

Centropages aegypticus sp. nov., a new calanoid copepod from the northern Red Sea

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A new species of calanoid copepod, Centropages aegypticus sp. nov. collected from the Egyptian coasts of the northern Red Sea is described. This species is unique in having two pointed conical processes on the dorsal surface of cephalosome in both sexes, female genital compound somite with irregular-surface outline of the right swelling part and transverse dorsolateral row of spinules on the left side, 2-segmented exopod of the female leg 5, asymmetrical medial processes of the female leg 5, of which the left one is longer and medially-curved and the right one with oblique row of thick spinules, and a club-shaped medial seta on the third exopodal segment of the male leg 5. The new species is similar to *C. tenuiremis*, but is not assigned to the same species group as the latter species or to any other groups.

Keywords: calanoid Copepoda, *Centropages aegypticus*, new species, taxonomy, Red Sea

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INTRODUCTION

Species of the genus *Centropages* Krøyer, 1849 have wide distribution from temperate to tropical and from coastal brackish to oceanic waters. The importance of this genus is well documented in the literature as a food source for fish (Brodsky, 1950; Chen & Zhang, 1965). Species of this genus are distributed in the epipelagic waters (Vervoort, 1964; MacKinnon & Kimmerer, 1988; MacKinnon & Dixon, 1994; Bradford-Grieve, 1999; Bradford-Grieve *et al.*, 1999). To date, seven species have been recorded from the Red Sea (Halim, 1969; Razouls, 1995), namely, *C. calaninus* Dana, 1849, *C. elongatus* Giesbrecht, 1896, *C. furcatus* (Dana, 1849), *C. gracilis* (Dana, 1849), *C. orsinii* Giesbrecht, 1889, *C. ponticus* Karavaev, 1894 and *C. violaceus* (Claus, 1863). In this paper, a new species of *Centropages* collected from the neritic water of the Sharm El-Sheikh area, in the northern Red Sea is described.

MATERIALS AND METHODS

Plankton samples were collected by horizontal tows of a plankton net (40 cm in mouth diameter, 100- μ m mesh) from a small, shallow and semi-enclosed bay called Sharm El-Maya located at the entrance of Sharm El-Sheikh city, the northern Red Sea (27°51'39"N 34°17'53"E; water depth 2.5 m at the sampling point) in 2000 and 2001. This bay was used for about 20 years as a local port and a park for fishing and tourist diving boats. Its salinity yearly ranged between 40.5 and 41.5 psu, temperature between 22.7 and 30.9°C, and chlorophyll-*a* between 0.18 and 1.5 mg m⁻³ (El-Sherbiny, 1997; Aamer *et al.*, 2006).

The samples were fixed immediately after collection in 5% buffered formalin seawater. Specimens of the new species were

sorted out of the samples and then preserved in 70% alcohol. The specimens were dissected in lactophenol and examined with a differential interference microscope (Nikon, E600). All drawings were made with the aid of a camera lucida and the measurements with an ocular micrometer. The terminology used follows Boxshall & Husley (2004). The type specimens are deposited at the National Science Museum, Tokyo (NSMT).

SYSTEMATICS

Family CENTROPAGIDAE Giesbrecht, 1892

Genus *Centropages* Krøyer, 1849

Centropages aegypticus sp. nov.

(Figures 1–4; Table 1)

Type material

Holotype: 1 adult female, 1.70 mm, completely dissected and mounted on three glass slides [NMST-Cr 16880].

Allotype: 1 adult male, 1.58 mm, partly dissected and mounted on two glass slides [NSMT-Cr 16881].

Other paratypes: 17 females (body length: 1.50–1.67 mm, mean \pm SD = 1.62 \pm 0.057 mm) and 13 males (body length: 1.50–1.70 mm, mean \pm SD = 1.62 \pm 0.058 mm) whole specimens in 70% ethanol [NSMT-Cr 16882].

The holotype and allotype specimens were collected on 22 June 2000 and other paratypes were on collected 27 June 2001. All type specimens were collected by M.M. El-Sherbiny.

