



First Record of *Calanopia metu* Uysal & Shmeleva, 2004, A Mediterranean Calanoid Copepod from Indian Waters

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Abstract: The present study deals with the first record of a calanoid copepod, *Calanopia metu* Uysal & Shmeleva, from coastal waters of Cochin region, which is situated in the south west coast of Arabian Sea, region of Indian Ocean. A total of 48 specimens ranged from 350 μ m and 512 μ m were recorded from the region. The mean abundance was 1 ± 1.4 individuals per m^3 . The species is native to the Mediterranean Sea and was originally described in 2004 from the Levantine basin. The occurrence of *Calanopia metu* in the study region is inferred as an introduction of non-native species through the ballast water of cargo hold ships. For the present study, the samples of *Calanopia metu* were collected from three stations of Cochin estuary during the Pre-monsoon period.

Keywords: Zooplankton, Cochin estuary, Ballast water, Arabian Sea

Copepods are the most abundant and diverse group of small crustaceans distributed in almost all types of aquatic habitats. They have a promising role in the ecosystem, because they act as a connection link between the phytoplankton and the higher organisms. Order Calanoida, represents a major group of copepods with nearly 2266 valid species, belonging to 42 families (Boxshall and Halsey 2004, Razouls et al 2005-2016). Genus *Calanopia* under the family Pontellidae consist of a total of eighteen species (Unal and Shmeleva 2002, Al-Aidaros et al 2016, El-Sherbiny and Al-Aidaros 2017) of which fourteen species were reported from the Indo-Pacific waters and the remaining four species from the Mediterranean and Atlantic waters. Members of genus *Calanopia* are typically marine inhabitants but also reported from estuaries during high saline periods (Costello 2001, Vineetha et al 2015). Of the fourteen species reported from Indo-Pacific waters, the species such as *Calanopia elliptica* Dana, 1849, *Calanopia aurivilli* Cleve, 1901, and *Calanopia minor* Scott A, 1902 are the common species distributed in the marine and coastal waters of the Arabian Sea (Prusova et al 2011). *Calanopia metu* is reported first time from Mediterranean waters (Uysal and Shmeleva 2012). Cochin estuary is the largest estuarine system located in the south west coast of India and emptying into the south-eastern Arabian Sea of Western Indian Ocean. The estuary is called monsoonal estuary, because it is heavily influenced by south west monsoon (Vijith et al 2009). It permanently opens to the

Arabian Sea at Cochin (width 450m) and at Azhikode (width 250m) (Vineetha et al 2015, Vinita et al 2015). Estuaries becomes merely an extension of the adjoining Sea, with environmental features almost similar to those of the coastal waters (Sivaprasad et al 2013) and most of the coastal/marine species were encountered during the high saline pre-monsoon and post-monsoon season (Vineetha et al 2015). During the dry season, the Cochin estuary is also more productive and the diversity, richness and evenness of copepod species become high (Jyothisbabu et al 2006). The present study deals with the new record of *Calanopia metu* from the coastal waters of India and this is the first report from the Indian Ocean.

MATERIAL AND METHODS

Samples were collected from three locations (Vallarpadam – 9.98°N, 76.25° E, Bolgatty-9.98°N, 76.26°E, Marine drive-9.97° N, 76.27°E) in bar mouth area of Cochin estuary (Fig. 1) during pre-monsoon period (February 2018). Copepod sampling performed in the morning between 6 am and 8 am during low tide by using the conical zooplankton net (mesh size- 200 μ m; diameter -60cm) in the upper water column. A calibrated flow meter (Model: Hydro-Bios-438110) fitted with net used to estimate the volume of water filtered. The net was hauled horizontally for 10 minutes by maintaining a minimum speed of ~2 knots. Collected samples were properly washed and filtered with pre filtered

water and preserved with 4-5% formaldehyde solution and stored in sample containers for further analysis in the shore lab. Water samples were collected for analysing the physical parameters such as temperature and salinity. Temperature measured using 0-50°C precision thermometer. Salinity using a calibrated hand refractometer (Model: ERMA accuracy ± 0.001).

