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# A new species of *Calanopia* (Copepoda, Calanoida, Pontellidae) from the plankton of the central Red Sea

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**Abstract** *Calanopia tulina* sp. nov., a new pontellid copepod, is described from plankton samples collected in Saudi Arabian waters of the Red Sea. The female of the new species differs from other congeners in having the genital operculum located posteroventrally on the genital compound somite and by a slightly asymmetrical leg 5, in which the right leg is slightly shorter than the left one. The male is distinguished by: (1) the presence of a distinct notch on the medial margin of the right prosomal corner; (2) the structure of leg 5, in which the second exopodal segment of the left leg has one medially directed spine and two large laterally directed and curved serrated spines distally; and (3) the first exopodal segment of the right leg has a very small rounded-tip thumb located at the mid-length. The new species is most similar to *Calanopia media* described from the Red Sea. The presence of the new species in night collection may be due to the diel vertical migration behavior that is known for some species of this genus.

**Keywords** Copepoda · *Calanopia* · New species · Red Sea

## Introduction

The calanoid copepod genus *Calanopia* (Dana, 1852) currently accommodates 16 species (Razouls et al. 2017; Walter and Boxshall 2017); most of them (13 species) are distributed in the Indian and Pacific oceans (Silas and Pillai 1973; Al-Aidaros et al. 2016). To date, five species of *Calanopia* are known to occur in the Red Sea: *C. elliptica* Dana, 1849 was recorded by Giesbrecht (1896); subsequently, *C. minor* A. Scott, 1902 was described by Scott (1902). *Calanopia media* Gurney, 1927 was first described by Gurney (1927) from the Suez Canal and later recorded in the southern and central Red Sea by Pesta (1941) and El-Sherbiny (2017), respectively. *Calanopia kideysi* Ünal and Shmeleva, 2002 was described by Ünal and Shmeleva (2002) from the central Red Sea and *C. thompsoni* A. Scott, 1909 was recorded by Al-Aidaros et al. (2016) from the Saudi Arabian waters of the Red Sea. During the taxonomic studies on the pelagic copepods in the neritic waters off Jeddah, Saudi Arabian coast of the Red Sea, an undescribed species of *Calanopia* was found in plankton samples, and is described here based on male and female specimens.

## Materials and methods

Male and female specimens of the new species of *Calanopia* were sorted from zooplankton samples collected horizontally by surface tows (0.5 m beneath the surface) with a 50-cm mouth diameter plankton net (150- $\mu$ m mesh size) for 10 min at a speed of about 1–1.5 knots from the neritic waters off Jeddah, Saudi Arabian coast of the central Red Sea. Immediately after collection, samples were fixed in a 4% formalin–seawater solution. For microscopic examination, specimens were dissected in lactic acid using bright-field and

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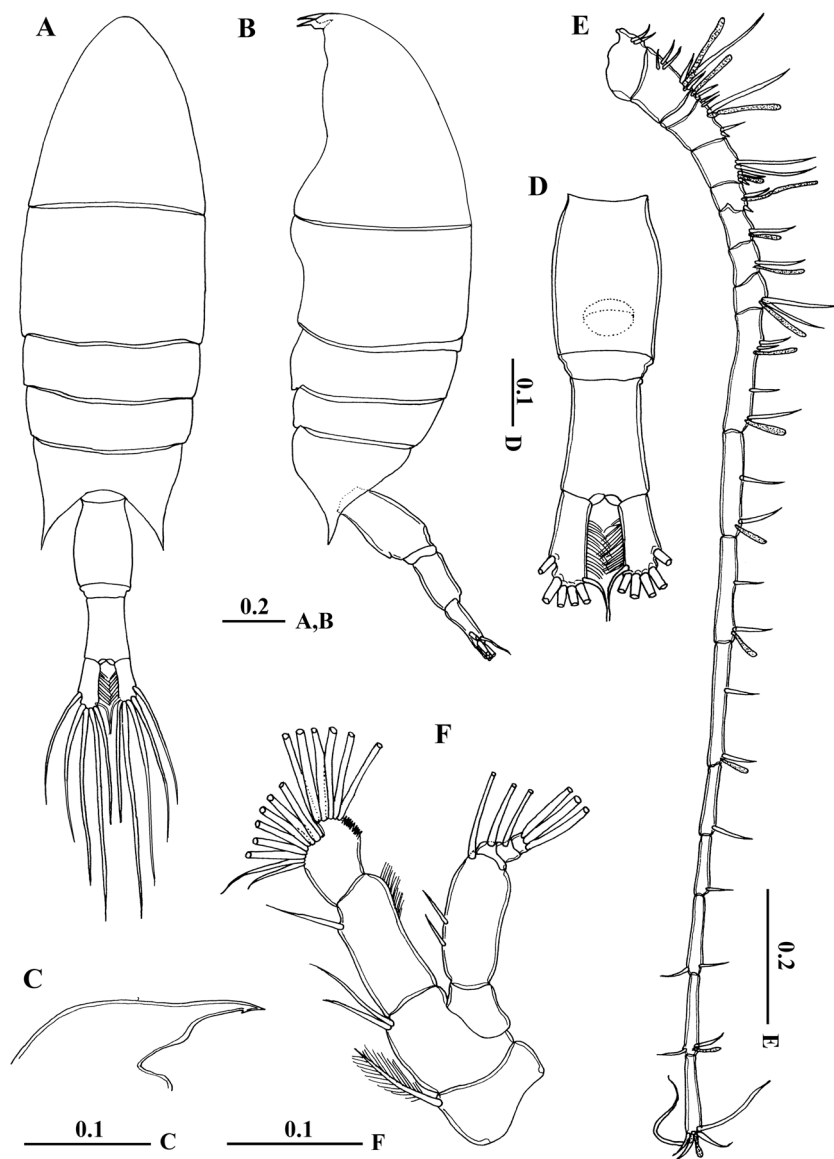
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**Fig. 1** *Calanopia tulina* nov. sp. Female holotype. **a** Habitus, dorsal view; **b** habitus, lateral view; **c** rostrum, lateral view; **d** urosome, dorsal view; **e** antennule; **f** antenna. Scale bars in mm