Description

FEMALE (HOLOTYPE)

Body (Figure 1A) robust, prosome plump, widest at posterior border of first pediger; prosome about 2.5 times as long as urosome; cephalosome distinctly separate from first pediger, with two pointed conical processes mid-dorsally and small

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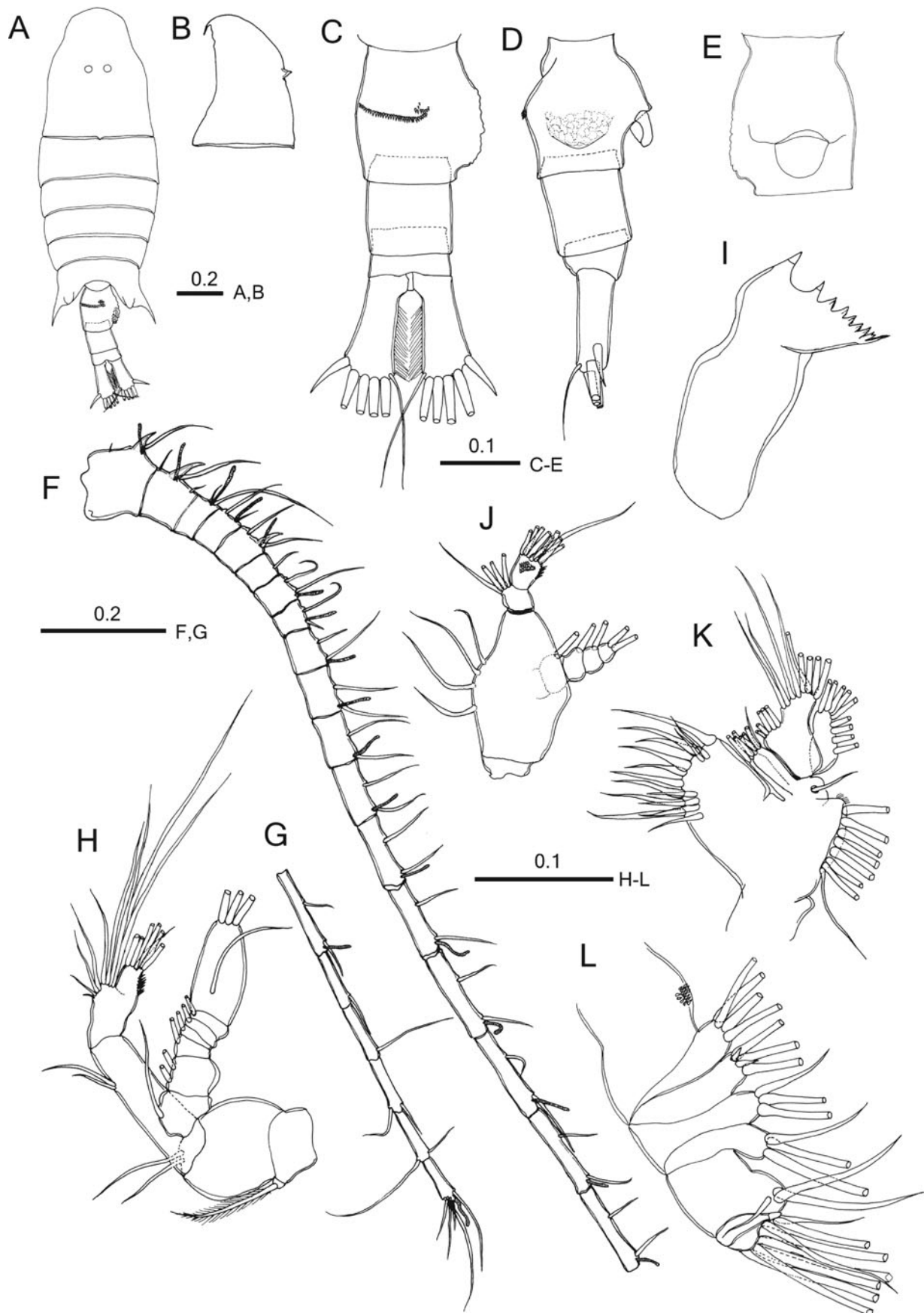


Fig. 1. *Centropages aegypticus* sp. nov. female (holotype). (A) Habitus, dorsal view; (B) cephalosome, lateral view; (C) urosome, dorsal view; (D) urosome, lateral view; (E) genital compound somite, ventral view; (F–G) antennule; (H) antenna; (I) mandibular gnathobase; (J) mandibular palp; (K) maxillule; (L) maxilla. Scale bars in mm.

