

A new species of *Centropages* (Copepoda: Calanoida) from the neritic waters of Sharm El-Sheikh, the Red Sea

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A new species of calanoid copepod, Centropages uedai sp. nov., is described from the neritic waters of the northern Red Sea. This species is characterized by: (1) symmetry of a globular female genital double-somite that is ornamented with an anterior irregular group of spinules as well as transverse and dorsolateral rows of spinules on each side; (2) second exopodal segment of female leg 5 bearing a strong trough medial process serrated along the distal 4/5 of its posterior margin; (3) second exopodal segment of male right leg 5 serrated laterally along distal 1/5 of its medial process; (4) third exopodal segment of male right leg 5 with medial seta bifurcated at its tip and with hyaline ridge on both sides; and (5) second exopodal segment of male right leg 4 asymmetrical with undulating, thicker and longer lateral spine than left leg. The new species does not belong to any known species groups of the genus.

Keywords: *Centropages uedai*, copepods, new species, northern Red Sea

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INTRODUCTION

Knowledge of the Red Sea plankton is limited and incomplete when compared to other marine waters. Most observations of the Red Sea plankton by earlier workers were based on a limited number of samples taken exclusively from oceanic waters (Weikert, 1987). However, during the last three decades studies of the Red Sea have resulted in the descriptions of planktonic copepod new species from the northern Gulf of Aqaba (Almeida Prado-Por, 1984), the oceanic water of the central Red Sea (Boxshall & Böttger, 1987; Böttger-Schnack & Boxshall, 1990; Böttger-Schnack, 1992, 1999, 2002, 2003, 2005; Huys & Conroy-Dalton, 2000), and the neritic waters around Sharm El-Sheikh area (Ohtsuka *et al.*, 2000; El-Sherbiny & Ueda, 2008a). Some species represented new records for the Red Sea (El-Sherbiny, 1997, 2009; El-Sherbiny & Ueda, 2008b) while others remained under study. Most of these species belong to genera with wide biogeographical distribution patterns (e.g. *Centropages*, *Labidocera*, *Oncaea* and *Pontella*).

The Centropagidae is a remarkable family of copepods found in a wide range of environments, from fresh to marine waters and from low to high latitudes (Vervoort, 1964; Bradford-Grieve, 1999; Bradford-Grieve *et al.*, 1999; Boxshall & Halsey, 2004). The genus *Centropages* Krøyer, 1849 is one of the dominant centropagids in marine epipelagic waters (Bradford-Grieve *et al.*, 1999), accommodating 31 nominal species (Razouls *et al.*, 2009). So far, eight species have been recorded from the Red Sea (Halim, 1969; El-Sherbiny & Ueda, 2008a), namely, *Centropages aegypticus* El-Sherbiny &

Ueda, 2008, *C. calaninus* Dana, 1849, *C. elongatus* Giesbrecht, 1896, *C. furcatus* (Dana, 1849), *C. gracilis* (Dana, 1849), *C. kroyeri* Giesbrecht, 1892, *C. orsinii* Giesbrecht, 1889 and *C. violaceus* (Claus, 1863). In this paper, a new species of *Centropages* is described from the neritic waters of Sharm El-Sheikh area, in the northern Red Sea.

MATERIALS AND METHODS

Centropages specimens were sorted from neritic zooplankton samples collected with a plankton net (diameter 40 cm and mesh size 100 µm). The net was towed close to the surface at daytime for about 5 minutes at a speed of 1.5–2 knots. Samples were fixed immediately after collection in 4% buffered formalin–seawater solution. Individuals of the new species were isolated and preserved in 70% alcohol. They were dissected in lactophenol and examined with a differential interference microscope (Nikon, E600). Drawings and measurements were made with the aid of a camera lucida and an ocular micrometer. Terminology used follows Huys & Boxshall (1991). The type specimens were deposited at the National Science Museum, Tokyo, Japan (NSMT).

Study area

Sharm El-Maya Bay, the type locality of the new species, is located at the entrance of Sharm El-Sheikh city, in the northern Red Sea (Figure 1). It is a small, shallow, semi-enclosed bay (3–9 m depth); bottom sediments are soft. Salinities range from 40.5 to 41.5; water temperatures fluctuate between 22.7 and 30.9°C, and the chlorophyll-*a* concentration is relatively high compared to offshore waters, with an average of 0.8 mg/m³ (El-Sherbiny, 1997; Aamer *et al.*, 2006).

