

First report of cyclopoid copepods (oithonidae) from north-eastern Arabian Sea, Karachi, Pakistan

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Introduction

Among marine communities, the importance of small species has been neglected and major attention has been paid to the larger representatives (Mazzochi and Paffenhoper, 1998). Small copepods are now assigned as a significant component within marine food webs (Tuner, 2004). Their ecological habitat comprises estuarine, pelagic and coastal environments. *Oithona* plays a vital role as a food source for other copepods, Chaetognaths, fish larvae and planktivorous fishes.

Members of the genus *Oithona* are distributed throughout the world (Nishida, 1985; McKinnon, 2000; Galliene and Robins, 2001). More than

54 species of *Oithona* were recorded from the world and 27 species were reported to occur in the Indian Ocean (Razouls, *et al.*, 2005-2016). The species belonging to genus *Oithona* were reported widely from many parts of Western Indian Ocean including the Arabian Sea (Kasturirangan, 1963; Madhupratap *et al.*, 1992; Al-Yamani *et al.*, 2011). They were reported to be the most abundant species in the zooplankton samples. However, in Pakistan the taxonomy of copepods were mostly confined to the calanoid copepods and the information about the diversity of this important and abundant genus was limited only to the report of single species *Oithona plumifera* (Haq *et al.*, 1973). Therefore, the present

study was conducted to determine the species composition of the genus *Oithona* previously not known from the coastal waters of Pakistan.

Material and methods

The zooplankton sampling was conducted monthly (March 2010–September 2013) at four stations in Manora Channel and the Sandspit backwater mangrove forest area using zooplankton net (mesh size 170 µm). Samples were preserved immediately in 4 % formalin. Cyclopoid copepods of genus *Oithona* were sorted out from samples under a stereomicroscope and examined under a compound microscope (using objective lens 100x, oil immersion). The total length (measured dorsally from tip of the prosome to the end of the caudal ramus, excluding caudal setae), prosome length (from tip of head to last thoracic segment), urosome length (from last thoracic segment to caudal rami) of specimens were measured with a calibrated ocular micrometer. Species were identified according to an identification guide for *Oithona* (Nishida, 1985; Razouls *et al.* 2005). In the text the following abbreviations are used: mandibles (Md), maxillule (Mx1), inner lobe 2 of maxillule (Li2); outer lobe 1 of maxillule (Le1), maxilla (Mx2), antenna (A2), antennule (A1) and swimming legs (P1 to P5).

Results and discussion

Systematics

Family: Oithonidae Dana, 1852

Genus: *Oithona* Baird, 1843

Diagnosis

Prosome short, 5 segmented, oval to fusiform in dorsal view. Anterior margin of cephalosome rounded or with 1 rostrum in females and truncate without rostrum in males. Posterior margin of cephalosome wide. Posterior margin of prosome rounded. First antennae twice geniculate in males and not geniculate in females. P5 with 2 lateral process on pedigerous segment. Urosome slender with 6 somites in males while 5 in females. Genital somite long and swollen laterally in females, simply cylindrical in males. Caudal rami with 1 outer, 1 dorsal and 4 apical setae (Baird, 1843).

Oithona rigida (Giesbrecht, 1896)

Female size: 0.831 mm (Fig. 1)

Synonym: *Dioithona rigida*

Description

Cephalosome robust with blunt rounded and anteroventrally bent into blunt rostrum. Prosome short oval, posterior end with greatest width (Fig. 1a). Prosomal length is 0.44 mm. Posterior width of cephalosome is 0.2 mm and urosome is 0.43 mm. A1 0.8 times of prosomal length. A2 base bears 3 setae; endoode segment I bears 5 setae 2 medial and 3 terminal; endopod segment II 7 terminal setae (Fig. 1b). Md basis bears 2 sharp spines, endopod of Md armed with five spines outer most is hirsute (Fig. 1c), whereas exopod 4 segmented with 1, 1, 1, 2

setae as in *O. oculata*. Mx1 endopodite with 2 setae (Fig. 1d). Terminal modified spine of P4 exopod is equal to the last segment of the exopod. Caudal rami 3.3 times longer than wide. Outer spines on the exopod of P1 to P4 is 113, 113, 113, and 112. (Fig. 1e).