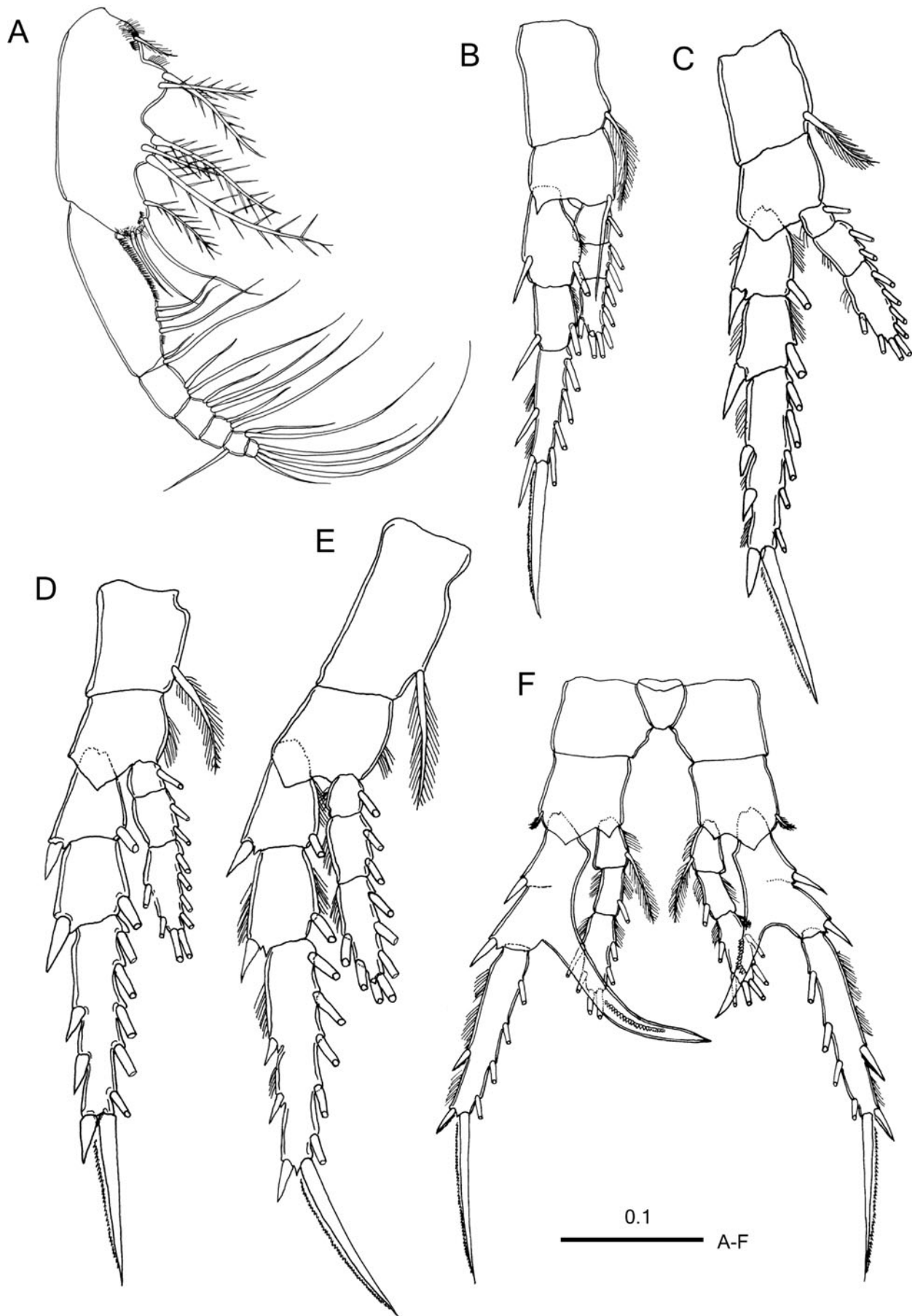


Fig. 2. *Centropages aegypticus* sp. nov. female (holotype). (A) Maxilliped; (B) leg 1; (C) leg 2; (D) leg 3; (E) leg 4; (F) leg 5. Scale bars in mm.