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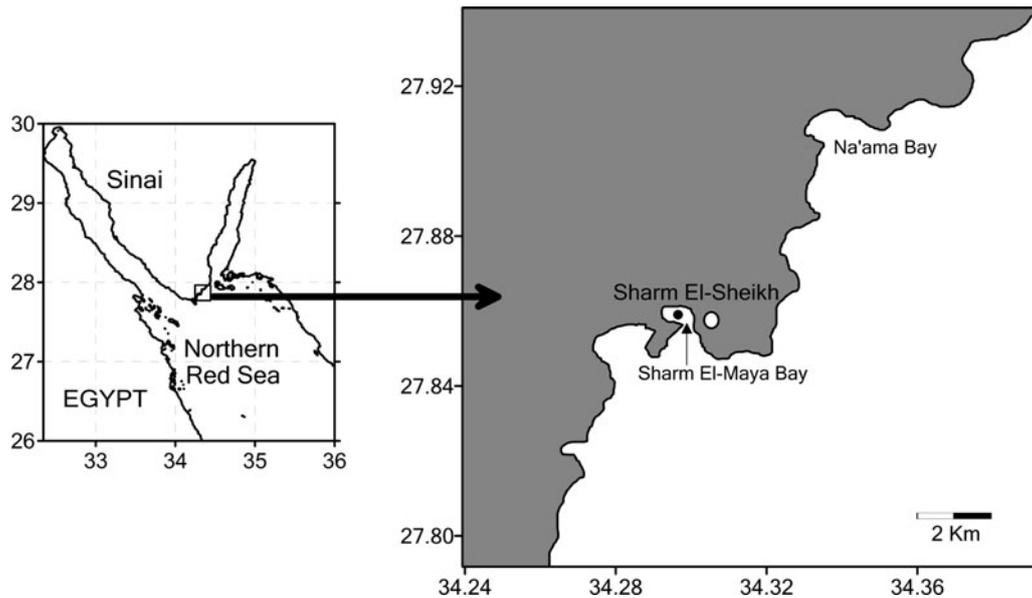


Fig. 1. Sampling site (closed circle) of *Centropages uedai* sp. nov. in Sharm El-Maya Bay, the northern Red Sea.

RESULTS

SYSTEMATICS

- Subclass COPEPODA Milne-Edwards, 1830
 Order CALANOIDA Sars, 1903
 Family CENTROPAGIDAE Giesbrecht, 1892
 Genus *Centropages* Krøyer, 1849
Centropages uedai sp. nov.
 (Figures 2–5)

TYPE MATERIAL

Holotype: 1 adult female, 1.91 mm, dissected and mounted on 3 glass slides (NMST-Cr 20863).

Allotype: 1 adult male, 1.83 mm, partly dissected and mounted in 1 glass slides (NSMT-Cr 20864).

Additional paratypes: 4 adult females (body length: 1.88–1.193 mm, mean \pm SD = 1.91 \pm 0.029 mm) whole specimens in 70% ethanol (NSMT-Cr 20865).

All types were collected at Sharm El-Maya Bay (27°51.39'N 34°17.53'E), on 27 June 2007 by M.M. El-Sherbiny.

DESCRIPTION

Female (holotype)

Body (Figure 2A) robust, quasi-cylindrical prosome, widest at posterior end of first pedigerous somite; cephalosome distinctly separate from first pedigerous somite, with 2 pointed, conical processes mid-dorsally and small knob medially on posterodorsal margin (Figure 2A, B); prosome about 2.3 times as long as urosome. Rostrum bearing pair of long filaments with broad bases; fourth and fifth pedigerous somites separated; fifth pedigerous somite produced posteriorly into asymmetrical, acute processes, right one slightly longer than left one and slightly exceeding posterior end of genital double-somite (Figure 2A). Urosome (Figure 2C–E) 3 free somites. Genital double-somite (Figure 2C–E) globular, symmetrical, ornamented with an anterior irregular group of spinules, transverse and rows of spinules dorsally and longitudinal row of spinules anterolaterally on each side. Genital orifice

located posteriorly along ventral surface and covered by heart-shaped, blunt operculum (Figure 2E). Second urosomal somite symmetrical, slightly longer than genital double-somite; anal somite symmetrical. Caudal rami symmetrical, length approximately 3 times width; caudal seta V longest, lateralmost terminal seta short.

