



Taxonomy of mudcrabs of the genus *Scylla* (De Haan) from Cochin Backwaters, Kerala, India

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ABSTRACT

The present study was carried out to resolve the species ambiguity of *Scylla* species found in Cochin Backwaters, Kerala, India by analysing 365 adult mudcrabs (211 males and 154 females). The work focused mainly on the description of the species based on morphological characters, specifically the first and second pleopods and the third maxillipeds which are commonly used for the identification of closely related species of crabs. These structures were dissected out, examined under a binocular microscope and described with the help of camera lucida drawings. Two species of *Scylla* were identified and the structures revealed remarkable variations between them. Earlier works reported the existence of two species of mudcrabs, viz., *Scylla serrata* and *Scylla tranquebarica* in Cochin Backwaters. But results of the present study indicated that the species occurring in Cochin Backwaters are *S. serrata* and *S. olivacea*. The present study also reports the occurrence of *S. olivacea* in Cochin Backwaters for the first time, on the basis of valid classical taxonomic evidence.

Keywords: Cochin Backwaters, Morphology, Mudcrab, *Scylla*, Taxonomy

Introduction

Crabs belonging to the genus *Scylla* are commonly known as the mudcrabs. They inhabit brackishwaters in estuaries/mangrove areas and are widely distributed throughout the Pacific and Indian Ocean from Tahiti, Australia and Japan to Southern Africa (Chhapgar, 1957; Hill, 1975; Sakai, 1976). In India, mudcrabs are reported from the estuaries of the rivers, Ganga, Mahanadi, Krishna and Cauvery and from the brackishwater lakes viz., Chilka and Pulicut on the east coast; from estuaries of Narmada and Tapti as well as brackishwaters of Kerala on west coast. They are also found to inhabit the mangrove regions of Andaman and Nicobar Islands, Andhra Pradesh, Tamil Nadu and Kerala (Anil, 1997).

Mudcrabs are commercially important due to their large size and nutritive value and are of great demand in domestic as well as international market. The attractive prices offered for live crabs in the export trade prompted efforts to culture mudcrabs in some parts of India as practised in a more organised manner in South-east Asian countries (Suseelan *et al.*, 1995). India earns about 18 million US\$ as foreign exchange from the export of live mudcrabs (MPEDA, 2011). Export of live mudcrabs from India to countries like Singapore, Malaysia and Hong Kong stimulated increased exploitation of mudcrabs from their natural habitats in the recent past.

There exists considerable confusion regarding taxonomy of mudcrabs. A detailed taxonomic revision of the genus *Scylla* was made by Estampador (1949) who recognised three species and described a new subspecies from Philippines. Serene (1952) reported the occurrence of four forms of genus *Scylla* in Vietnam. These works were subsequently reviewed by Stephenson and Campbell (1960) and Holthius (1978). They pointed out the inconsistent and variable nature of the distinguishing characters. Fuseya and Watanabe (1996) proposed three species for genus *Scylla* on the basis of variations noticed in electrophoretic analysis. Keenan *et al.* (1998) collected mudcrab specimens from the Red Sea and throughout the Indo-Pacific regions and classified them into four species, *Scylla serrata*, *S. tranquebarica*, *S. olivacea* and *S. paramamosain*, on the basis of morphological, morphometric and molecular analyses.

In India, taxonomy of mudcrabs was studied by Kathirvel (1981), Radhakrishnan and Samuel (1982), Joel and Sanjeevaraj (1983) and Kathirvel and Srinivasagam (1992). Kathirvel (1981) recorded two species of *Scylla*, one being a larger species and the other a smaller one; *S. oceanica* and *S. serrata* respectively. Radhakrishnan and Samuel (1982) dealt with *S. serrata* from Cochin Backwaters and described a subspecies *S. serrata serrata* on the basis of morphological characters. Joel and Sanjeevaraj (1983) reported the occurrence of two

species, namely *S. tranquebarica* and *S. serrata* from Pulicut Lake. Taxonomy of mudcrabs from India was critically analysed by Kathirvel and Srinivasagam (1992) who reported two species from Indian waters, *S. serrata* and *S. tranquebarica*, which are characterised by the differences in size, spines on the outer border of the carpus of the cheliped and habitat preferences. They were also of the opinion that the sub-species *S. serrata serrata* reported by Radhakrishnan and Samuel (1982) could be *S. serrata* only. However, Devi and Joseph (2013a, b; 2014) identified three species of *Scylla* from Cochin Backwaters, based on morphological variations. The present study describes the taxonomy and classification of *Scylla* species on the basis of morphological characters and the description of first and second male pleopods which form an important taxonomic tool for the identification of closely related species of crabs (Estampdor 1949; Fuseya, 1998; Keenan *et al.*, 1998; Khan and Ravichandran, 2009).