Oithona oculata (Farran, 1913) ♀

Female size: 0.77mm (Fig. 1 f- l)

Synonym: *Dioithona occulata*

Description

Cephalosome robust with blunt rounded and anteroventrally bent into blunt rostrum. Prosome short oval, posterior end with greatest width (Fig. 1f). *O. oculata* shows resemblance with *O. rigida*. Caudal rami 2 times longer than

wide. A2 base bears 3 setae covered with hairs, endopod segment I with 5 setae: 1 medial and 4 terminal, endopod segment II armed with 7 terminal setae. (Fig. 1g). Mx1 endopodite with 4 setae with asymmetric size (Fig. 1h). Md basis comprises of 2 sharp, hirsute and pointed spines. The endopod of Md composed of 5 setae 2 proximal and 3 distally present, exopod is 4 segmented with 1,1,1,2 setae (Fig. 1i). Terminal spines of exopod of swimming legs P1 to P4 is longer than last segment of exopod. (Figs. 1j and k). P5 consists of two segments: a broad basal segment with long outer seta and a narrow segment with 2 setae; leg present laterally on genital somites (Fig. 1 l).

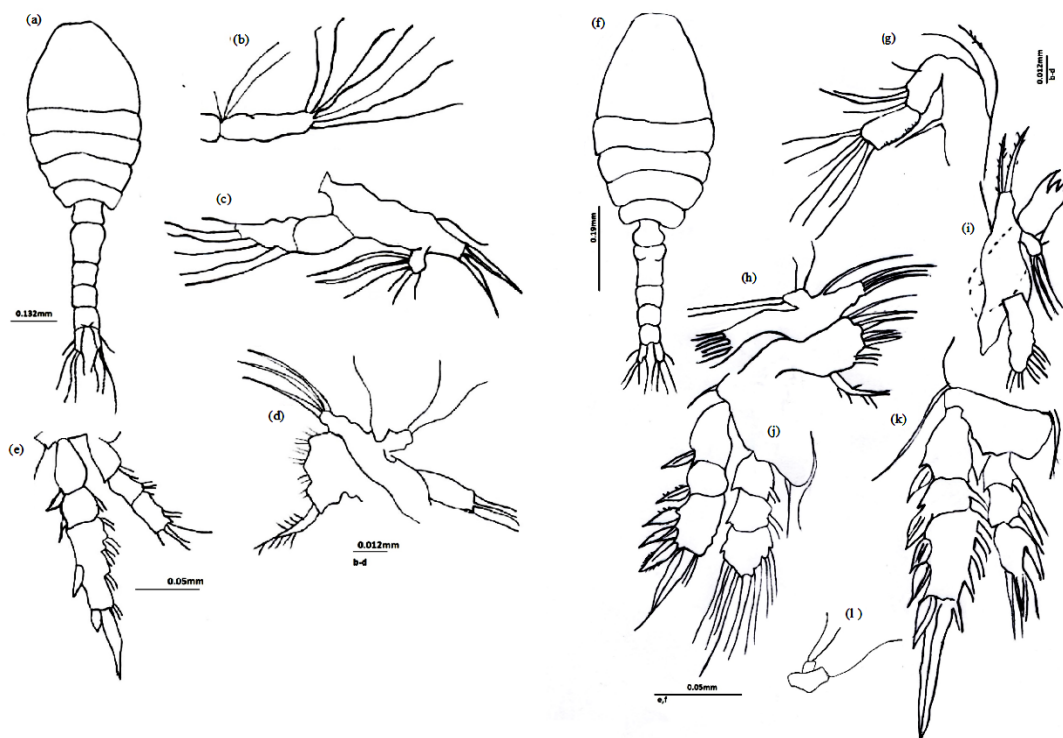


Figure 1: *Oithona rigida* ♀ (a) dorsal view; (b) A2; (c) Md; (d) Mx1; (e) P IV. *Oithona oculata* ♀; (f) dorsal view; (g) A2; (h) Mx1; (i) Md; (j) P I; (k) P III; (l) P V.