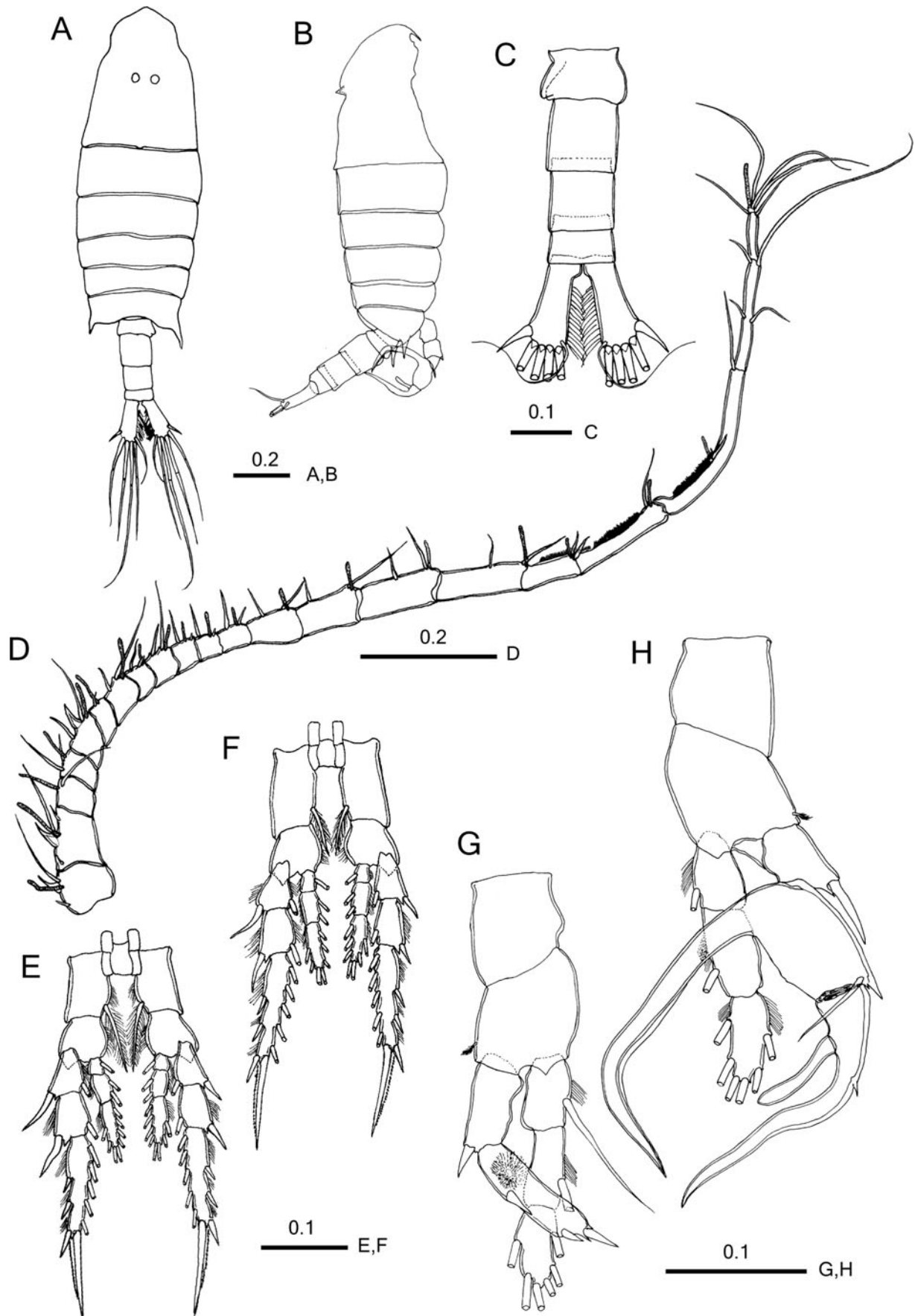


Fig. 3. *Centropages aegypticus* sp. nov. male (allotype). (A) Habitus, dorsal view; (B) habitus, lateral view; (C) urosome, dorsal view; (D) right antennule; (E) leg 3; (F) leg 4; (G) left leg 5, posterior view; (H) right leg 5, posterior view. Scale bars in mm.

