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Morphology and morphometrics of *Dotilla myctiroides* (Decapoda: Brachyura: Dotillidae) from an impacted beach of Goa along west coast of India

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Original Article

Abstract

Goa along the west coast of India supports diverse assemblages of marine organisms. However, increase in anthropogenic activities has resulted in habitat alteration thereby negatively affecting inter-tidal fauna. The present study describes the Sand bubbler crab *Dotilla myctiroides* from an impacted sandy beach (Miramar) along Goa, west coast of India. Fortnightly sampling surveys along the sampling site from July 2014 to October 2014 yielded only 49 specimens of this species. A comprehensive taxonomic diagnosis of this species is provided for the first time aided by 11 morphometric characters, eight morphometric ratios, Scanning Electron Micrographs of first gonopod and spoon-tipped setae of second maxillipeds.

Key words: *Brachyura, Dotillidae, morphometry, SEM, Goa*

Introduction

Goa with a 105 km coastline flanking the Arabian Sea supports diversified habitats representing coral reefs, sandy and rocky shores, estuarine mangrove wetlands and near shore submerged rocky patches (Rodrigues *et al.*, 1998, Qasim, 2003, Sluka, 2013). However, direct release of untreated sewage into these estuaries (Ramaiah *et al.*, 2007) is a potential threat to estuarine biota. Maritime activities in the vicinity of the Mormugao Port are potential threats to the benthic habitat structure and marine food web (Anil *et al.*, 2002). Intensive fishing in the coastal fishing grounds by mechanized fishing vessels have resulted in excessive exploitation of marine living resources (Ansari *et al.*, 1995). Crude oil spills from offshore tankers result in frequent deposition of tarballs along the sandy shores along the Goan coastline (Suneel *et al.*, 2013). Despite, increase in anthropogenic activities that threaten marine ecosystems, literature pertaining to the invertebrate faunal composition of these waters is scarce (Padate *et al.*, 2010, 2013a, 2013b; Hegde and Rivonker, 2013; Hegde *et al.*, 2013; Velip and Rivonker, 2015).

Dotilla myctiroides (H. Milne Edwards, 1852) is a small-sized crab inhabiting in sand which have high percentage of silt-clay fraction. This species is known to either occur throughout

the shore, or along the lower water line and in some cases, it also co-occurs with another dotillid species namely *Scopimera proxima* (Silas and Sankarankutty, 1967). Its intense burrowing and filter feeding activities regulate recycling of organic matter and nutrients in the ambient environment (Takagi *et al*., 2010). This species is known to tide over the extreme environmental temperature by burrowing and igloo-construction that allows it to reach below the water level (Nguyen *et al*., 2011). It is also capable of aerial respiration and controls osmoregulation through its tympanic membrane (Matsumasa *et al*., 2001).

A review of literature revealed that Alcock (1900) and Kemp (1919) carried out the most comprehensive studies on dotillid crabs of Indian coasts and reported seven out of eight valid *Dotilla* species including *D. myctiroides*. Altevogt (1957) studied the biological and behavioural aspects of *D. myctiroides* from Mumbai and revealed its characteristic burrowing pattern. Chhapgar (1957) and Sankarankutty (1961, 1966) reported this species from coasts of Indian mainland and Andaman Islands, and illustrated diagnostic characters including gonopod and spoon-tipped setae of second maxillipeds. Ingole (2003) reported this species and its burrowing habit from Miramar beach, Goa. Varadharajan and Soundarapandian (2014) reported its occurrence and distribution along Tamil Nadu coast. Ali *et al.* (2014) studied its abundance and spatio-temporal distribution patterns along Aksa beach (Mumbai) and revealed size-related differentiation in spatial distribution.

It is apparent from the above survey of literature that besides preliminary reporting (Ingole, 2003), there have been no attempts to describe the dotillid crabs from Goa, west coast of India. Further, given the perils of habitat degradation and in general species invasion induced by anthropogenic activities along Goa coast, it is pertinent to create a baseline data of epibenthic fauna for the region. In view of the above, the present study was focused to provid preliminary information on the occurrence and taxonomy of *D. myctiroides* from the region.