Oithona brevicornis (Giesbrecht, 1891)

♀, ♂

Female size: 0.69 mm (Fig. 2 a - f)

Description

Prosome elongate and 2 times width of cephalosome, anteriorly rounded, head ventrally sharp pointed in lateral view. First antennae reaches up to 2nd metasomal segment only, caudal rami consist of 4 apical plumose setae and 1 lateral naked setae (Fig. 2a). A2 base put up with 3 setae covered with hairs, 1 is at inner margin and 2 at outer margin while endopod segment I is armed with 5 setae (one proximal, one distal and three terminal) (Fig. 2b); Segment II of endopod bears 7 terminal setae. Base of Md bear curved, blunt thick spines; endopod of mandible bear 4 setae outer most is hirsute (Fig. 2c). Endopod of Mx1 with three setae (Fig. 2d). P1 exopod III segment has 1 elongated spine with hirsute tip (Fig. 2e). P4 endopod III segment is bearing modified spine (Fig. 2f).

Oithona similis (Claus, 1866) ♀

Synonym: *O. helgolandica* (Claus, 1863)

Female size: 0.744 mm (Fig. 2g - n)

Description

Prosome elliptical, rounded and long 0.47mm. Antennules slightly longer than prosome about 1.1 times of Prosome. Rostrum rounded dorsally and pointed ventrally (Fig. 2g). The length of prosome is 0.5 mm and 2.6 times to its width in our samples. First antennae reaches up to the end of metasome. Antennule 1 is 0.75 times of

prosomal length. Urosomal somites varies in length, divided into 5 somites (Fig. 2h). A2 is 5 segmented, basipod segment II covered with 1 outer and 1 inner seta present at distal end; Endopod segment II bears 2 outer setae apart from each other; Exopod segment III roofed with 7 terminal setae (Fig. 2i). Md basis bearing 2 sharp curved and pointed spines covered with spinules. One minute and 3 subequal setae present on endopod, outer most one is hirsute, exopod 4 segmented with 1,1,1,2 setae (Fig. 2j). MxI with endopodite one seta which is absent in *O. fallax* which resembles to *O. similis*. (Fig. 2k). Terminal spines of P1 to P4 are 3.5 times longer than the last exopod segment (Figs. 2 l and m). P5 of *O. similis* with 2 setae present on broad basal segment (Fig. 2n).