Antennule (Figure 2F, G) 24-segmented, last 2 segments extending beyond caudal rami; first, second and fifth segments each with prominent spiniform attenuation. Armature elements as follows: 1 = 2 + aesthetasc (ae), 2 = 3 + ae, 3 = 2 + ae, 4 = 2 + ae, 5 = 2 + ae, 6 = 1 + ae, 7 = 2 + ae, 8 = 2 + ae, 9 = 2 + ae, 10 = 2 + ae, 11 = 2 + ae, 12 = 2 + ae, 13 = 2 + ae, 14 = 2 + ae, 15 = 2 + ae, 16 = 2 + ae, 17 = 2 + ae, 18 = 2 + ae, 19 = 2 + ae, 20 = 1, 21 = 1, 22 = 1 + 1, 23 = 1 + 1 + ae, 24 = 5 + ae.

Antenna (Figure 3A) coxa bearing stout, plumose seta at distomedial corner; basis with 2 medial setae of subequal length at distomedial corner; exopod 8-segmented, setal formula of 1, 2, 1, 1, 1, 1, 3 + 1; endopod 2-segmented, first segment with 2 medial setae of unequal length at distal 1/3; second segment bilobed, with 9 setae on proximal lobe and 7 setae on distal lobe.

Mandible (Figure 3B) gnathobase with 8 teeth on coxal cutting edge and 1 spinulose seta; third to sixth teeth bicuspidate and third to seventh teeth with group of irregular spinules anterodistally at base. Palp biramous; basis with 4 unequal setae medially; exopod 5-segmented with setal formula of 1, 1, 1, 1, 2; endopod 2-segmented, proximal segment with 4 setae at distal corner, distal segment with 8 marginal setae, anterodorsal seta and row of fine dorsal spinules medially.

Maxillule (Figure 3C) praecoxal arthrite with 9 marginal, strong setae and 7 slender, submarginal setae; coxal epipodite with 8 setae; coxal endite with 3 setae; basal exite with 1 seta; proximal and distal basal endites bearing 4 and 5 setae, respectively; basis completely fused to proximal endopodal segment; proximal endopodal segment bearing 4 setae along medial margin; distal endopodal segment with 5 setae; exopod 1-segmented, lobate with 9 setae.