Material and methods

Sampling was carried out along the sandy shore located at Miramar (15°29′ N, 73°48′ E). Five transects from high tide to low tide with a width of 10 meters and length of 40 meters covering 200 sq. m. were used for survey. Samples of *D. myctiroides* were handpicked from the head of Aguada Bay (Fig. 1), along Goa, central west coast of India, and placed in plastic container and brought to the laboratory for detailed examination.

Taxonomic identification was carried out using conventional methods involving phenotypic analysis such as morphology, colour, texture patterns, meristic counts, morphological measurements and gonopod structure. Taxonomic identification was aided by published literature for brachyuran crabs (Alcock, 1900; Ng, 1998).

Morphological characteristics of the crabs were photographed with an Olympus Digital Camera (Model No. E-PL1) mounted on Olympus SZX–16 stereo-zoom microscope. Subsequently, line diagrams of diagnostic morphological characters were drawn using Adobe Photoshop CS5 software. Standard morphometric parameters were measured up to the nearest 0.01 mm using vernier caliper (200 mm). Altogether 11 morphometric parameters were measured (Table 1), and eight ratios (Table 2) were derived from these parameters.

This species was also subjected to detailed taxonomic diagnosis using adult morphology and Scanning Electron Microscopy (SEM) of the first gonopod and spoon-tipped setae of second maxilliped as potential tools for species

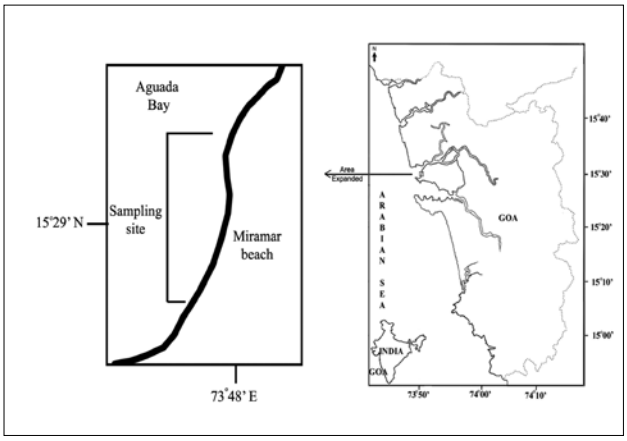

Fig. 1. Map of study area indicating sampling site

Table 1. Morphological measurements for *D. myctiroides* (N=49)

Sr. No.	Body part	Morphological parameters	Data ($\mu \pm \sigma$)
1.	Carapace	CW	0.53±0.05
		CL	0.55±0.05
		FW	0.13±0.04
		SW	0.24±0.07
		AW	0.21±0.01
2.	Third maxillipeds	ML3m	0.48±0.10
		MW3m	0.26±0.05
3.	Chelipeds	DLch(left)	0.41±0.10
		PLch(left)	0.37±0.13
		ChL(left)	1.29±0.22
4.	Pereiopods	PrL2	1.13±0.17
		PrL3	1.04±0.05
		PrL4	1.03±0.07
		PrL5	1.06±0.03

Table 2. Morphometric ratios for *D. myctiroides* (N = 49)

Sr. No.	Body part	Morphometric ratios	Data ($\mu \pm \sigma$)
1.	Carapace	CW/CL	0.97 ± 0.07
		FW/CW	0.24 ± 0.06
		AW/CW	0.40 ± 0.05
		SW/CW	0.44 ± 0.08
2.	Third Maxillipeds	ML3m/MW3m	1.86 ± 0.34
3.	Chelipeds	ChL(left)/CL	2.35 ± 0.38
		DLch(left)/PLch(left)	1.24 ± 0.41
		DLch(right)/PLch(right)	1.25 ± 0.43
4.	Pereiopods	PrL2/CL	2.08 ± 0.34
		PrL3/CL	1.92 ± 0.19
		PrL4/CL	1.89 ± 0.23
		PrL5/CL	1.95 ± 0.17