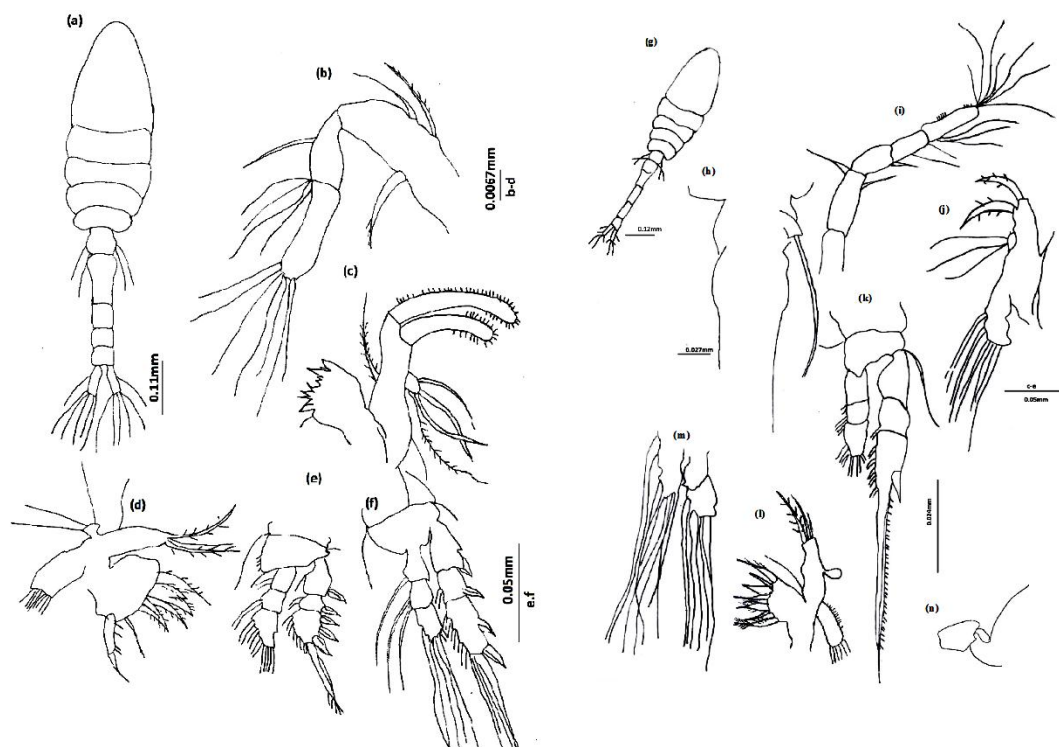


Figure 2: *Oithona brevicornis* ♀ (a) dorsal view; (b) A2; (c) Md; (d) Mx1; (e) P I; (f) endopod of P IV with modified spine. *Oithona similis* ♀ (g) dorsal view; (h) genital somite; (i) A2; (j) Md; (k) Mx1; (l) P II; (m) P IV; (n) P V.

Oithona pseudofrigida (Rosendorn, 1917) ♀

Female size: 0.82 mm (Fig. 3a-g)

Description

Prosoma pointed anteriorly elliptical in shape; rostrum Antero ventrally pointed and sharp, Urosome with 5 somites with three spines on last segment in a lateral view (Fig. 3a and b). A2 basipod bearing 3 setae, 2 outer medial and proximal hirsute. Endopod I segment has 5 setae (1 medial, 1 proximal and 3 terminal) while second segment has 6 terminal setae, 2 small and naked and other 4 hirsute (Fig. 3c). Md basis occupy 2 sharp, recurved and pointed spines covered with hairs; endopod possess 4 setae, 3 subequal and

proximal one large hirsute. Exopod 4 segmented with 1, 1, 1, 2 setae (Fig. 3d). Mx1 is shown in figure with one setae on endopodite segment (Fig. 3e). All swimming legs are diverse, exopod of leg I to IV with 3.7-4 times larger terminal spine than the last exopod segment. Short inner seta present inner margin of exopod I of P2 and P4 (Fig. 3 f and g). P3 is characterized with 2 rudimentary spinules on III segment of exopod.

Oithona attenuata (Farran 1913) ♀

Female size: 0.68mm (Fig. 3 h-m)

Description

Prosoma rounded and increases in width towards posterior end. Lateral

view of species shows small process (Figs. 3 h and i). Urosome is slender, comprises of 5 urosomal somites. Genital segment is 1.4 times longer than wide. A2 basipod segment I bears 2 inner and 1 outer marginal setae, 1 of the inner one is hirsute and present at the base of basipod segment II. 2 setae (1 small and 1 large) medially present on second basipod segment. Endopod of Segment I with 5 setae; 1 medial, 1 distal and 3 (2 hirsute) terminal setae. Second endopod segment is terminally covered with 7 (2 small and 5 sub

equal) setae. Md basis has 2 spines one small, pointed and sharp and second one is thick, pointed, hirsute and recovered; endopod with 4 semi equal setae (Fig.3j). Mx1 endopodite constitute 4 setae of subequal sizes and one thick and one thin terminal spine. (Fig. 3k). Terminal spine of exopod of swimming legs P1 is 3 times longer (Fig. 3 l). P2 to P3 1.5 to 1.7 times longer than last segment of exopod (Fig. 3 m).