In the laboratory, copepods were sorted with help of a zoom stereo microscope (Model: Magnus MSZ-Tr) and the numerical abundance was recorded. Folsom plankton splitter was used to get the subsample in the case of large samples. The species identification was done by dissecting the fifth pleopods and mounted on a clean slide and observed under the microscope (Model: Leica DM500). Photographs and measurements were done by using Leica microscope Camera (Leica ICC50 HD) fitted with the microscope and image analysing software (LAS EZ) respectively. Taxonomic identification up to species level was done using the following manuals: Kasturirangan (1963), Uysal and Shmeleva (2004) and Conway (2006). Marine planktonic copepod databases were also used for identification (<https://copepodes.obs-banyuls.fr/en/>).

RESULTS AND DISCUSSION

During the study period, the salinity varied from 31 to 32 ppt and the surface temperature fluctuated between 28 and 30°C. A total of 48 specimens of *Calanopia metu* were collected during the survey. All specimens were in the advanced copepodite IV and V stage of both males (43%) and females (56%). Mean abundance recorded during the period was 1 ± 1.4 individuals per m^3 with a size range from 350 to 512 μm . The samples were deposited in the national zoological collection of crustacean division ZSI/FPS of Zoological Survey of India, Kolkata and the reference ID issued is C8930/2.

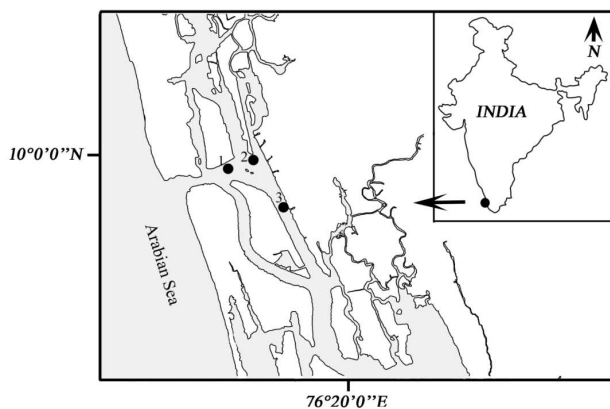


Fig. 1. Sampling locations of Cochin estuary-South-west of Arabian Sea

Classification

Phylum	: Arthropoda Von Siebold 1848
Subphylum	: Crustacea Brnnich 1772
Class	: Copepoda Milne Edwards 1840
Order	: Calanoida Sars GO 1903
Family	: Pontellidae Dana 1852
Genus	: <i>Calanopia</i> Dana 1852
Species	: <i>Calanopia metu</i> Uysal & Shmeleva 2004

Description of the species: Cephalosome lacks cephalic hook; rostral spines present. Specimens examined include 36 males and 46 females.

Male: Total length of the body varied from 350 μm to 487 μm . Cephalosomes are similar to females. Antennule 14 segmented, reaching up to the first urosomal segment (Fig. 2E). Urosome four segmented (Fig. 2F). Fifth leg asymmetrical left one slightly longer than the right one; exopod of the left leg 3 times wider than the right with 4 small spines on ventro-lateral margin. Right leg exopod bearing 3 small spines (Fig. 2G). In males, all the characters were identified the same as in the original, male described as copepodite V stage in the original description.