identification. For SEM studies of the gonopod and spoon-tipped setae, the specimens were air dried in 70 % alcohol for three days and mounted on small screws for gold coating. The samples were then coated with gold at 6-8 mbar pressure with Quorum sputter coater (Model SC7620). Subsequently, the gold-coated samples were photographed with a Zeiss EVO 18 Special Edition Scanning Electron Microscope available at the University Science Instrumentation Centre (USIC), Goa University.

The following abbreviations are used in the description and tables. AW, abdominal width; CL, carapace length; CW, carapace width; ChL, Cheliped length; DL_{ch}, Cheliped dactyl length; FW, width of frontal margin of carapace; G1, first gonopod; ML_{3m},Third maxilliped merus length; MW_{3m},Third maxilliped merus width; P, pereiopod; PL_{ch}, Cheliped propodus length, PrL, Pereiopod length; SW, Sternal width.

The specimens were stored in 5% buffered formalin (buffered with hexamethylene tetramine to prevent fragmenting of appendages) solution in pre-labelled transparent plastic bottles. These are deposited at the Marine Biology laboratory, Department of Marine Sciences, Goa University, Goa.

Results

Systematic position

Phylum - Arthropoda
Subphylum - Crustacea
Class - Malacostraca
Order - Decapoda
Family - Dotillidae
Genus - *Dotilla*, Stimpson, 1858
Species - *myctiroides*

Fortnightly, sampling survey along Miramar beach, Goa, during July 2014 to October 2014 yielded 49 specimens of *D. myctiroides*.

Diagnosis

Carapace as long as broad, except for the lateral grooves practically devoid of sculpture and chelipeds at least three times of CL. Sternum with tympana on all segments. Abdomen with setal band on distal margin of fourth somite. Cheliped dactyli twice the length of propodi. Fourth pereiopod with tympanum on dorsal surface. First gonopod slightly sinuous, with blunt tip, furnished with numerous unbranched setae.

Description

Carapace oval, almost as broad as long (CW/CL = 0.97±0.07) with rugose dorsal surface (except cardiac regions). Dorsal surface of carapace longitudinally and transversely convex, with scattered microscopic granules. Frontal margin of carapace narrow (FW/CW = 0.24±0.06), unilobed, deflexed anteriorly (Fig. 2a), its deflexed tip separates the antennulary fossa of either side. Antennules short, concealed beneath frontal margin. Antennae short, thin with eight segments. Basal antennal segment large, flagellum extremely thin, tapering comprises of seven segments (Fig. 2b). Orbits wide, occupy approximately three-fourths of anterior carapace margin. Eyes (cornea) elongated, ocular peduncle slightly

