   | absent                        | absent                                 |                                 |
| Shape of third segment of fifth legs | tapering, elongated | tapering                                 | absent                          | tapering                 | tapering                      | tapering                              | tapering, stout                   |
| Large spinules of third segment of fifth legs | absent          | present                                  | absent                          | absent                   | absent                        | present                               | absent                          |
| Outer seta on third segment of fifth legs | present         | present                                  | present                         | present                  | absent                        | absent                                | present                         |
| Terminal tapering part of the segment of fifth legs | curved, distal potion furnished | curved, distal potion both sides | finely serrated fringe on outer margin | row of denticles on distal margin | finely serrated fringe on outer margin | row of spinules on distal margin | two rows of denticles on distal part |
| **Male**                         |                   |                                          |                                 |                          |                               |                                        |                                 |
| Body length (mm)                 | 0.93              | 0.91                                     | 0.62                            | 0.85                     | 0.73                          | 0.73                                   | 0.44-0.45                       |
| Posterior lateral corners        | asymmetrical, with lateral lobe on left margin | asymmetrical | symmetrical | -                        | -                            | asymmetrical, slightly produced on the left side | slightly asymmetrical |
| Shape of genital double–somite   | asymmetrical with protruding lobe on left side | asymmetrical, spinules on lateral margin | symmetrical | -                        | -                            | asymmetrical, produced on the left side | asymmetrical, produced laterally on left side |
| Antennule extension              | distal margin of fifth pedigerous somite | distal margin of fifth pedigerous somite | distal margin of third urosomite | distal margin of third urosomite | distal margin of second urosomite | distal margin of second urosomite | beyond posterior margin of fifth pedigerous somite |
| Type of left segment of fifth leg | left segment 4 swollen | left segment 4 swollen | left segment 4 narrow | left segment 4 swollen | left segment 4 narrow | left segment 4 narrow | left segment 4 narrow |

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species: (1) the body length in both sexes; (2) the shape of postero-lateral corners in both sexes; (3) the shape and ornamentations of the genital double-somite in females; (4) the presence and/or absence of spinules on the caudal rami in both sexes; (5) the antennule extension in both sexes; and (6) the ornamentation and shape of fifth legs in both sexes.

The principal differences between the three new species and their congeners are summarized in Table 1. Although some features occasionally overlap within the all species considered herein, the characteristic combinations proposed are different for each species, showing them to be essential diagnostic elements. These morphological characteristics were very useful and important criteria for identifying each species of stephids.

To date, the genus *Stephos* consists of 35 valid species, including those described herein (Boxshall and Halsey 2004; Jaume et al. 2008; Kršinić 2012, 2015; Moon et al. 2015; Suárez-Morales et al. 2017; this study). Additionally, most of the genus *Stephos* species were not described following modern standards, and most of them need to be redescribed. Thus, the taxonomy, morphological variability, and distribution of stephids are well understood (Bradford-Grieve 1999; Moon et al. 2015; Suárez-Morales et al. 2017). These facts suggest that more detailed research on its taxonomy, biodiversity, and molecular features is necessary for a better understanding of its evolutionary history.

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