differential interference microscopes (Nikon DM6000). Drawings and measurements were made with a camera lucida attached to the microscope and an ocular micrometer. Morphologic terminology follows Huys and Boxshall (1991). Type specimens were deposited the German Center for Marine Biodiversity Research (DZMB), Wilhelmshaven, Germany (SMF 37098/1-30). The specimens were observed with a scanning electron microscope (Hitachi S-3500N).

## Results

### Systematics

Subclass COPEPODA Milne-Edwards, 1830  
Order CALANOIDA Sars, 1903

Family PONTELLIDAE Dana, 1852

Genus *Calanopia* Dana, 1852

*Calanopia tulina* sp. nov.

(Figs. 1, 3, 4, 5, and 7; Table 1)

### Type material

**Holotype** 1 adult female, 2.19 mm, dissected and mounted on 1 glass slide with CMC-10 (SMF 37096/1).

**Allotype** 1 adult male, 2.03 mm, partly dissected and mounted on 1 glass slide with CMC-10 (SMF 37097/1).

**Paratypes** 18 adult females (body length: 1.94–2.22 mm, mean  $\pm$  SD = 1.91  $\pm$  0.029 mm) and 12 adult females (body length: 1.88–2.08 mm, mean  $\pm$  SD = 2.00  $\pm$  0.05 mm) whole specimens in 5% formalin (SMF 37098/1-30).

All type specimens were collected from the neritic waters off Jeddah, Saudi Arabian coast of the central Red Sea (21° 39' 34.17" N, 39° 0' 54.90" E) on 20 September 2014 during the night by M.M. El-Sherbiny. Seawater surface temperature and salinity were 29.5 °C and 39.3, respectively, during the sampling time.

## Description

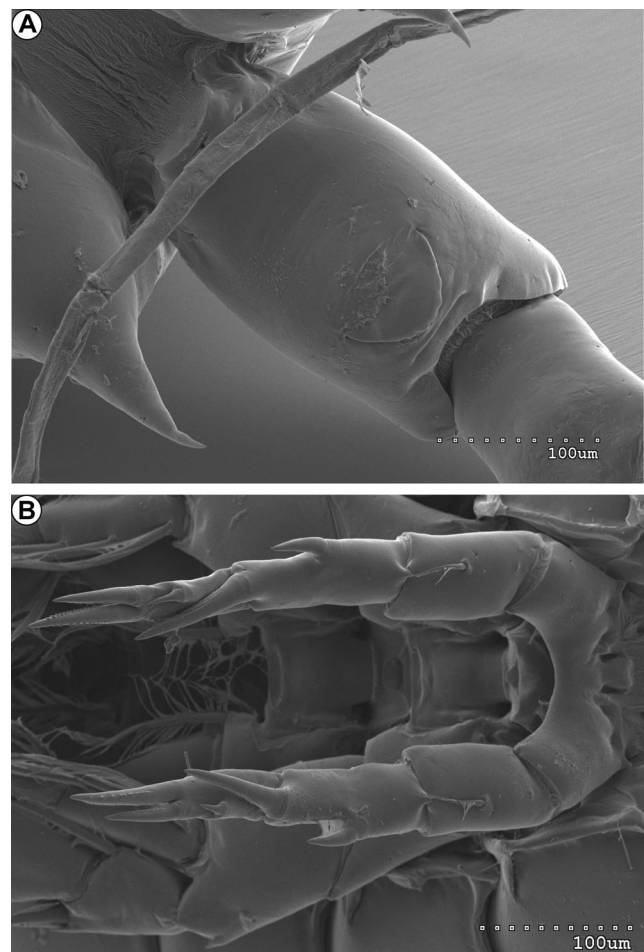
### *Female (holotype)*

Body (Fig. 1a, b) with elliptical prosome comprising cephalosome and four free pedigerous somites; prosome 2.6 times as long as urosome (from the anterior margin of cephalosome to the tip of posterior wing). Cephalosome and first pedigerous somites completely separated; fourth and fifth pedigerous somites completely fused. Posterior margins of prosome symmetrical in dorsal view, tapering to pointed process at each lateral corner, slightly inclined ventrally, reaching nearly halfway along genital compound somite. Rostrum (Fig. 1c) typical of the genus, bifid, with broad bases and small medial subterminal notch. Urosome (Fig. 1d) with 2 free somites. Genital compound somite symmetrical in dorsal view; ventral surface without any process and with smooth evenly rounded operculum located posteroventrally (Figs. 1d and 2a). Postgenital second urosomite symmetrical and slightly shorter than genital compound somite. Caudal rami asymmetrical, left one slightly longer than right, approximately 2.5 times as long as wide. First and second urosomites and left caudal rami in proportions of 47:30:23, respectively.