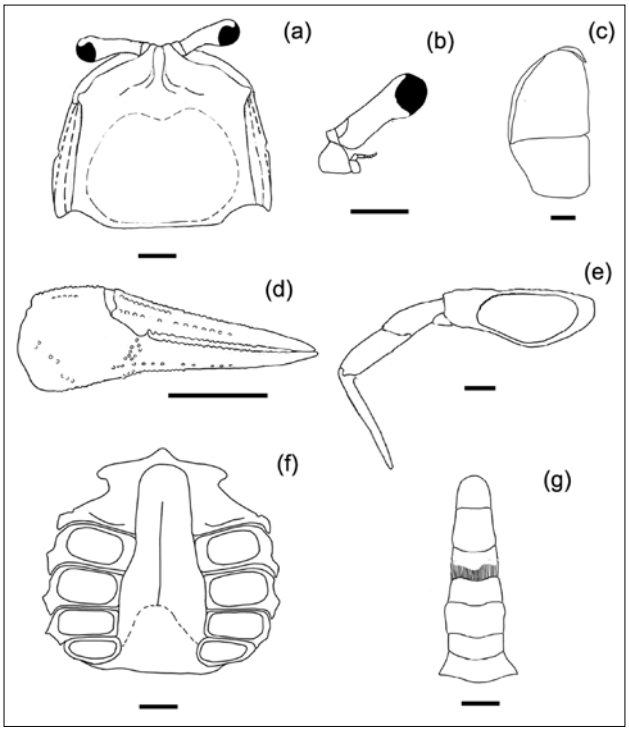

Fig. 2. *Dotilla myctiroides* (Line diagrams): (a) Frontal margin of carapace; (b) Orbit; (c) Third maxilliped; (d) Major cheliped – dactylus and propodus; (e) Pereiopod (f) Male sternum; (g) Male abdomen. Scale bar: 1mm.

longer than cornea (Fig. 2b). Lateral margins of carapace divergent, pubescent, granulated in anterior half, and possess longitudinal folds along their entire length. Raised area corresponding to posterior branchial, cardiac, and intestinal regions membranous (Fig. 2a). Posterior margin of carapace straight and broad (Fig. 2a).

Buccal cavern broader than long, rounded anterolaterally, wider posteriorly. Epistome narrow. Third maxillipeds large, oval shaped, do not leave gape when closed; merus bluntly triangular, longer than ischium, with finely pitted glossy surface (Fig. 2c), its length approximately twice its width (ML_{3m}/MW_{3m} = 1.86±0.34); exopod extremely slender; palp articulates at middle of anterior margin of merus (Fig. 2c). Second maxillipeds with numerous characteristic spoon-tipped setae on inner surface of merus (Fig. 3a). Each seta with three lobes at distal tip (Fig. 3b), among which the middle lobe is further split into median petalloid shaped lobe and two slightly curved lobes (Fig. 3c).

Chelipeds (P1) slender, compressed, subequal with glossy surface; their length greater than twice of CL (left cheliped ChL = 2.35±0.38; right cheliped ChL = 2.38±0.44). Fingers slender, slightly curved and tapering, leave a narrow gap between them (Fig. 2d). Dactylus is longer than propodus (DL_{ch}/PL_{ch} (left) = 1.24±0.41; DL_{ch}/PL_{ch} (right) = 1.25±0.43); dorsal surface covered with two longitudinal rows of serrations separated by a shallow groove; cutting edge with short serrations (Fig. 2d). Pollex with short serrations on cutting edge. Propodus (including pollex) with single serrated ridge on dorsal surface, ventral surface with two serrated ridges, which converge at distal tip of pollex (Fig. 2d). Inner surface of propodus smooth and glossy, outer surface granular (Fig. 2d). Carpus large, with smooth glossy surface and serrated ridge on upper surface flanked with silken setae, outer surface granular. Merus larger than carpus, ornamentation similar to that of carpus; its inner surface with tympanum. Ischium, basis and coxa fused.

P2-P5 slender, shorter than chelipeds. P2 longest, approximately twice CL (PrL/CL = 2.08±0.34), P3-5 subequal. Pereiopod dactyli slender, normal, shorter than propodi, terminate distally in acute tip (Fig. 2e). Pereiopod meri with characteristic elongated tympana (Fig. 2e). Margin of tympanic membrane marked with depressed granules.

Thoracic sternum smooth, glossy, narrow (SW/CW = 0.44±0.08), eight segmented, all segments possess tympana (Fig. 2f). Sternal sutures continuous (Fig. 2f). Sterno-abdominal cavity present (Fig. 2f). Male abdomen narrow (AW/CW = 0.40±0.05), comprised of seven distinct, narrow segments; fourth segment overlapping fifth, with a thick brush of hairs at distal end (Fig. 2g).

G1 slightly sinuous, lacks ornamentation (Fig. 4a). Its proximal half covered with long unbranched setae on outer margin (Fig. 3a). Distal tip blunt, covered with tuft of numerous long unbranched setae at outer margin (Fig. 4b). Details of morphological measurements ($\mu \pm \sigma$) and morphometric ratios ($\mu \pm \sigma$) are provided in Tables 1 and 2, respectively.