Female: Body robust without cephalic hooks. (Fig. 2A). Total length of the body varied from 350 μm to 512 μm . Antennule 16 segmented, reaching up to first urosomal segment

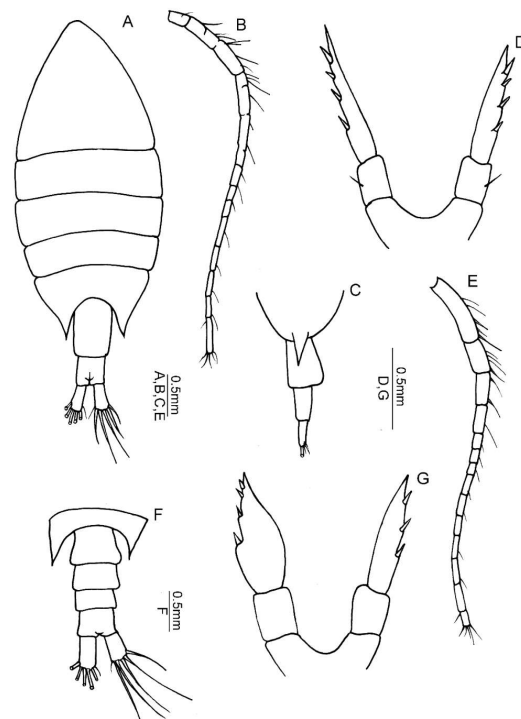


Fig. 2. External morphology of *Calanopia metu* A) *Calanopia metu* female dorsal view; B) Female antennule; C) Female urosome; D) Female P5; E) Male antennule; F) Male urosome; G) Male P5

(Fig.2B); Postero lateral segment of the 5th pedigerous somite produced symmetrical acuminate spines. Urosome two-segmented; genital somite bulged Postero ventrally (Fig. 2C). Fifth leg three segmented, asymmetrical; right leg slightly shorter than left. Basis bearing short setae, exopod having four short, sharp spines (Fig. 2D).

The detailed examination of the specimen showed urosomal structure and fifth pedigerous somite are similar to *Calanopia metu* and were noticeably varied when compared to other species of the genus commonly in the region such as *Calanopia elliptica* and *Calanopia aurivilli* (Table 1) (Fig. 3). Even though all the specimens collected were late copepodite stages, the species identification characteristics were prominent and according to Czaika (1982) copepodites can also be used for the species identification. *Calanopia*

metu is a truly marine species, first described in 2004 by Uysal & Shmeleva from the Levantine basin of Eastern Mediterranean Sea. According to Uysal and Shmeleva (2012), this is an abundant species in the Levantine basin of the Eastern Mediterranean Sea and they emphasized the suitability of environmental condition of the basin to support all developmental stages of *Calanopia metu*. Temperature and salinity of the Mediterranean Sea varied from 16 to 29°C and 38.5 to 39.4 ppt, respectively which is conducive for the successful survival of this species. The observation on the occurrence of *Calanopia metu* in the Cochin estuary i.e., the present study forms the first report of this species from the entire Indian Ocean region (Al-Aidaros et al 2016). The species *Calanopia metu* was observed in Cochin estuary during the high saline pre-monsoon season. The

Table 1. Comparison of *Calanopia metu* with *Calanopia aurivilli* and *Calanopia elliptica*