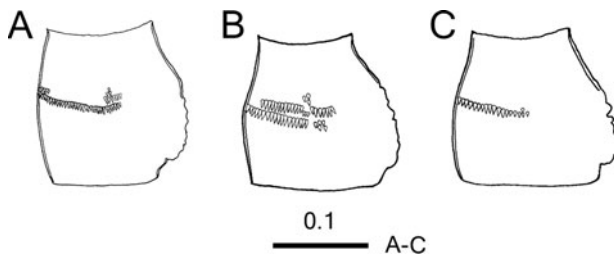


Fig. 4. *Centropages aegypticus* sp. nov. (A–C) Variations in the female genital compound somite. Scale bar in mm.

knob on posterodorsal median border (Figure 1A & B); fifth pediger asymmetrical, produced posteriorly into wing-like lappets, each terminating with acute process; right process directed backward, nearly reaching posterior border of genital compound somite, slightly longer than left process; left process directed more laterally than right one (Figure 1A). Rostrum (Figure 1B) bearing pair of long filaments with broad bases. Urosome (Figure 1C,D) three free somites. Genital compound somite (Figure 1C&E) asymmetrical, with irregular surface outline swelling on right side and two transverse rows of spinules at midlength, anterior short row of them dorsally and posterior long one dorsolaterally on left side; genital operculum (Figure 1E) located half way along ventral surface. Second free urosomite symmetrical; anal somite very small and symmetrical; caudal rami symmetrical and approximately 3.5 times as long as wide.

Antennule (Figure 1F & G) 24-segmented, when extended exceeds the caudal rami by the last four segments, reaching half way along longest caudal setae; first, second and fifth segments each with prominent spine almost fused with segment. Fusion pattern and armature elements as follows: I (1) = 2 + aesthetasc(ae) + spine(sp), II–IV = (2) 3 + ae + sp, V = (3) 2 + ae, VI = (4) 2 + ae, VII = (5) 2 + ae + sp, VIII (6) = 1, IX = (7) 2 + ae, X (8) = 2 (1 spiniform) + ae, XI (9) = 2 + ae, XII (10) = 2 + ae, XIII (11) = 2 + ae, XIV (12) = 2 + ae, XV (13) = 2 + ae, XVI (14) = 2 + ae, XVII (15) = 2 + ae, XVIII (16) = 2 + ae, XIX (17) = 2 + ae, XX (18) = 2 + ae, XXI (19) = 2 + ae, XXII (20) = 1, XXIII (21) = 1, XXIV (22) = 1 + 1, XXV (23) = 1 + 1, XXVI–XXVIII (24) = 5 + ae.

Antenna (Figure 1H) with short coxa bearing plumose seta; basis with two subequal terminal setae; exopod indistinctly 7-segmented with setal formula of 1, 2, 1, 1, 1, 1 + 3; endopod 2-segmented, first segment with two unequal subterminal setae; second segment bilobed, with proximal and distal lobes bearing nine and seven setae, respectively.

Table 1. Spine and setal formula of legs 1–5 of *Centropages aegypticus* sp. nov.

	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 (Female)	0–0	1–0	II–0;		II,I,4	0–1;	0–1;	2,2,2

Mandible (Figure 1I) with eight cusped teeth and spinulose seta along the coxal cutting edge; basis bearing four medial setae at midlength; exopod 5-segmented with setal formula of 0, 1, 1, 1, 2; endopod 2-segmented, carrying four setae at distal corner of proximal segment and nine setae and two rows of fine spinules anteriorly on distal segment.

Maxillule (Figure 1K) with 15 well-chitinized setae on praecoxal arthrite; coxa bearing seven well developed and short proximal seta on epipodite and three setae on endite; basis completely fused to endopod, exite with seta and first and second endites with four and five setae, respectively; endopod indistinctly 2-segmented, bearing six setae along the medial margin of proximal segment and three setae on distal segment; exopod with nine lateral setae.

Maxilla (Figure 1L) praecoxal endites with 4, 3 setae, coxal endites with 3, 3 setae, basal endite with two strong and one short slender setae, and endopod with eight setae.