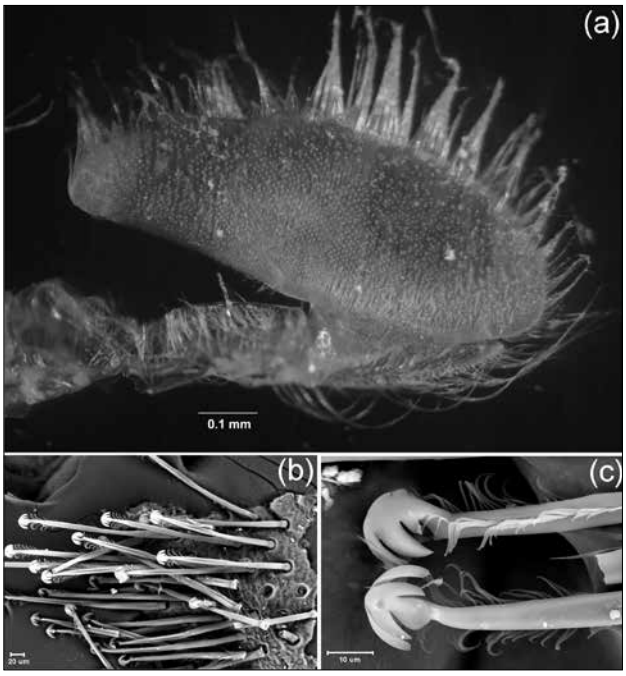

Fig. 3. (a) Photograph of entire second maxilliped *Dotilla myctiroides*, (b) SEM photograph of section of second maxilliped showing numerous setae, (c) SEM photograph of distal portion of spoon-tipped setae

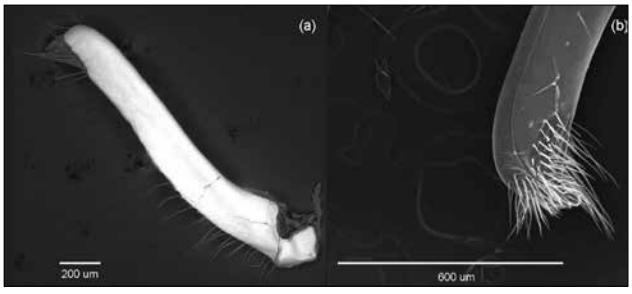

Fig. 4. SEM photographs of (a) entire G1 (b) distal half of G1 of *Dotilla myctiroides*

Colour

Colouration of fresh specimens is dirty yellow dorsally with scattered melanophores (Fig. 5a), raised area corresponding to posterior branchial, cardiac, and intestinal regions brown

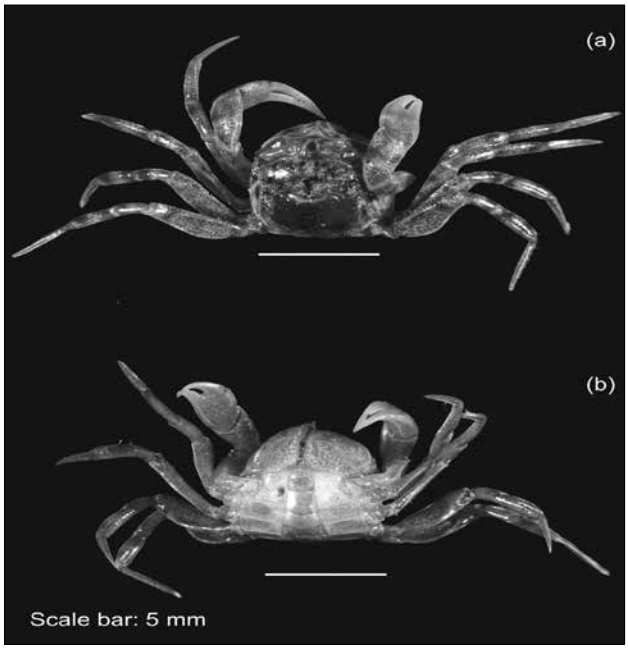

Fig. 5. Dorsal view (a) and ventral view (b) of fresh specimen of *Dotilla myctiroides*