Antennules (Fig. 1e) of 18 segments, reaching slightly beyond posterior border of genital compound urosomite. Fusion pattern and armature as follows: ancestral segment I (segment 1) = 2 setae (S), II–VI (2) = 6S + aesthetasc (ae), VII (3) = 1S + ae, VIII–X (4) = 5S (1 spiniform) + ae, XI–XII (5) = 3S (1 spiniform) + ae, XIII (6) = 2S (1 spiniform) + ae, XIV (7) = 1S + ae, XV (8) = 1S + ae, XVI (9) = 2S + ae, XVII–XVIII (10) = 4S + 2ae, XIX (11) = 2S + ae, XX (12) = 2S + ae, XXI (13) = 2S + ae, XXII (14) = 1S, XXIII (15) = 1S, XXIV (16) = 1S + 1S, XXV (17) = 1S + ae + 1S, XXVI–XXVIII (18) = 5S + ae.

Antenna (Fig. 1f) with coxa bearing plumose seta medially. Basis with 2 distomedial subequal setae. Exopod 5-segmented with setal formula of 0, 3, 1, 1, 3. Endopod with seta on first segment; second segment with 8 setae on proximal lobe, and 6 setae and row of spinules on posterior surface of distal lobe.

Mandible (Fig. 3a) gnathobase bearing 8 teeth on cutting edge and anteriorly with group of short spinules proximal to third to seventh teeth. Palp basis with 4 unequal setae on medial margin; exopod 5-segmented with setal formula of 1, 1, 1, 1, 3. Endopod 2-segmented, proximal segment with 3 setae at distomedial corner, distal segment crowned with 6 long setae.



**Fig. 2** Scanning electron microscope (SEM) micrograph of *Calanopia tulina* nov. sp. Female paratype. **a** Female urosome, ventral view; **b** leg 5, posterior view

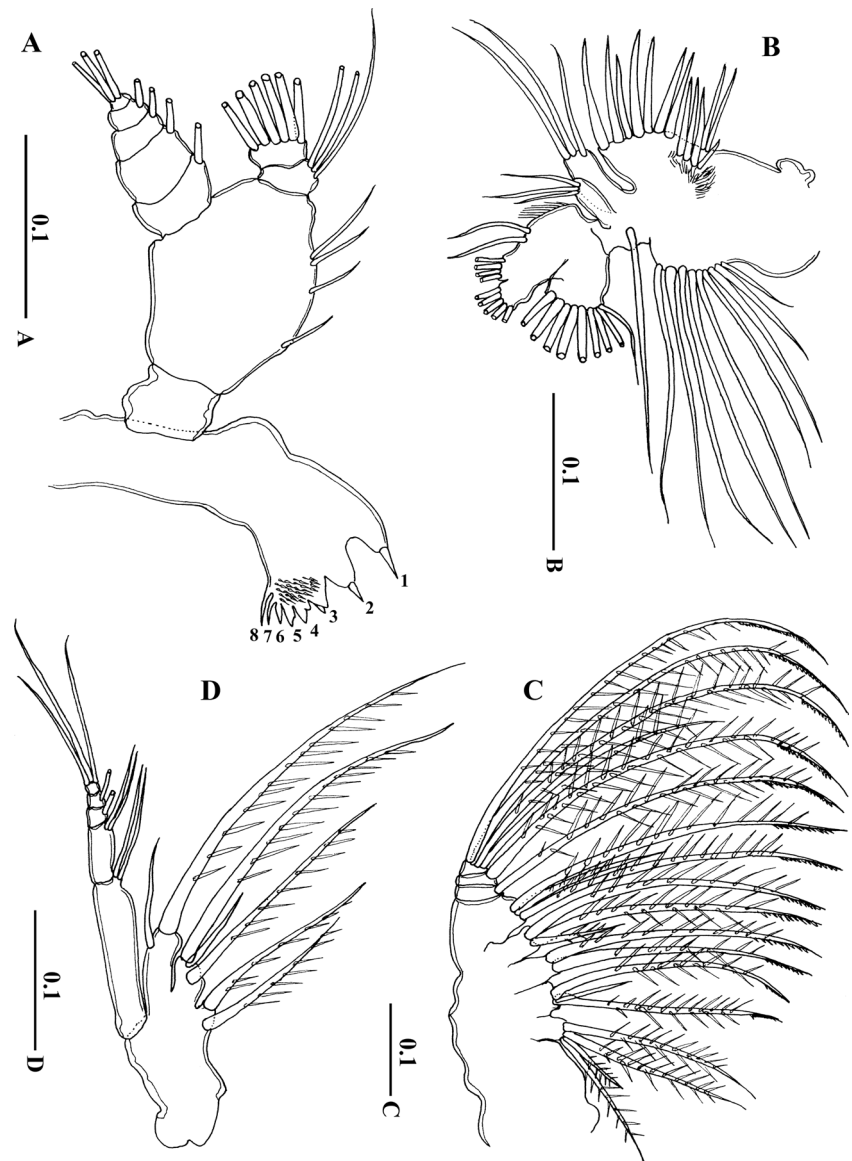
Maxillule (Fig. 3b) praecoxal arthrite with 13 setal elements (9 marginal and 4 on posterior surface). Coxal epipodite carrying 9 setae; coxal and basal endites each with 3 setae; basal exite with 1 long seta. Exopod bearing 9 setae. Endopod incorporated into basis with 2 setae laterally and 9 setae terminally.