Maxilliped (Figure 2A) with four syncoxal lobes, with 1, 2, 3, 4 setae respectively; basis with spinular row along three-quarters of medial margin and bearing three plumose setae distally; endopod 6-segmented, of which first segment almost completely incorporated into basis, with two unequal setae and second to sixth segments bearing 2, 3, 2, 2 + 1, 4 setae, respectively.

Seta and spine formula of legs 1 to 5 shown in Table 1. Leg 1 basis (Figure 2B) with medial spinulose seta. Legs 2 to 4 (Figure 2C–E) similar to each other except for the number of medial setae on third endopodal segment and longer coxa of leg 4. Leg 5 (Figure 2F) asymmetrical, with 2-segmented exopod and 3-segmented endopod; proximal exopodal segment with incomplete articulation between the two ancestral segments posterolaterally and long sword-like process medially; process of left leg located at three thirds of segment length, thicker and longer than right one, nearly as long as second segment, curved medially, with row of spinules on posterior surface; process of right leg located at midlength of segment, with oblique row of thick spinules; distolateral corner of first endopod segment produced into rounded process.

MALE

Body (Figure 3A) more slender than female; cephalosome with two pointed conical processes (Figure 3A & B); left posterior process of prosome longer than right. Urosome (Figure 3C) four free somites, almost symmetrical except for genital somite with genital aperture located ventrolaterally at posterior rim on left side.

Right antennule (Figure 3D) geniculate, 22-segmented, with terminal segment small but well defined; fusion and armature elements as follows: I (1) = 2 + ae + sp, II–IV (2) = 3 + ae + sp, V (3) = 1 + ae, VI (4) = 2 + ae, VII (5) = 2 + ae + sp, VIII (6) = 1 + ae, IX (7) = 2 + ae, X (8) = 2 (1 spiniform) + ae, XI (9) = 2 + ae, XII (10) = 2 (1 spiniform) + ae, XIII (11) = 2 (1 spiniform) + ae, XIV (12) = 2 + ae, XV (13) = 2 + ae, XVI (14) = 2 + ae, XVII (15) = 2 + ae, XVIII (16) = 2 + ae, XIX (17) = 1 + ae + process, XX (18) = 1 + ae, XXI–XIII (19) = 2 (1 rudimentary) + ae + process, XXIV–XXV (20) = 2 + 2, XXVI (21) = 1 + 1, XXVII–XXVIII (22) = 3 + ae.

Mouthpart appendages, legs 1 and 2 as in female. Legs 3 and 4 (Figure 3E & F) asymmetrical with right lateral spines on first and second exopodal segment longer than left ones.

Leg 5 (Figure 3G & H) with narrower intercoxal sclerite and wider coxa than of other legs; basis bearing outer seta on sub-terminal corner; first endopodal segment of both legs produced distolaterally into round process as in female. Left leg 5 (Figure 3G) with 2-segmented exopod and 3-segmented endopod; second exopodal segment approximately 1.5 times as long as first segment, proximally with tuft of hair on posterior surface bearing two spines laterally and one spine apically. Right leg 5 (Figure 3H) with 3-segmented rami; first exopodal segment with thick distolateral seta; second exopodal segment with seta at distolateral corner and curved, undulating long medial process bearing hyaline ridge along lateral edge; third exopodal segment with small lateral spine at one-third distance from proximal border and club-shaped thick medial seta, and terminally recurved tip; endopod extending beyond second exopodal segment.

VARIATIONS

The shape and number of spinule row on the female genital compound somite varied among individuals. For example, some specimens had long but intermittent anterior row dorsolaterally on the left side (Figure 4A & B), and another one had only a single row (Figure 4C). No notable variation was detected among the male specimens except for body length.

ETYMOLOGY

The specific name of the new species is from the Latin *aegypticus* and alludes to the Egyptian water from which the new species was collected.