coloured (Fig. 5a); ventral surface of sternum and abdomen whitish with scattered melanophores (Fig. 5b). Fingers off-white, with scattered white, orange, yellow speckles and melanophores (Fig. 5a, b). Colouration of pereiopods similar to that of carapace (Fig. 5a, b). Formalin preserved specimens appear whitish yellow.

Habitat and habit

D. myctiroides was observed to inhabit in sandy substratum that was subjected to alternate submergence and exposure. This species was observed to live in small sized burrows. Further, observations on its behaviour revealed that it undertook foraging movements in the close vicinity of burrow, and left characteristic pseudofaecal pellets radially around the burrow. The mean density of occurrence was 24 individuals /m^2.

Discussion

The present study has made an attempt to provide a comprehensive morphological description of *D. myctiroides* aided by external morphology, 11 morphometric parameters and eight ratios derived from these. In addition, SEM of G1 and spoon-tipped setae of second maxillipeds is provided to validate its identification. A review of literature on the taxonomic description of this species suggested that the original description of this species given by H. Milne-Edwards (1852) was concise but lacked illustrations. Alcock (1900) provided a brief description of this species. Kemp (1915) reported *D. myctiroides* from Chilka Lake, east coast of India along with diagrams of male and female abdomens. Chhapgar (1957) provided a short description illustrated with diagrams of carapace and G1. Sankarankutty (1961) provided a short description of *D. myctiroides* complemented with diagrams of pterygostomial grooves and spoon-tipped setae of second maxillipeds. Vogel (1984) provided SEM photographs of spoon-tipped setae of second maxillipeds. Allen (2010) attempted a revision of the genus *Dotilla*, and provided a diagnostic description of *D. myctiroides* supported with diagrams of carapace of male abdomen, cheliped, pereiopod and G1.

The present observations on the morphology of carapace and pereiopods of *D. myctiroides* suggested that body shape enables the crab to dig burrows efficiently and protect itself from extreme environmental conditions influencing its habitat (Takeda *et al*., 1996). Moreover, the spoon-tipped setae on the second maxillipeds in combination with hairs on first maxillipeds enable sorting of organic matter from sand particles for ingestion (Vogel, 1984).

Observations on the habitat of this species suggested that it inhabited the well-drained sandy substratum at mid and low tide level. This observation is also in agreement with the previous study (Silas and Sankarankutty, 1967). The present survey yielded only 49 individuals / 200 sq. m. of this species from the study area. In contrast, Hails and Yaziz (1982) reported up to 579 individuals m^{-2} from the Malaysian coast. Low abundance of *D. myctiroides* along the study area could be attributed to high level of anthropogenic activity as Miramar beach is a popular tourist destination along with intense fishing activity by shore seiners. Further, observations on the behavioural aspects of this species suggested that it left the burrows at mid tide and scampered back to the burrow before the onset of high tide. Moreover its feeding area was restricted to a small perimeter around its burrow. These observations were in confirmation to those made in earlier published literature and suggested that these strategies enabled to protect the crabs from extreme environmental conditions and potential predators including ocypodid crabs (Bradshaw and Scoffin, 1999).

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References

Alcock, A. 1900. Materials for a carcinological fauna of India.No. 6. The Brachyura Catometopa, or Grapsoidea. *J. Asiat. Soc. Bengal,* 69 (3): 279-456.

Ali, S., S. K. Chakraborty and P. Kumar. 2014. Abundance and spatio-temporal distributional pattern of *Dotilla myctiroides* (Milne Edwards) on exposed sandy beach of Aksa, Mumbai. *Proceedings of the National Academy of Sciences, India* (Section B, Biological Sciences), DOI: 10.1007/s40011-014-0392-x

Allen, C. J. 2010. Ecology of the intertidal crab *Dotilla intermedia* from tsunami-impacted beaches in Thailand. Ph. D thesis submitted to University of Southampton, 194 pp.