<i>Calanopia metu</i>	<i>Calanopia aurivilli</i>	<i>Calanopia elliptica</i>
Female	Female	Female
Cephalosome without lateral hook	Cephalosome without lateral hook	Cephalosome without lateral hook
Prosoma in dorsal view, slightly less than twice as long as wide. The 5 th segment with symmetrical acuminate spines, inclined a little outward.	Prosoma produced in to posteriorly directed acute spines	Thoracic segment reduced posteriorly in to strong process reaching middle genital segment
Urosome 2-segmented, symmetrical and unarmed	Urosome 2-segmented	Urosome 2-segmented
Genital somite lacking ventral spine, distinctly evolved laterally, slightly protuberant ventrally and genital operculum rosette shaped	Genital segment shorter than anal segment	Genital segment same in length as urosomite
P5 slightly asymmetrical, last segment having 4 shorts spines resembling well developed finger like projections	P5 symmetrical and uniramous; exopod 1-segmented apex terminates in 3 spines, inner being distinctly longer and plumose at its distal margin	P5 asymmetrical left leg longer than right. Exopodal segment 1 with 1 median and distolateral sine; exopodal segment 2 ending in an acute spine with 2 outer marginal spine
Male	Male	Male
Description of Copepodite stage V Body similar to female Metasome 2.2 times longer than urosome 4-segmented with symmetrical caudal rami	Body similar to female. Cephalosome without hook.	Body similar to female except the right thoracic process is longer than left and pointed inward
A1 extending to first urosomite	Right A1 geniculate	Right A1 geniculate, segments 13-16 swollen while segments 19-21 denticulate. A1 extended to the genital segment
Urosomite 1 1.6 times longer than urosomite 2. Ventral spines of urosomite 2 absent	Urosome 5-segmented	Urosome 5-segmented, urosomite 2 with 1 spiniform process on distal right margin
Copepodite V leg 5 is asymmetrical with length of the third segment of right leg twice longer than the second segment and with smaller spines. Length of third segment of left leg 3 times as long, with 4 small spines on ventro-lateral margin.	P5 asymmetrical and chelate; right leg 4-segmented, proximal inner margin of basis swollen, exopodal segment 1 with well-developed thumb, claw spoon shaped, slightly swollen at tip with 1 outer marginal seta, 1 terminal and 2 inner marginal; left leg basis swollen and gibbose, exopod segment 1 with distolateral seta, terminal segment with 2 unequal apical spines	P5 asymmetrical; right leg exopodal segment 2 with 3 process along the inner margin; left leg, exopodal segment 1 with 2 outer marginal spines, 1 at mid –outer margin and another distolaterally; exopodal segment 2 with 2 outer marginal spines and terminates in a strong acute spine with setules on the outer margin

The characters were taken from the original description as well as from the copepod database (<https://copepodes.obs-banyuls.fr/en/>) for the comparative purpose