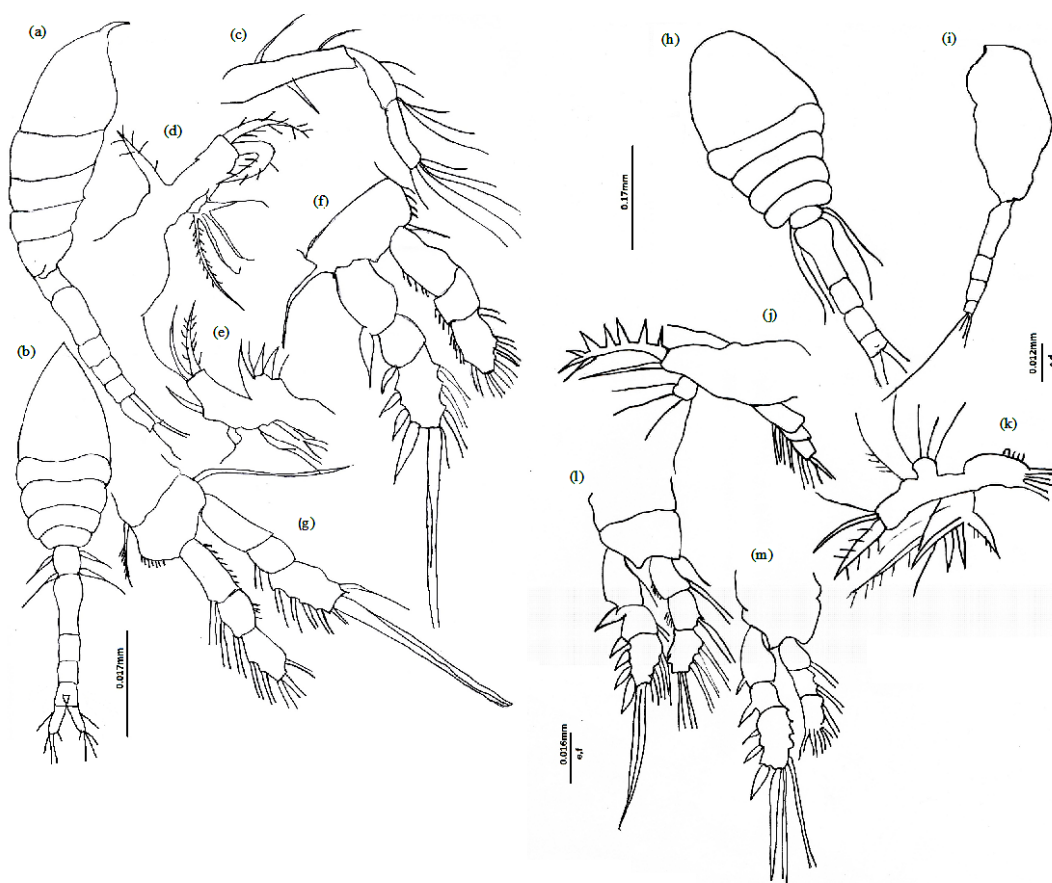


Figure 3: *Oithona pseudofrigida* ♀ (a) lateral view; (b) dorsal habitus; (c) A2 (d) Md (e) Mx1 (f) P I (g) P IV. *Oithona attenuata* ♀ (h, i) lateral and dorsal view; (j) Md; (k) Mx1; (l) P I; (m) P III.

Remarks

The present specimens of *O. rigida* agree with Nishida (1985) and disagree with Giesbrecht (1896). Only slight size variation was observed in our specimens. *O. oculata* is closely related to the *O. rigida*, differing it by having large terminal spines of swimming legs whereas in *O. rigida* the terminal spines of exopod is shorter than the last segments of swimming legs. Endopod of MX1 with 2 setae in *O. rigida*, and 4 setae in *O. oculata*.