Altevogt, R. 1957. Beiträge zur Biologie und Ethologie von *Dotilla blandfordii* Alcock und *Dotilla myctiroides* (Milne Edwards) (Crustacea, Decapoda). *Z. Morphol. Ökol. Tiere*, 46: 369-388 (in German).

Anil, A. C., K. Venkat, S. S. Sawant, M. Dileepkumar, V. K. Dhargalkar, N. Ramaiah, S. N. Harkantra and Z. A. Ansari. 2002. Marine bioinvasion: Concern for ecology and shipping. *Curr. Sci.,* 83 (3): 214-218.

Ansari, Z. A., A. Chatterji, B. S. Ingole, R. A. Sreepada, C. U. Rivonker and A. H. Parulekar. 1995. Community Structure and seasonal Variation of an Inshore Demersal Fish Community at Goa, West Coast of India. *Estuar. Coast. Shelf. S.,* 41: 593-610.

Bradshaw, C. and T. P. Scoffin. 1999. Factors limiting the distribution and activity patterns of the soldier crab *Dotilla myctiroides* in Phuket, South Thailand. *Mar. Biol.,* 135: 83-87.

Chhapgar, B. F. 1957. On the marine crabs of Bombay State. Part II. *J. Bombay Nat. Hist. Soc.,* 54 (3): 503-549.

Hails, A. J. and S. Yaziz. 1982. Abundance, breeding and growth of the ocypodid crab *Dotilla myctiroides* (Milne-Edwards) on a West Malaysian beach. *Estuar. Coast. Shelf. S.,* 15: 229-239.

Hegde, M. R., V. P. Padate, D. T. Velip and C. U. Rivonker. 2013. An updated inventory of new records of macrofauna along Goa, west coast of India. *Indian J. Geo-marine Sci.*, 42 (7): 898-902.

Hegde, M. R. and C. U. Rivonker. 2013. A new record of *Temnopleurus decipiens* (De Meijere, 1904) for the Indian waters - A comparative analysis. *Zoosystema,* 35: 97-111.

Ingole, B. S. 2003. Benthic life on the tropical sandy shore: Miramar beach a case study. In K. G. Hiremath (Ed.) *Recent advances in environmental science*. New Delhi. Discovery Publishing House, p. 459-470.

Kemp, S. K. 1915. Fauna of the Chilka Lake. No. 3: Crustacea: Decapoda. *Mem. Indian. Mus.,* 5: 199-325, plates XII-XIII.

Kemp, S. K. 1919. Notes on Crustacea Decapoda in the Indian Museum. XII. Scopimerinae. *Rec. Indian Mus.,* 16 (5): 305-348.

Matsumasa, M., S. Kikuchi, S. Takeda, S. Poovachiranon S., S. H. Yong and M. Murai. 2001. Blood Osmoregulation and Ultrastructure of the Gas Windows (Tympana) of Intertidal Ocypodid Crabs: *Dotilla vs. Scopimera. Benthos Res.,* 56 (2): 47-55.

Milne Edwards, H. 1852. Observations sur les affinités zoologiques et la classification naturelle des Crustacés. *Ann. Sci. Nat.,* 3, 18: 109-166, plates 3, 4. (in French).

Ng, P. K. L. 1998. Crabs. In: K. E. Carpenter and V. H. Niem (Eds.) *FAO Species Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific*. Volume 2. Rome. Food and Agriculture Organization, p. 1045-1155.

Nguyen, K. D. T., S. A. Morley, C. -H. Lai, M. S. Clark, K. S. Tan, A. E. Bates and L. S. Peck. 2011. Upper Temperature Limits of Tropical Marine Ectotherms: Global Warming Implications. *PLoS One*, 6 (12): e29340.