Materials and methods

The study area selected was Cochin Backwaters. Fifteen sampling stations were fixed along the study area; viz., Thanneermukkom, Vaikom, Aroor, Valanthakad,

Kumbalangi, Kandakkadavu, Thevara, Thoppumpady, Cochin Barmouth, Marine Science Jetty, Varappuzha, Vallarpadam, Vypin, Munambam and Azhikode (Fig.1). Sampling was conducted on a monthly basis for a period of two years from June 2010 to May 2012 for collection of crabs.

Mudcrab specimens were collected from local markets, local fishermen and from Chinese dipnet operators. The specimens were transported live to the laboratory and the following morphological characters were noted: colour and shape of the carapace, shape of the frontal lobes, spination of the anterolateral borders as well as the chelate legs, and the presence of hexagonal markings.

The specimens were numbered by freezing and then preserved in 10% formaldehyde (Ajmal Khan and Ravichandran, 2009). The first and second pleopods and third maxillipeds from both sexes were dissected out carefully using forceps and scissors. They were observed under a binocular microscope to study variations among species. Images of pleopods and the maxillipeds were then drawn using a camera lucida. A total of 365 adult mudcrabs (211 males and 154 females) with average internal carapace width of 95 mm were considered for the study, in order to avoid juvenile variations. Crabs were then identified using the identification key provided by Keenan *et al.* (1998).

Results

The study confirmed occurrence of two species of the genus *Scylla* viz., *S. serrata* and *S. olivacea* from Cochin Backwaters. Analysis of the first and second male pleopods using camera lucida, clearly indicated variations among the two species, while the third maxillipeds and the pleopods of females were found to be similar. Male pleopods of the two species were similar in shape, but showed variation in the pattern of setation. First pleopods of females of both the species are stouter with hairy tufts on both sides, while the second pleopods are slender and long with fine hairs at the tip (Fig. 2). The third maxillipeds possess a broad and flattened ischium, lined with thick hairs on inner side and did not show species-wise or sex-wise variation (Fig. 3).

Scylla serrata (Forsk, 1775)

Synonyms: *Cancer serratus* Forskal, 1775: 90; *Portunus serratus* Ruppell, 1830: 10, pl.2; *Portunus (Scylla) serrata* de Haan, 1833-1849 (1835): 44; *Achelous crassimanus* MacLeay, 1838: 61; *Scylla tranquebarica* var. *oceanica* Dana, 1852: 270; *Scylla serrata* Milne Edwards A., 1861: 349, Miers, 1886: 185, de Man, 1888d: 332, Alcock, 1899a: 27, Nobili, 1903c: 29, Stimpson, 1907: 75, Sakai, 1935a: 69, Sakai, 1936b: 133, fig. 63, Shen, 1936c: 66,