Typical form of *O. brevicornis* is slightly elongated reported from Australian waters and China Sea. The specimen from the Black Sea is slightly smaller in size (0.5- 0.6 mm♀, 0.45 mm♂) as compared to our specimen (Selifonova, 2009). The *O. brevicornis* collected from Pakistani waters have resemblance with the specimens of the Persian Gulf as the lateral setae reach beyond the caudal rami unlike the Australian one in which lateral setae are short. Thus the present specimen of *O. brevicornis* collected from Pakistani waters are closest to the ones reported by Giesbrecht (1891). *O. brevicornis* share some characteristics with *O. aruensis* and *O. davisae*. *O. brevicornis* differs from these two species in possessing a distal spine on the inner lobe of Mx1 which is shorter as compared to the other two species. In *O. brevicornis* the inner lobe of MX1 bears 1 setae like in *O. aruensis* and no setae in *O. davisae*. Endopod of Md with four spines in *O. brevicornis* shares the characteristics of Md with *O.*

aruensis and *O. davisae*. The second basal segment bears two blunt, thick and slightly curved spines with fine spines on margins which are specific to the Md of *O. brevicornis* as compared to the other two species which do not have blunt and thick spines.

O. similis is allied with two species *O. fallax* and *O. decipiens*. Our specimen of *O. similis* do not have setae on the inner margin of the first joint of P2 to P4, which is the characteristic of *O. fallax*. MX1 of *O. similis* have 1 seta on Li2 and Le1 with 1 seta which are absent in *O. fallax* whereas in *O. decipiens* Le1 with 1 seta and Li2 without setae.

Typical form of *O. attenuata* is larger in size (0.7-0.8 mm) and the present specimen is closest to that reported by Nishida (1985) and Cleve (1901). *O. attenuate* show similar characteristics with *O. fallax* Li1 of MX1 armed with distal seta twice longer than other setae. All setae on Li1 are of similar length in *O. nana*.

O. pseudofrigida closely resembles *O. frigida*, and is distinguished by having 1 inner marginal setae P1 to P4 segment. Exopod segment 3 of P3 to P4 with short outer marginal spines. 2 spinules on the exopod third segment of P3 (Nishida, 1985).

Research and studies on marine zooplankton species composition was neglected since many years in Pakistan. This is the first study on the *Oithona* species composition in Pakistani waters after 4 decades. We compared our specimens with published works from

neighboring countries and other parts of the world to minimize error in identification. The collections were organized in 2010, 2012 and during 2013 for the statement that our selected species were not introduced artificially and by ballast water. All of the six recorded species are permanent residents of Pakistani waters.

The species composition of *Oithona* was reported from many parts of the Indian Ocean (Kasturirangan, 1963). *O. rigida* has been reported from Iranian and Indian waters (Santhanam and Perumal, 2003). *O. brevicornis* and *O. attenuata* are reported from India (Thompson, 1986), Kuwait and Oman (Al-Yamani *et al.*, 2011). *O. similis* is a widely reported species (Nishida, 1985; Thompson, 1986). *O. spinirostris* is reported from both Indian and Iranian waters (Santhanam and Perumal, 2003). In the present study *O. pseudofrigida* was reported for the first time from north-western Indian Ocean. This species was reported earlier to occur in the south-western Indian Ocean (Convey *et al.*, 2003). The presently reported species were abundantly distributed in our coastal and mangrove forest channel waters and represent a very important component of zooplankton samples. Further studies are required to ascertain the species abundance of genus *Oithona* in other near shore waters of Pakistan.