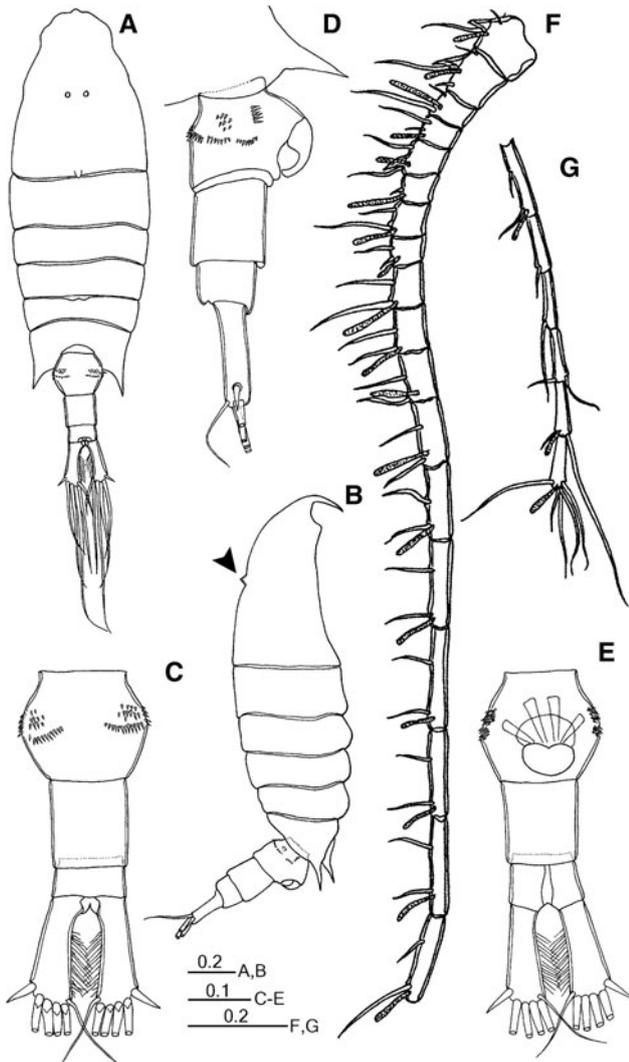


Fig. 2. *Centropages uedai* sp. nov. Female (holotype): (A) habitus, dorsal view; (B) habitus, lateral view (2 mid-dorsal spines arrowed); (C) urosome, dorsal view; (D) urosome, lateral view; (E) urosome, ventral view; (F, G) antennule. Scale bars in mm.

Maxilla (Figure 3D) praecoxal and coxal endites with 4, 3 setae, respectively; basal endites with 3, 3 setae; proximal endopodal segment with 1 long, 1 medium and 1 short setae; remaining part of endopod reduced, indistinctly 2-segmented, with 3, 4 setae.

Maxilliped (Figure 3E) 8-segmented; syncoxal lobes with setal formula of 1, 2, 3, 4 representing 3 praecoxal and 1 coxal endites; basis slightly shorter than syncoxa, with fine spinular row along proximal 2/3 of medial margin and 3 plumose setae; endopod with setal formula of 2, 2, 3, 2, 2 + 1, 3 + 1.

Swimming legs 1–5 (Figure 4A–E) each with 3-segmented rami. Basis of leg 1 (Figure 4A) with medial, straight, spinulose seta. Legs 2 to 4 (Figure 3B–D) similar to each other except for the number of medial setae on third endopodal segment, 4, 4, 3, respectively, and relatively longer coxa of legs 3 and 4.

Leg 5 (Figure 4E) symmetrical; basis with short, lateral seta; first exopodal segment with bulge along medial margin; second exopodal segment bearing strong trough medial process distally (approximately as long as segment) with serration along distal 4/5 of posterior margin (Figure 4E). First

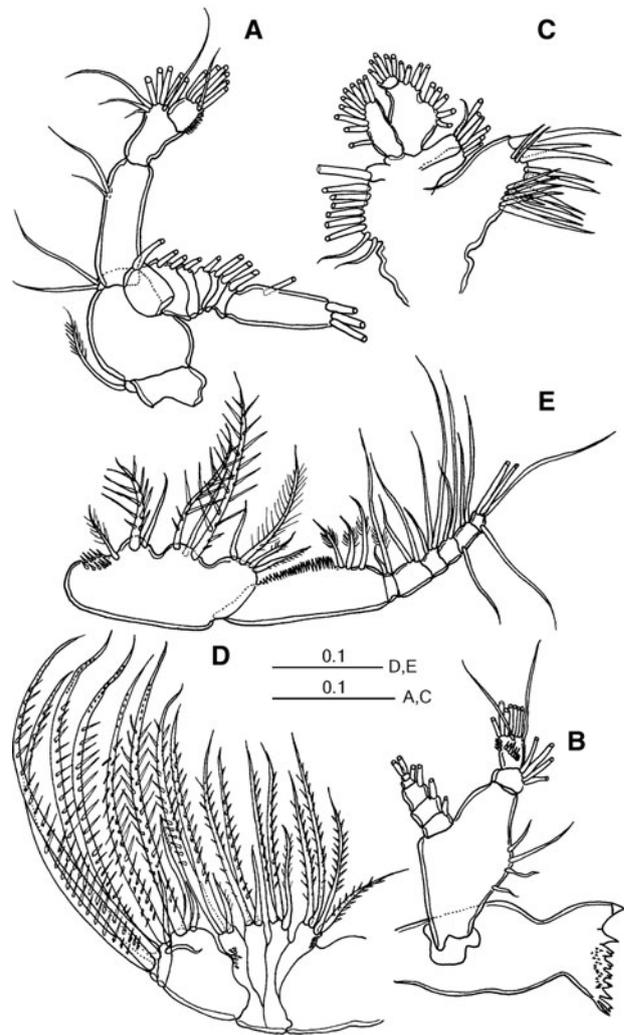


Fig. 3. *Centropages uedai* sp. nov. Female (holotype): (A) antenna, (B) mandible; (C) maxillule; (D) maxilla, (E) maxilliped. Scale bars in mm.

endopodal segment of both legs produced distolaterally into round tip. Armature of legs as follows:

Legs	Coxa	Basis	Exopod			Endopod		
			1	2	3	1	2	3
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
Leg 5	0-0	1-0	I-0;	I-1;	II,I,4	0-1;	0-1;	2,2,2

Male (allotype)

Body (Figure 5A, B) as in female; cephalosome with 2 pointed, conical processes mid-dorsally and posterodorsal knob as in female; left posterior process of prosome longer than right. Urosome (Figure 5C) with 4 free somites, almost symmetrical except genital somite with genital aperture located ventrolaterally at posterior rim the left side.