Maxilla (Fig. 3c) with first praecoxal endites bearing 4 and 3 (2 long and 1 short) setae, respectively; coxal endites with 2 and 3 (2 long and 1 short) setae, respectively. Basal endite with 2 long and 1 medium setae. Endopod 3-segmented, bearing 1, 1, and 4 spinulate setae.

Maxilliped (Fig. 3d) praecoxa and coxa fused; 3 syncoxal endites well developed carrying strong spinulose setae with setal formula of 2, 3 (2 long and 1 short), 2 (1 long and 1 short). Basis relatively long with 2 distal setae. Endopod 4-segmented with setal formula of 2, 1, 1, 3.

Setal and spine formula of legs 1 to 4 shown in Table 1. Legs 1–4 (Fig. 4a–d) each with 3-segmented exopod and 2-segmented endopod. Coxa of leg 1 to leg 3 bearing distomedial plumose seta and 2 patches of hair-like setules

**Fig. 3** *Calanopia tulina* nov. sp. Female holotype. **a** Mandible; **b** maxillule; **c** maxilla; **d** maxilliped. Scale bars in mm



on lateral and medial margins, respectively. Basis of legs 3 and 4 each with 2 small prominences posteriorly. First endopodal segments of legs 1–4 each with lateral pointed notch. All lateral spines on exopods of legs 1–4 with serrated hyaline margins.

Leg 5 (Figs. 2b and 4e) slightly asymmetrical (right leg slightly shorter than left leg); coxa and intercoxal sclerite fused. Basis with short seta posteriorly. Exopod 2-segmented, first exopodal segment of left leg nearly 1.3 times as long as right one, with small laterally serrated spine at mid length and large medially directed serrated terminal spine. Second exopodal segment longer than first one, bearing 2 serrate lateral spines (distal one longer and nearly about two-thirds the length of distal spiniform process), and ending as a serrated long, distal spiniform process.

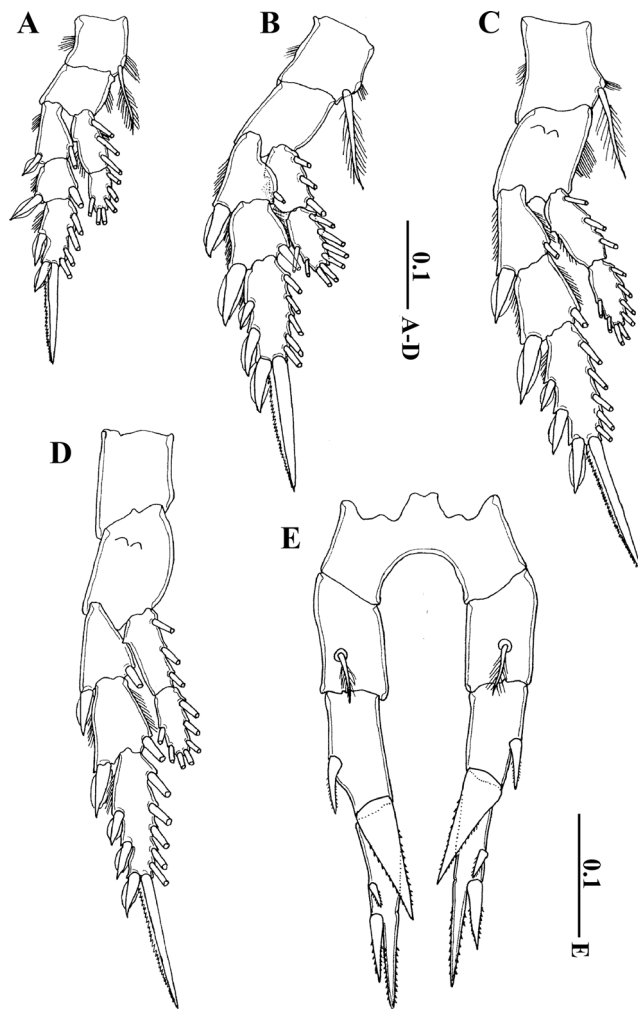
#### Male (allotype)