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References

- Al-Yamani, F.Y., Skryabin, V., Gubanova, A., Khvorov, A. and Prusova, I., 2011.** Marine zooplankton practical guide for the northwestern Arabian Gulf. Volume 2. Kuwait Institute for Scientific Research, Kuwait. 96-102 pp.
- Baird, W., 1843.** Notes on British Entomostraca. *The Zoologist* (Newman), 1,193-197.
- Convey, D.V.P., White, R.G., Hugues-Dit-Clies, J., Gallienne, C.P. and Robins, D.B., 2003.** Guide to the coastal and surface zooplankton of the south-western Indian Ocean. Occasional Publication of the Marine Biological Association of the United Kingdom, No. 15, Plymouth, UK.
- Gallienne, C.P. and Robins, D.B., 2001.** Is *Oithona* the most important copepod in the world's Oceans? *Journal of Plankton Research*, 23, 1421-1432.
- Giesbrecht, W., 1896.** Über pelagische copepoden des meeres, gesammelt vom Marine stabsarzt Dr. Augustin Kramer. *Zoologische Jahrbücher. Abteilung für Systematik, Geographie und Biologie der Tiere*, 9, 315-328.
- Giesbrecht, W., 1891.** Elenco dei copeodi pelageci raccolti dal tenente di vascello Gaetano Chierchia durante il viago della R. Corvetta "Vettor Pisani" negli anni 1882-1885, e dal tenente di vascello Francesco Orsini nel Mar Rosso, nel 1884. *Att Accad. Naz. Lincei Rc.*, 4, 7, 474-481.

- Haq, S.M., Khan, J.A. and Chughtae, S., 1973.** The distribution and abundance of zooplanktons along the coast of Pakistan during postmonsoon and premonsoon periods. *The Biology of Indian Ocean*, 3, 257-272.
- Kasturirangan, L.R., 1963.** A key for the identification of the more common planktonic copepoda of Indian coastal waters. Council of Scientific and Industrial Research. pp. 75-77.
- Mackinon, D.A., 2000.** Two new species of *Oithona* (Copepoda, Cyclopoida) from mangrove waters of north Queensland, Australia. *Plankton Biology and Ecology Journal*, 47(2), 100-113.
- Madhuratap, M., Haridas, P., Ramaiah, N. and Achuthankutty, C., 1992.** Zooplankton of the southwest coast of India: abundance, composition, temporal and spatial variability in 1987. In: *Oceanography of the Indian Ocean*. (eds, B. Desai), pp. 99-112. Oxford and IBH Publishing Co. Ltd., New Delhi.
- Mazzochi, M.G. and Paffenhoper, G.A., 1998.** First observation on the biology of *Clausocalanus furcatus* (Copepod: Calanoida). *Journal of Plankton Research*, 20(2), 331-342.
- Nishida, S., 1985.** Taxonomic and distribution of the family Oithonidae (Copepoda, Cyclopoida) in the Pacific and Indian Oceans. *Bulletin of the Ocean Research Institute*, University of Tokyo, 20, 1-167.
- Razouls, C., De Bovee, F., Kouwenberg, J. and Desreumaux, N., 2005-2016.** Diversity and geographic distribution of marine planktonic copepods. Available at <http://copepodes.obs-banyuls.fr/en>.
- Santhanam, P. and Perumal, P., 2003.** Diversity of zooplankton in Parangipettai coastal waters, southeast coast of India. *Journal of the Marine Biological Association of India Cochin*, 45(2), 144-151.
- Selifonova, P.Z., 2009.** *Oithona brevicornis*, Giesbrecht (Copepoda, Cyclopoida) in harborages of the northeastern part of the Black Sea shelf. *Inland Water Biology*, 2(1), 30-32.
- Thompson, M.P.K., 1986.** Seasonal distribution of cyclopoid copepods of the mud banks off Alleppey, Kerala coast. *Journal of the Marine Biological Association of India, Cochin*, 28(1-2), 48-56.
- Turner, J.T., 2004.** The importance of small planktonic copepods and their roles in pelagic Marine food webs. *Zoological Studies*, 43, 255-266.