Right antennule (Figure 5D) 22-segmented, geniculate between segments 18 and 19; first, second and fifth segments each with prominent spiniform attenuation; terminal segment small but well defined; armature elements as follows

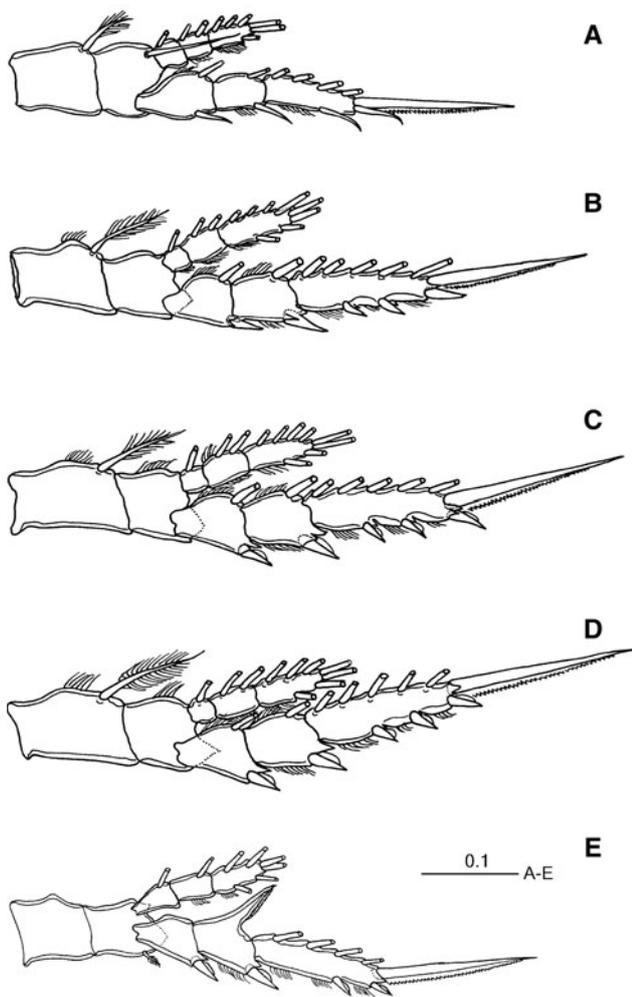


Fig. 4. *Centropages uedai* sp. nov. Female (holotype): (A) leg 1; (B) leg 2; (C) leg 3; (D) leg 4; (E) leg 5. Scale bar in mm.

(SS, specialized seta): 1 = 2 + ae, 2 = 3 + ae, 3 = 1 + ae, 4 = 2 + ae, 5 = 2 + ae, 6 = 1, 7 = 2 + ae, 8 = 2, 9 = 2 + ae, 10 = 2 (1 spiniform) + ae, 11 = 2 (1 spiniform) + ae, 12 = 2 + ae, 13 = 2 + ae, 14 = 2 + ae, 15 = 2 + ae, 16 = 2 + ae, 17 = 1 + ae + SS, 18 = 2 + ae + process, 19 = 1 + ae + SS, 20 = 2 + 2 + ae, 21 = 1 + 1, 22 = 3 + ae.

Mouthpart appendages, legs 1 to 3 similar to those of female. Leg 4 (Figure 5E) asymmetrical with right lateral spine on the second exopodal segment undulating, thicker and longer than left leg spine.