Body (Fig. 5a, b) forehead more rounded than female in dorsal view. Prosome 1.9 times as long as urosome; fourth and fifth pedigerous somite fused and produced posterolaterally into

**Table 1** Spine and setal formula of legs 1–4 of *Calanopia tulina* sp. nov. from the Red Sea

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





**Fig. 4** *Calanopia tulina* nov. sp. Female holotype. **a** Leg 1; **b** leg 2; **c** leg 3; **d** leg 4; **e** leg 5. Scale bars in mm

asymmetrical pointed corners, the right one wider and slightly longer than the left one, with distinct notch on its medial margin, and reaching end of first urosomite (Figs. 5a and 6a). Rostrum (Fig. 5c) notched as in female. Urosome (Figs. 5d and 6a) with 5 free somites, almost symmetrical except for genital somite with genital aperture on left side. Second and third urosomites with same length and longer than other urosomites; anal somite much shorter than preceding somite. Caudal rami symmetrical, nearly 4 times longer than wide. Urosomites 1–5 and caudal rami in proportions of 18:19:15:5:24, respectively.

Right antennule (Fig. 5e, f) with 17 segments, extending to anterior margin of second urosomite. Armature as follows: ancestral segment I (segment 1) = 2 setae (S), II–V (2) = 7S + aesthetasc (ae), VI–VII (3) = 4S + 2 ae, VIII (4) = 5S (2 spiniform) + ae, IX (5) = 2S (1 spiniform) + ae, X (6) = 1S + ae, XI (7) = 1S + ae, XII (8) = 1S + ae, XIII–XIV (9) = 2S + ae, XV (10) = naked, XVI–XVII (11) = 3S + 2 ae, XVIII–XIX (12) = 1S + process + ae, XX (13) = 1S + ae,

XXI–XXIII (14) = 2S + process + ae, XXIV (15) = 1S + 1S, XXV (16) = 1S + ae + 1S, XXVI–XXVIII (17) = 5S + ae.

Left antennule, antenna, mouthparts and legs 1–4 as in female. Left leg 5 (Figs. 6b, c and 7a) shorter than right one; coxa coalesced into intercoxal sclerite; basis 1.9 times longer than coxa carrying plumose seta posteriorly. Exopod 2-segmented; first segment 0.5 times as long as basis, with pointed spine at distolateral corner; second segment about twice longer than first exopodal one, hirsute on posteromedial surface, armed distally with lateral spine directed medially and 2 relatively long, curved, and medially serrated terminal spines.

Right leg (Figs. 6b and 7b) longer than left; basis slightly shorter than coxa, with plumose seta posteriorly. Exopod 2-segmented, forming a stout chela; first segment (chela) with very small rounded-tip thumb-like process located nearly halfway, central part of the chela smooth with deep depression laterally and seta near to thumb base (Figs. 6d and 7b); second segment (finger) shorter than first, curved at distal two-thirds its length medially with blunt apex and 2 medial setae within depression, and laterally with 2 unequal setae, proximal one long (more than half-length of finger itself) and distal one short, nearly at distal two-thirds of finger.