DISCUSSION

Centropages aegypticus sp. nov. differs from all other congeneric species in the following characters: two pointed processes on the mid-dorsal cephalosome; the female genital compound somite with irregular surface outline swelling on the right side and one or two rows of spinules dorsolaterally on the left side; 2-segmented exopod of the female leg 5; asymmetrical medial processes of the female leg 5, of which the left one is longer and the right one with oblique row of thick spinules; and the third exopodal segment of the male leg 5 with a club-shaped medial seta. Each of these characters is unique to the present species. Two-segmented exopod of the female right leg 5 by fusion of the ancestral first and second segments is also seen in *C. tenuiremis* Thompson & Scott, 1903 that is distributed in the Indo-West Pacific (see Chen & Zhang, 1965; Mulyadi, 1998), but the fusion in both left and right legs has never been reported in the genus. *Centropages tenuiremis*, *C. orsinii* and *C. furcatus* have apparently asymmetrical medial processes of the female leg 5 (see Mori, 1937; Mulyadi, 1998), but their longer process is on the right leg in contrast to that on the left leg of *C. aegypticus*.

Other characteristic features of the new species are: three prominent spines each on the first, second, and fifth antennular segments in both sexes as in *C. furcatus* and *C. typicus* Kröyer, 1849; medially-curved medial process on the exopod of the female left leg 5, which is generally straight or curved toward the tip of the segment; the process on the right leg located at midlength of the segment, which is generally at the distal corner of the segment; and the asymmetrical male legs 3 and 4, in which lateral spines on the first and second exopodal segments of the right legs are longer. Some

centropagid species have rarely asymmetrical legs other than leg 5. For example, Mori (1937) described *C. tenuiremis* (as *C. yamadai* Mori, 1934) as having longer lateral spines on the first and second segments of the male right leg 4 than those of the left leg as in *C. aegypticus*. 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 leg, in *C. abdominalis* Sato, 1913 (Mori, 1937) and *C. brevifurcatus* Shen & Lee, 1963 (Shen & Lee, 1963; Ohtsuka *et al.*, 2003). As far as we know, asymmetry of leg 3 of the present species is first reported in copepods. Asymmetry of legs 3 and 4 is sexually dimorphic, limited to the male, and the longer spine is always on the right leg as the male leg 5 forming a chela to grasp a female for copulation is always the right one. This indicates that the right leg 4 (plus the right leg 3 in *C. aegypticus*) in these species plays an auxiliary role for copulation.

Vervoort (1964) divided *Centropages* species into five species groups, namely *typicus*, *furcatus*, *hamatus*, *orsinii* and *violaceus* groups according to the shape of the last thoracic somite, shape of abdomen, morphology of leg 5 and the male antennule (cf. McKinnon & Kimmerer, 1988). Subsequently, Ohtsuka *et al.* (2003, 2005) recognized two other groups, *trispinosus* and *alcocki*. In spite of many unique characters of *C. aegypticus*, it is similar to *C. tenuiremis* of the *hamatus* group in the following characters common to the two species: shape of pointed prosome ends and relatively long caudal rami in both sexes; 2-segmented exopod of the female leg 5; medial process of exopod of the female right leg 5 located nearly at midlength of the segment; asymmetry in female leg 5 and the male leg 4; and absence of distomedial spine on distal exopodal segment of the male left leg 5, which is the character used by Ohtsuka *et al.* (2005) to distinguish the *alcocki* group. However, the exopod of the right leg 5 of the *C. aegypticus* male, which has an undulating long medial process on the second segment and recurved tip of the somewhat S-shaped third segment, is apparently different from that of the *hamatus* group, which includes *C. hamatus* (Lilljeborg, 1853), *C. kroyeri* Giesbrecht, 1892, *C. ponticus*, *C. tenuiremis*, *C. abdominalis* Sato, 1913 (Vervoort, 1964) (Ohtsuka *et al.* (2003) moved *C. trispinosus* Sewell, 1914 from this group). This indicates that *C. aegypticus* does not belong to the *hamatus* groups in spite of the similarity to *C. tenuiremis*. One may consider *C. dorsispinatus* Thompson & Scott, 1903 of the *typicus* group as another similar species because both species have a prominent dorsal spine on both the female and male cephalosome. However, *C. dorsispinatus* has a single spine at the posterodorsal margin of the cephalosome instead of two short spines on the mid-dorsal region of the cephalosome in *C. aegypticus*. The spine of the *C. dorsispinatus* is undoubtedly homologous to a small knob on the same position of *C. aegypticus* and therefore these dorsal spines do not indicate their relationship. No other species are as similar as *C. tenuiremis*. In conclusion, the new species does not belong to existing species groups, nor does it comprise a new group.