Leg 5 (Figure 5F, G) basis bearing lateral seta subterminally; first endopodal segment of both legs produced distolaterally into round tip as in female. Left leg (Figure 5F) with 2-segmented exopod and 3-segmented endopod; second exopodal segment about 1.5 times as long as first one, hirsute on posteromedial surface, bearing 3 subequal spines at tip and 2 lateral spines. Right leg 5 (Figure 5G) with 3-segmented rami; second exopodal segment with seta at distolateral corner and curved, long process medially, serrated on about distal 1/5 of its lateral margin; third exopodal segment curved inward with sharply pointed process laterally and with medial seta bifurcated at its tip and with hyaline ridge on both sides (Figure 5H); endopod exceeding second exopodal segment. Distal endopodal segments of both legs with setal formula of 1, 2, 3.

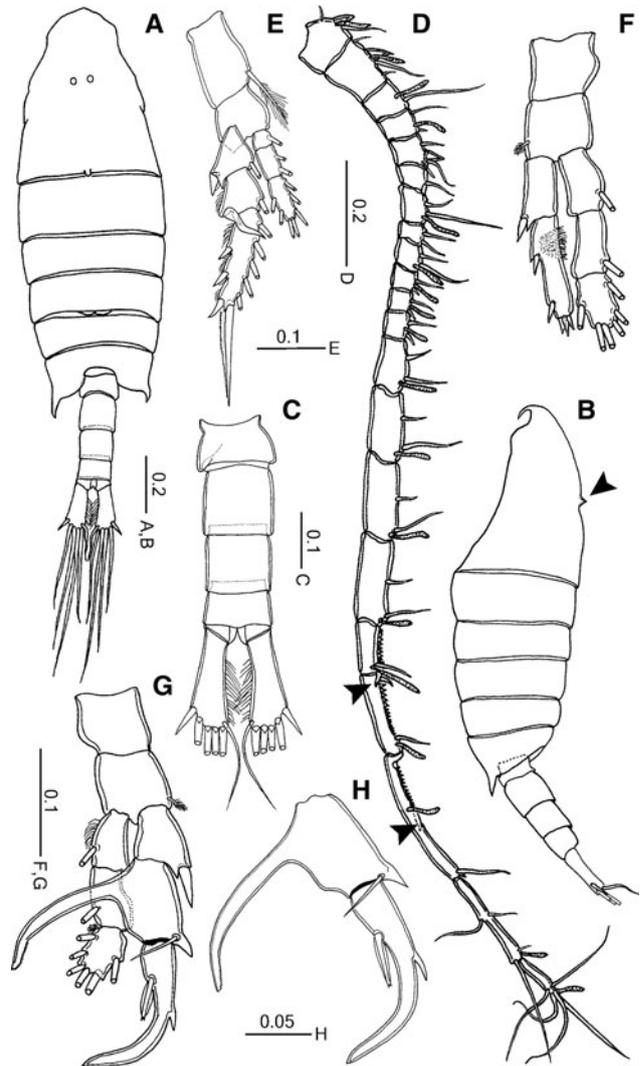


Fig. 5. *Centropages uedai* sp. nov. Male (allotype): (A) habitus, dorsal view; (B) habitus, lateral view (2 mid-dorsal spines arrowed); (C) urosome, dorsal view; (D) right antennules (specialized seta on segments 17 and 19 arrowed); (E) leg 4; (F) left leg 5, posterior view; (G) right leg 5, posterior view; (H) first and second exopodal segment of right leg 5, posterior view. Scale bars in mm.

ETYMOLOGY

The specific name *uedai* is dedicated as a symbol of appreciation to Professor Hiroshi Ueda of the Usa Marine Biological Institute, Kochi University, Japan.

DISCUSSION

The new species *Centropages uedai* is distinguished from all described and known species by the following combination of characteristics: (1) female genital double-somite globular, symmetrical, ornamented with an irregular group of spinules, transverse and dorsolateral rows of spinules on each side; (2) symmetry of female fifth leg with 3-segmented exopod, of which second exopodal segment bearing strong medial process distally with serration along distal 4/5 of its posterior margin; (3) second exopodal segment of male right leg 5 serrated laterally along distal 1/5 of its medial process; (4) third exopodal segment of male right leg 5 curved inward with medial seta bifurcated at its tip and with hyaline ridge on

both sides; and (5) asymmetry of male leg 4, in which lateral spines on the second exopodal segments of the right leg is undulating, thicker and longer than the left one.