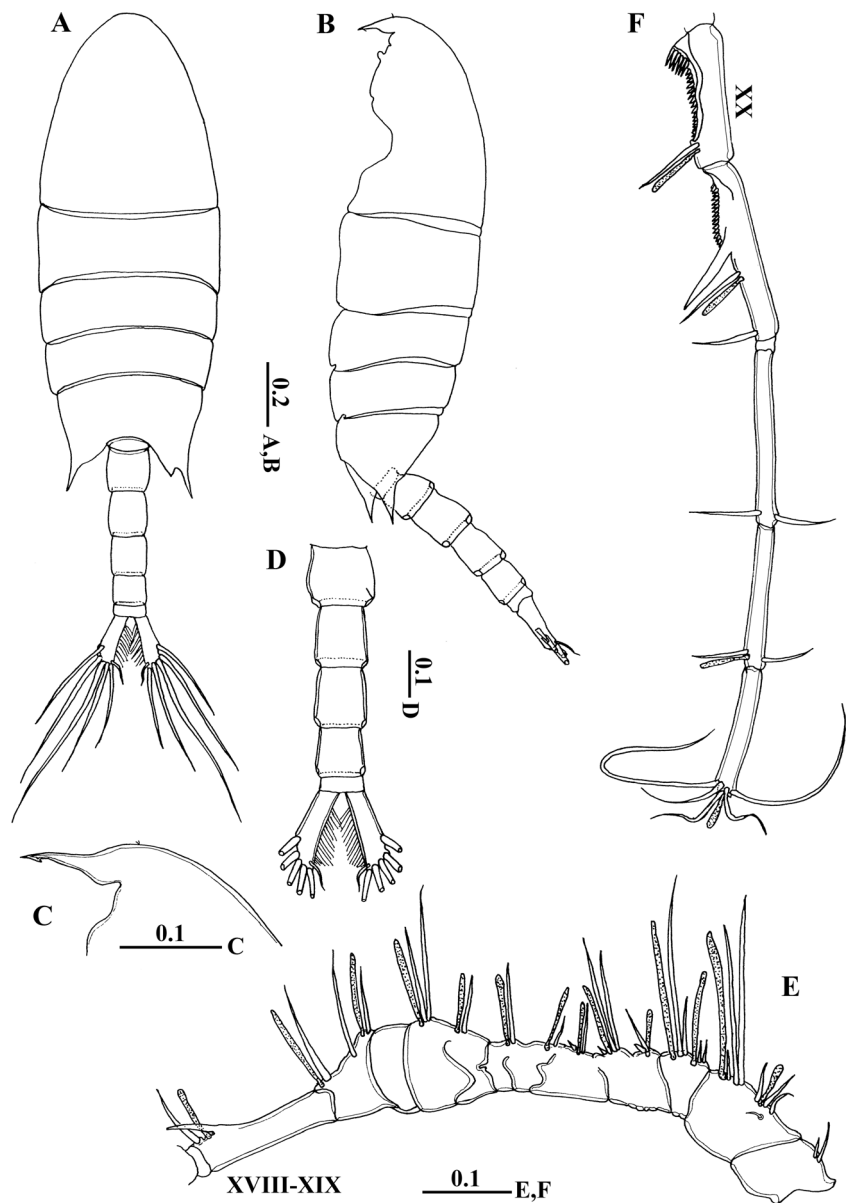
### Etymology

The species is named after “Tulin Al-Aidaros”, granddaughter of Professor Ali Al-Aidaros (the second author), as a symbol of appreciation for his support and giving the first author the opportunity to work on his Red Sea copepod collection.

### Remarks

The new species *Calanopia tulina* sp. nov. is distinguished from all described species by the following combination of characters: (1) cephalic lateral hooks are absent in both sexes, whereas these structures are present in *C. australica* Bayly and Greenwood, 1966, *C. sewelli*, Jones and Park, 1967, *C. seymouri* Pillai, 1969, and *C. thompsoni*; (2) the genital compound somite is slightly longer than the second urosomite. This somite is apparently shorter in *C. aurivilli* Cleve, 1901, *C. levantina* Uysal and Shmeleva, 2004, and *C. minor*, or nearly equally long in *C. biloba* Bowman, 1957, *C. elliptica*, *C. metu* Uysal and Shmeleva, 2004, and *C. thompsoni*; (3) the female leg 5 has a 2-segmented exopod and the first segment has 2 spines, of which the distomedial one is much larger than the proximal one. This character differs from the 1-segmented condition found in *C. americana* Dahl, 1894, *C. aurivilli*, *C. kideysi*, *C. levantina*, *C. metu*, and *C. minor*. In addition, the first exopodal segment is armed with 1 spine in *C. sarsi* B. Wilson, 1950 and the 2 spines are equal or subequal in *C. australica*, *C. biloba*, *C. elliptica*,

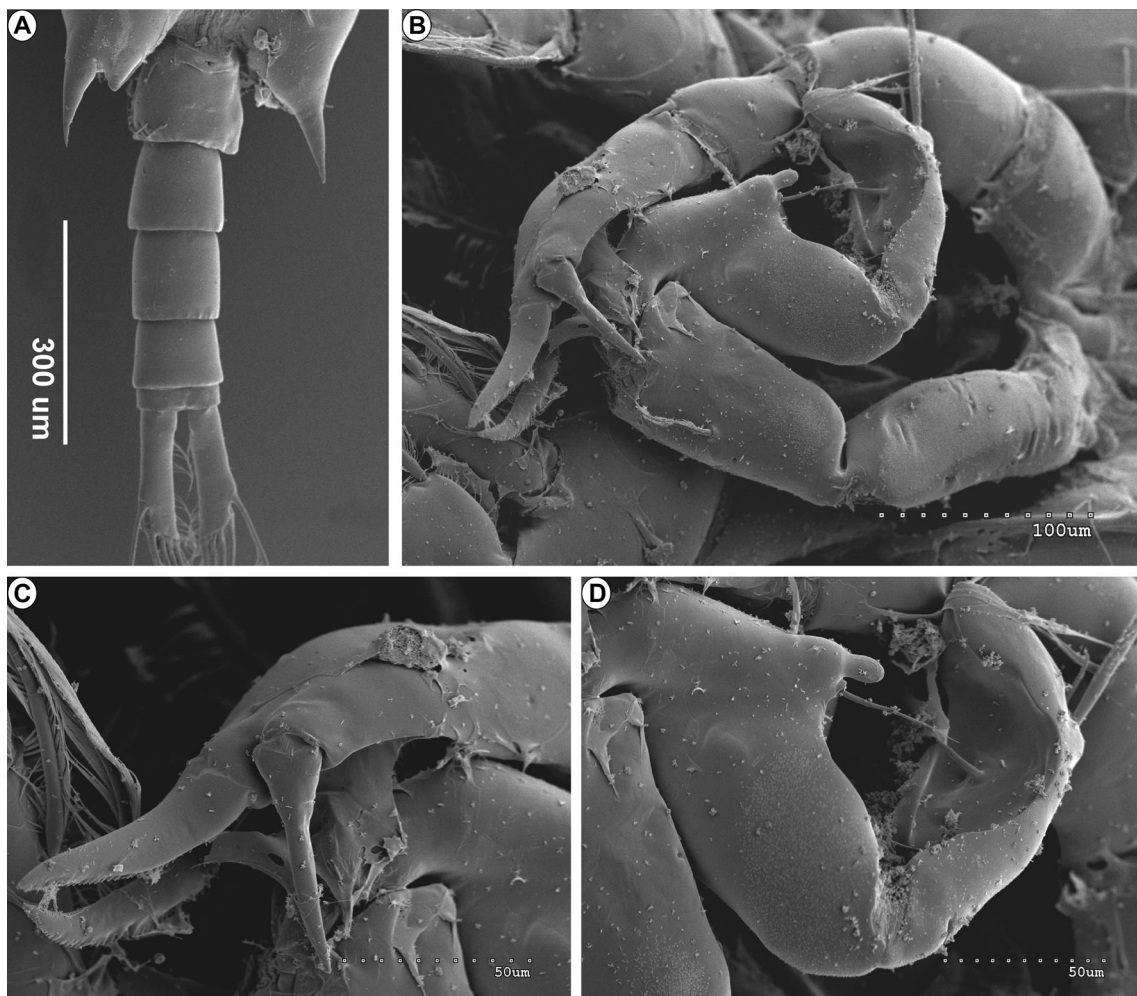
**Fig. 5** *Calanopia tulina* nov. sp. Male allotype. **a** Habitus, dorsal view; **b** habitus, lateral view; **c** rostrum, lateral view; **d** urosome, ventral view; **e, f** right antennule. Scale bars in mm