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REFERENCES

- Aamer M.A., El-Sherbiny M.M., Gab-Alla A.A. and Kotb M.M.** (2006) Studies on the ecology of zooplankton standing crop of Sharm El-Maiya Bay, Sharm El-Sheikh, northern Red Sea, Egypt. *Catrina* 1, 73–80.
- Boxshall G.A. and Hasley S.H.** (2004) *An introduction to copepod diversity I*. London: The Ray Society.
- Bradford-Grieve J.M.** (1999) The marine fauna of New Zealand: pelagic calanoid Copepoda: Bathypontiidae, Arietellidae, Augaptilidae, Heterorhabdidae, Lucicutiidae, Metridinidae, Phylloporidae, Centropagidae, Pseudodiaptomidae, Temoridae, Candaciidae, Pontellidae, Sulcanidae, Acartiidae, Tortanidae. *NIWA Biodiversity Memoir* 111, 1–268.
- Bradford-Grieve J.M., Markhaseva E.L., Roch C.E.F. and Abiahy B.** (1999) Copepoda. In Boltovskoy D. (ed.) *South Atlantic zooplankton*, Leiden: Backhuys Publishers, pp. 869–1098.
- Brodsky K.A.** (1950) *Calanoida of the Far Eastern Seas and Polar Basin of the USSR*. Moskva–Leningrad: Izdatel'stvo Akademii Nauk SSSR. [English translation: Israel Programme for Scientific Translations, Jerusalem, 1967.]
- Chen Q.-C. and Zhang S.-Z.** (1965) The planktonic copepods of the Yellow Sea and the East China Sea. I. Calanoida. *Studia Marina Sinica* 7, 20–131. [In Chinese with English abstract.]
- El-Sherbiny M.M.** (1997) *Some ecological studies on zooplankton in Sharm El-Sheikh (Red Sea)*. MSc thesis, University of Suez Canal, Ismailia, Egypt.
- Halim Y.** (1969) Plankton of the Red Sea. *Oceanography and Marine Biology: an Annual Review* 7, 231–275.
- McKinnon A.D. and Kimmerer W.J.** (1988) A new species of calanoid copepod from Shark Bay, Western Australia. *Record of the Western Australian Museum* 14, 171–176.
- McKinnon A.D. and Dixon P.** (1994) *Centropages acutus*, a new calanoid copepod from the Fly River Estuary, Papua New Guinea. *The Beagle* 9–14.
- Mori T.** (1937) *The pelagic Copepoda from the neighboring waters of Japan*. Tokyo: The Soyo Co. Inc.
- Mulyadi** (1998) New records and taxonomic reexamination of the genus *Centropages* (Copepoda: Calanoida), with notes on their geographic distribution in Indonesian waters. *Raffles Bulletin of Zoology* 46, 53–70.
- Ohtsuka S., Itoh H. and Mizushima T.** (2005) A new species of the calanoid copepod genus *Centropages* (Crustacea) collected from Shimizu Port, Middle Japan: introduced or not? *Plankton Biology and Ecology* 52, 92–99.
- Ohtsuka S., McKinnon D., Pinkaew K., Puchakarn S. and Chalermwat K.** (2003) New record of *Centropages brevifurcus* (Crustacea: Copepoda: Calanoida) from the Gulf of Thailand and its full redescription. *Species Diversity* 8, 67–78.
- Razouls C.** (1995) Diversité et répartition géographique chez les copépodes pélagiques. 1. Calanoida. *Annales de l'Institut Océanographique* 71, 81–401.
- Shen C. and Lee F.** (1963) The estuarine Copepoda of Chiekong and Zaikong Rivers, Kwaingtung Province, China. *Acta Zoologica Sinica* 15, 571–596. [In Chinese with English abstract.]
- and
- Vervoort W.** (1964) Notes on two Pacific species of *Centropages* (Copepoda, Calanoida), *C. australiensis* Fairbridge, 1944, and *C. aucklandicus* Krämer, 1895. *Crustaceana* 7, 293–311.

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