Padate, V. P., C. U. Rivonker and A. C. Anil. 2013. A new record of *Scylla olivacea* (Decapoda, Brachyura, Portunidae) from Goa, central west coast of India – A comparative diagnosis. *Indian J. Geo-marine. Sci.,* 42 (1): 82 – 89.

Padate, V. P., C. U. Rivonker, A. C. Anil, S. S. Sawant and K. Venkat. 2010. A new species of portunid crab of the genus *Charybdis* (De Haan, 1833) (Crustacea: Decapoda: Brachyura) from Goa, India. *Mar. Biol. Res.,* 6: 579– 590.

Qasim, S. Z. 2003. Indian Estuaries. Mumbai. Allied Publication Pvt. Ltd., 259 pp.

Rodrigues, C. L., S. Caeiro and S. V. Raikar. 1998. Hermatypic corals of the Goa coast, west coast of India. *Indian J. Mar. Sci.,* 27: 480–481.

Rodrigues, V., N. Ramaiah, S. Kakti and D. Samant. 2011. Long-term variations in abundance and distribution of sewage pollution indicator and human pathogenic bacteria along the central west coast of India. *Ecol. Indic.,* 11 (2): 318-327.

Sankarankutty, C. 1961. On Decapoda Brachyura from the Andaman and Nicobar Islands – Families Portunidae, Ocypodidae, Grapsidae and Mictyridae. *J. Mar. Biol. Ass. India,* 3 (1-2): 101-119.

Sankarankutty, C. 1966. On Decapoda Brachyura from the Gulf of Mannar and Palk Bay. *Mar. Biol. Ass. India Symp. Ser.,* 1: 347-363.

Silas, E. G. and C. Sankarankutty. 1967. Field investigations on the shore crabs of the Gulf of Mannar and Palk Bay, with special reference to the ecology and behaviour of the pellet crab *Scopimera proxima* Kemp. *Mar. Biol. Ass. India Symp. Ser.,* 2: 1008-1025.

Sluka, R. D. 2013. Coastal marine fish biodiversity along the western coast of India. *J. Threat. Taxa,* 5 (1): 3574–3579.

Suneel, V., P. Vethamony, M. P. Zakaria, B. G. Naik and K. V. Prasad. 2013. Identification of sources of tar balls deposited along the Goa coast, India, using fingerprinting techniques. *Mar. Pollut. Bull.*, 70 (1-2): 81-89.

Takagi, K. K., P. Cherdsukjai, I. Mimura, Y. Yano, K. Adulyanukosol and M. Tsuchiya. 2010. Soldier crab (*Dotilla myctiroides*) distribution, food resources and subsequent role in organic matter fate in Ao Tang Khen, Phuket, Thailand. *Estuar. Coast. Shelf. S.,* 87 (4): 611-617.

Takeda, S., M. Matsumasa, H. S. Yong and M. Murai. 1996. "Igloo" construction by the ocypodid crab, *Dotilla myctiroides* (Milne-Edwards) (Crustacea; Brachyura): the role of an air chamber when burrowing in a saturated sandy substratum. *J. Exp. Mar. Biol. Ecol.,* 198: 237-247.

Varadharajan, D. and P. Soundarapandian. 2014. Crab biodiversity from Arukkattuthurai to Pasipattinam, south east coast of India. *Indian J. Geo-marine Sci.,* 43 (4): 676-698.

Velip, D. T. and C. U. Rivonker. 2015. *Hexapus bidentatus* sp. nov. (Crustacea: Decapoda: Brachyura: Hexapodidae), a new species from Goa, west coast of India. *Mar. Biol. Res.,* 11 (1): 97-105.

Vogel, F. 1984. Comparative and Functional Morphology of the Spoon-Tipped Setae on the Second Maxillipeds in *Dotilla* Stimpson, 1858 (Decapoda, Brachyura, Ocypodidae). *Crustaceana*, 47 (3): 225-234.