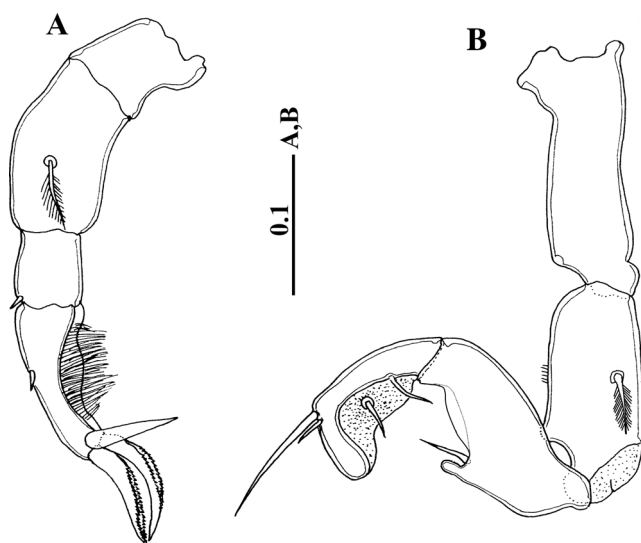
*C. herdmani* A. Scott, 1909, *C. media*, *C. seymouri*, and *C. thompsoni*; (4) the male right prosome has a distinct notch on its medial margin, such a notch is known only for *C. sarsi* [which bears a leg 5 having a short distal segment on the left leg 5 that is different by having the short distal segment of the left leg and a large acute lateral process (instead of a very small thumb-like process) on the right first exopodal segment] and *C. media* redescribed recently from the central Red Sea by El-Sherbiny (2017).

Among the known 16 congeners, *Calanopia tulina* sp. nov. is most closely related to *C. media* described from the Suez Canal by Gurney (1927) and from the Red Sea by El-Sherbiny (2017). These species share the following features: (1) the genital compound somite is slightly longer than the second urosomite; (2) the

second exopodal segment of the female left leg 5 is longer than the first; (3) the second exopodal segment of the female leg 5 carrying 2 lateral spines (proximal one is very short) and prolonged into a terminal process (fused to the segment), which extends beyond the distal lateral spine by about two-thirds the length of the latter; (4) asymmetry of prosomal ends, the right with distinct notch; (5) the first exopodal segment of male right leg 5 is shorter than basis as well as the second exopodal segment; (6) the first exopodal segment of male right leg 5 with small rounded-tip process, central part of the chela with concave depression laterally and 1 medial seta at process base; (7) the second exopodal segment of male right leg 5 shorter than the first, with 2 medial setae at mid length. *Calanopia tulina* differs from



**Fig. 6** SEM micrograph of *Calanopia tulina* nov. sp. Male paratype. **a** Posterior prosomal corners and urosome, ventral view; **b** male leg 5, posterior view; **c** enlarged distal segment of male left leg 5, posterior view; **d** enlarged first exopod segment of male right leg 5



**Fig. 7** *Calanopia tulina* nov. sp. Male allotype. **a** Left leg 5, posterior view; **b** right leg 5, posterior view. Scale bars in mm