Vervoort (1964) tabulated *Centropages* species into five groups with no definitions or diagnosis. This tabulation was based upon the shape of the last thoracic somite, shape of abdomen, morphology of leg 5 and the male antennule as reported by McKinnon & Kimmerer (1988). These species groups are: *typicus* (*C. aucklandicus* Kr mer, 1895, *C. australiensis* Fairbridge, 1944, *C. chierchiae* Giesbrecht, 1889, *C. dorsispinatus* Thompson & Scott, 1903 and *C. typicus* Kr yer, 1849), *furcatus* (*C. furcatus*), *hamatus* (*C. abdominalis* Sato, 1913, *C. alcocki* Sewell, 1912, *C. kroyeri*, *C. hamatus* (Lilljeborg, 1853), *C. ponticus* Karavaev, 1894, *C. tenuiremis* Thompson & Scott, 1903 and *C. trispinosus* Sewell, 1914), *orsinii* (*C. orsinii*) and *violaceus* (*C. bradyi* Wheeler, 1901, *C. calaninus*, *C. elongatus*, *C. gracilis*, *C. longicornis* Mori, 1932 and *C. violaceus*). Later, Ohtsuka *et al.* (2003, 2005) pointed out the presence of some common diagnostic features between the different groups of Vervoort (1964) and recommended the necessity of a revision of this species groups. They added 2 groups (*trispinosus* and *alcocki*) based on the shape of the prosome and its posterior corners, shape and symmetry of female genital compound somite, shape, curvature and shape of the lateral spine of the third exopodal segment of male right leg 5 and shape of distal exopodal segment of male left leg 5. *Centropages trispinosus* was moved by Ohtsuka *et al.* (2003) from *hamatus* group with *C. beryfurcus* Shen & Lee, 1963 to a *trispinosus* group. Ohtsuka *et al.* (2005) recognized the *alcocki* group which contained *C. alcocki* (from *hamatus* group), *C. karachiensis* Haq & Fazal-Ur-Rehman, 1973, *C. magio* Ohtsuka, Itoh & Mizushima, 2005 and *C. sinensis* Chen & Zhang, 1965.

Centropages uedai is similar to most species of the *typicus* group (i.e. *C. aucklandicus*, *C. australiensis*, *C. chierchiae* and *C. dorsispinatus*) in the shape of the last thoracic somite, symmetry of female leg 5 and the serrated posterior margin of the medial process of the second exopodal segment of male right leg 5. However, these species differ from *C. uedai* in having several long spines on the female genital double-somite and the asymmetry of female second urosomite. Also, the serrated posterior margin of the second exopodal segment of male right leg 5 of *C. uedai* is noted in *C. tenuiremis* of the *hamatus* group. It is worth mentioning that the new species is similar to *C. aegypticus* (collected from the same locality and not belonging to the above mentioned groups), *C. furcatus* (*furcatus* group) and *C. typicus* (*typicus* group) in the presence of three conspicuous spiniform attenuations each on the first, second, and fifth antennular segments in both sexes, which can be used as additional characteristics for distinguishing this new species. Furthermore, the new species *C. uedai* is similar to *C. aegypticus* in the shape of prosome ends and the presence of two pointed processes on the mid-dorsal cephalosome of both sexes. However, in *C. aegypticus*, the female has an asymmetrical genital double-somite and symmetrical leg 5 with 2-segmented exopod instead of a symmetrical genital double-somite and leg 5 with 3-segmented exopod of the new species. In addition, third exopodal segment of male right leg 5 of *C. aegypticus* carries a characteristic club-shaped medial seta. The asymmetry of leg 4 in *C. uedai* has been previously reported for some *Centropages* species such as *C. tenuiremis* (as *C. yamadai* Mori 1934 as proposed by McKinnon & Kimmerer (1988)) which has longer lateral spines on the first and second segments of the right leg

(Mori, 1937). Another type of asymmetry is seen in the length of distolateral spine on the third exopodal segment of the male leg 4, which is longer in the right leg than in the left in *C. abdominalis* (Mori, 1937) and *C. brevifurcus* (Shen & Lee, 1963; Ohtsuka *et al.*, 2003). Also, El-Sherbiny & Ueda (2008a) noted the asymmetry of both legs 3 and 4 in which the lateral spines on the first and second exopodal segments of the right legs were longer in *C. aegypticus*. In conclusion, the new species has unique characteristics and hence it does not belong to any of the known *Centropages* species groups.

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