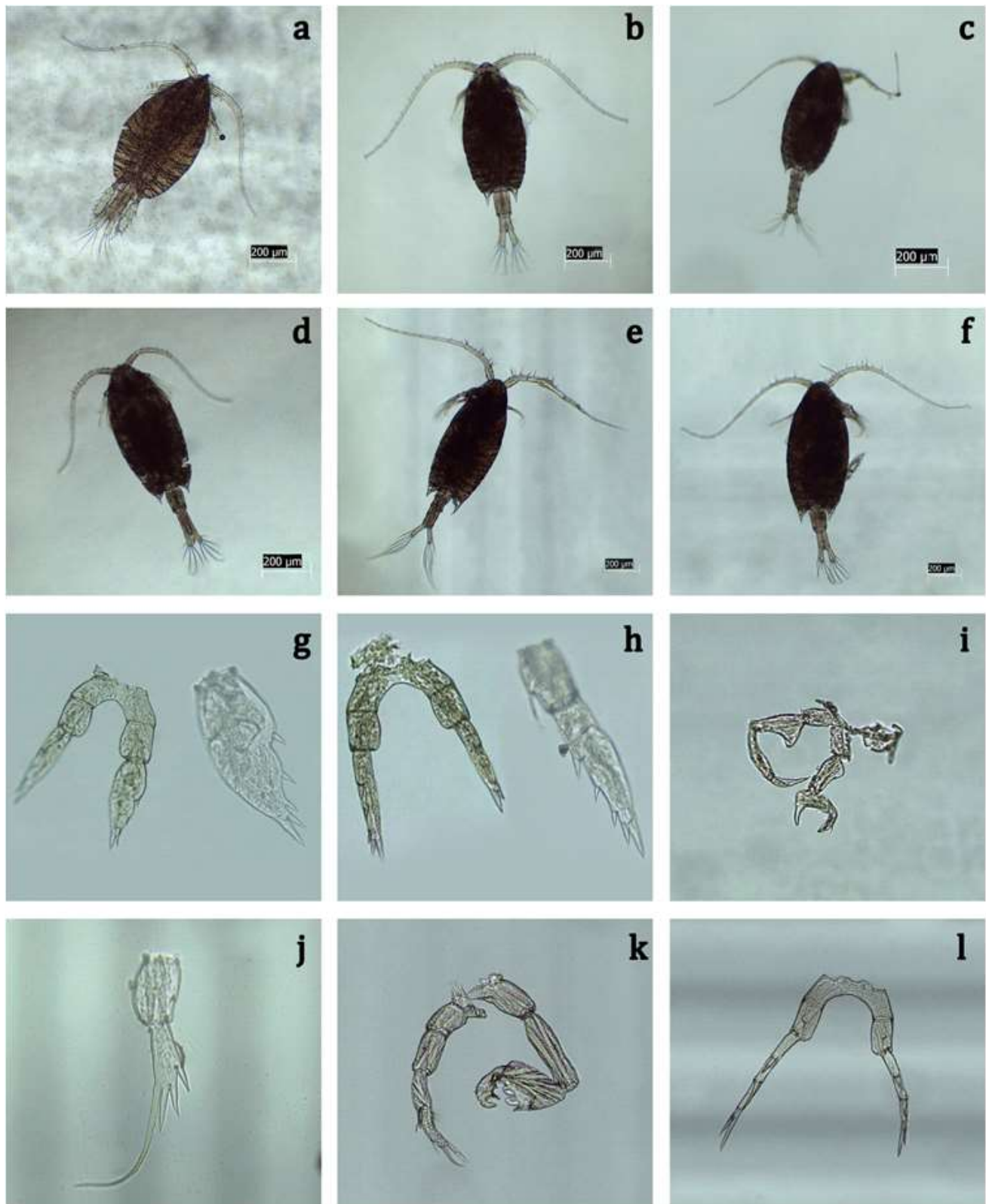


Fig. 3. External morphology of *Calanopia metu*, *Calanopia aurivillii* and *Calanopia elliptica* a) *C. metu* male dorsal view; b) *C. metu* female dorsal view c) *C. aurivillii* male dorsal view; d) *C. aurivillii* female dorsal view; e) *C. elliptica* male dorsal view; f) *C. elliptica* female dorsal view; g) *C. metu* male leg 5 and right exopod; h) *C. metu* female leg 5 and left exopod; i) *C. aurivillii* male leg 5; j) *C. aurivillii* female right leg 5; k) *C. elliptica* male leg 5; l) *C. elliptica* female leg 5

environmental condition persisted during the study period may be conducive for the survival of this Mediterranean species in the estuaries which point out the tolerance of this species to wide range of salinity and temperature

The presence of a non-native species in the Arabian Sea from its native place to a far distance new environment by two possibilities transport of species through oceanic circulation or water mass and through human interaction such as marine traffic/ ballast water. The first possibility can easily be ruled out from the present study because of the rare chance of anti erythraean or anti lessepsian migration (Zakaria 2015). The second possibility strongly supports the occurrence of this species in the Cochin estuary i.e., introduction through the ballast water of commercial cargo ships. Cochin bar mouth is the major site for port activities and it is one of the largest port cities in India. The country's first Trans - shipment hub-Kochi International Container Trans-shipment Terminal (ICTT) and the Cochin Shipyard were located in Cochin Estuary. Being an active/busy maritime destination, the chance of introduction of foreign species to the Cochin estuary through ballast water is quite high. Due to the vicinity of the International Container Transshipment Terminal, Cochin estuary is exposed to non-native species (Jayachandran et al 2019a). Considering these facts, can evince the second possibility of introduction of the species through the ballast water into the new environment.

CONCLUSION

Calanopia metu is introduced into the Cochin areas of Indian waters through the ballast waters. Occurrence of this species in the region suggests that the environmental conditions prevailed in the region is favourable for the survival of this species. The low relative abundance recorded may be due to the competition pressure on resources such as food and space with the native species. There may be a possibility of distributional extension of this species to the Arabian Sea. In order to ensure this, a comprehensive studies is required.

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