*C. media* in the following features: (1) lack of the two lateral setae on the right side of female genital compound somite; (2) asymmetry of caudal ramus (the right ramus slightly shorter than left); (3) asymmetry of female leg 5, in which left one slightly longer than right one; (4) male left leg 5 s exopodal segment with 2 terminal curved spines that differ in shape and size of *C. media*; (5) male right leg 5 second exopodal segment with lateral spine longer than in *C. media*. It is worth mentioning that the asymmetry of female caudal rami is also reported in *C. asymmetrica* Mulyadi and Ueda, 1996 collected from Indonesian waters, with the right ramus much wider and longer than the left. This asymmetry was also reported in *C. sewelli* collected from Marquesas, central Pacific, in which the right is longer and with a concave medial margin, and *C. australica* collected from Moreton Bay, Australia, in which the left ramus is longer than the right. Recently, El-Sherbiny (2017) reported the asymmetry in caudal rami of 90% of the *C. media* population collected from the central



**Table 2** Summary list and characters of the species groups of the genus *Calanopia*

Groups	Basis of grouping	Reference
Two groups	- Female exopod 1- or 2-segmented	Bayly and Greenwood (1966)
Three groups ( <i>aurivilli</i> , <i>elliptica</i> , and <i>thompsoni</i> )	- Structure of rostrum, - Presence of cephalic lateral hooks, - Structure of female leg 5, and - Structure of first and second exopodal segments of the male right leg 5	Silas and Pillai (1973)
Four groups ( <i>aurivilli</i> , <i>elliptica</i> , <i>herdmani</i> , and <i>thompsoni</i> ) and left <i>C. media</i> and <i>C. sarsi</i> unassigned	- Structure of rostrum, - Presence of cephalic lateral hooks, - Structure of female leg 5, - Structure of first and second exopodal segments of the male left and right leg 5, and - Structure of medial margin of the chela of the male right leg 5	Mulyadi and Ueda (1996)

Red Sea, where the right ramus is broader, slightly shorter than the left one, with an anteromedial expansion. This new species (*C. tulina*) and *C. sarsi* from Fiji waters and *C. media* reexamined recently from the central Red Sea (El-Sherbiny 2017) are the only species with asymmetry of male prosomal corners.

The genus *Calanopia* was subdivided into two species groups by Bayly and Greenwood (1966), later supplemented by several species (Mulyadi and Ueda 1996; Ünal and Shmeleva 2002; Uysal and Shmeleva 2004). Subsequently, the species of *Calanopia* recorded in the Indian Ocean were divided by Silas and Pillai (1973) into three groups, and four *Calanopia* species groups were established by Mulyadi and Ueda (1996) (Table 2). However, these authors were unable to place *C. media*, *C. sarsi*, and *C. sewelli* into one of the groups. The new species (*C. tulina*) closely resembles *C. media* and also does not fit any existing species group, nor does it comprise a new group.

## Discussion

Most members of the family Pontellidae are often ubiquitous in neustonic waters of tropical to warm temperate latitudes (e.g., Fleminger 1957, 1967; Matsuo and Marumo 1982; Ohtsuka et al. 1987; Mauchline 1998). The genus *Calanopia* is distributed mostly in the neritic waters of the Indo-pacific, except *C. americana* and *C. biloba*, which are known only

from the Atlantic Ocean. The presence of the described species (*C. tulina*) during night sampling may refer to its diel vertical migration (DVM). In general, some *Calanopia* species display high abundance during the night and/or exhibit a clear diel vertical migration. Gurney (1927) and Pesta (1941) reported that *C. media* has been found in high numbers in coastal waters mainly from the night samples at the southern part of the Suez Canal and the southern Red Sea, respectively. Recently, El-Sherbiny (2017) pointed out that *C. media* also showed a clear DVM at the central Red Sea, where they were collected with a considerable abundance (106 ind./m<sup>3</sup>) at sunset and with the highest density at a midnight collection (150 ind./m<sup>3</sup>), but were completely missed in morning and mid-day samples. Likewise, a comparable pattern was recorded for *C. americana* in the eastern Gulf of Mexico (Turner et al. 1979) and in the Brazilian waters (Pessoa et al. 2014). Moreover, in their experiment, Cohen and Forward (2005) suggested that both exogenous light signals and endogenous rhythms could be the main factors controlling the twilight DVM pattern of *C. americana*.

During the last two decades, more attention has been paid to the family Pontellidae, resulting in the description of two new species [*Calanopia kideysi* by Ünal and Shmeleva (2002), *Labidocera boxshalli* El-Sherbiny and Ueda, 2010 by El-Sherbiny and Ueda (2010)] and five new records [*Calanopia thompsoni* by Al-Aidaros et al. (2016), *Pontella karachiensis* Fazal-Ur-Rehman, 1973 by El-Sherbiny and Ueda (2008), *L. kroyeri* (Brady, 1883) by El-Sherbiny (unpublished), *Pontella princeps* Dana, 1849 by El-Sherbiny (2009), and *Pontella diagonalis* C.B. Wilson, 1950 and *Pontellopsis macronyx* A. Scott, 1909 by El-Sherbiny (unpublished)] for the Red Sea. Due to the neustonic nature of the family Pontellidae and/or limited sampling effort, further studies are recommended covering more spatial and temporal scales along the Red Sea.

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