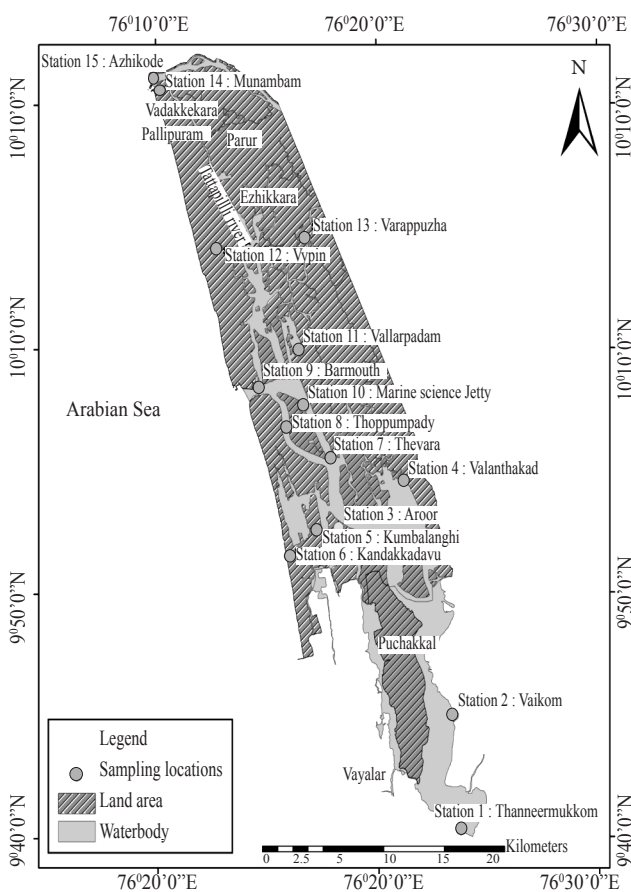


Fig. 1. Map of Cochin Backwaters showing the sampling stations



Fig. 2. Camera lucida drawings of first and second pleopods of female *Scylla* spp.

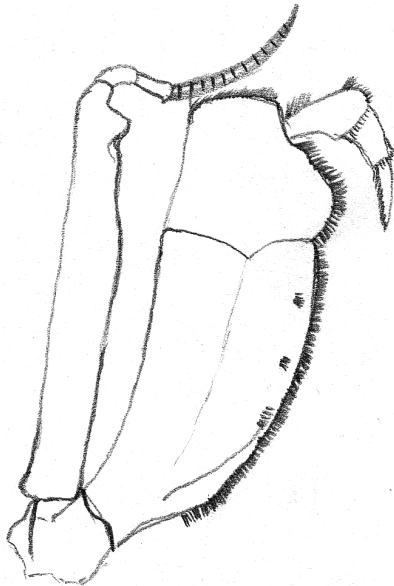


Fig. 3. Camera lucida drawing of third maxilliped of *Scylla* spp.

Chopra and Das, 1937: 391, Shen, 1937a: 99, Leene, 1938: 14, Sakai, 1939: 384, fig. 4, Shen, 1940b: 71, 81, Kamita, 1941b: 86, fig. 41, Lin, 1949: 18, Barnard, 1950: 160, figs. 31b-c, Chhapgar, 1957b: 17, pl. 5 a-c, Stephenson and Campbell, 1960: 111, fig. 2N, pl. 4, fig. 4, pls 5 N, Crosnier, 1962: 72, figs 128-129, Sakai, 1965b: 115, pl. 52, Guinot, 1967e: pl. 1, fig. 1, Holthuis and Sakai, 1970: 125, 318, pl. 20, Stephenson, 1972a: 141. Stephenson, 1972b: 44, 1974: 51, Stephenson, 1975: 188, Muraoka, 1976: pls. 2-3, Sakai, 1976a: 335, pl. 115, Yamaguchi *et al.*, 1976: 36, Takeda and Nunomura,

1976: 68, Melo, 1983: 159, figs 1-3; *Scylla oceanica* (not Dana, 1852) Estampador, 1949: 101, pl. 1, fig. 2. *Scylla serrata* var. *paramamosain* (not Estampador, 1949), Serene, 1952: 134, fig. 1D, pl. 1, fig. 4, pl. 2, figs 4, D. *Scylla tranquebarica* (not Fabricius, 1798) Joel and Raj, 1980: 39, figs 1, 3.

Materials examined: 84 males (95-135 mm carapace width, CW) and 62 females (95-142 mm CW) from all the 15 sampling stations of the study area.

Diagnostic features: Carapace smooth with conspicuous transverse ridges. Colour pale green to olive green, fingers of chelae pale orange. H-shaped gastric groove deep. Frontal margin of carapace cut into bluntly pointed teeth, with rounded interspaces. Anterolateral margin of carapace cut into 9 narrow teeth. Chelipeds large and strong with propodus inflated. Distinguishing character is the presence of two prominent sharp spines on the distal half of outer margin of the carpus of cheliped (Fig. 4). Conspicuous hexagonal pattern on limbs in both sexes. Largest among the *Scylla* species.

First male pleopod with two patches of thin and inconspicuous setae on the inner margin of the posterior end. Second male pleopod smaller than first. Tip of second male pleopod bilobed, pleopod without setation (Fig. 5).

Remarks: Taxonomy of *Scylla* has been controversial for a long time, since the morphological features which separate the species are rather subtle and sometimes difficult to recognise in smaller specimens. *S. serrata*, the largest among the four *Scylla* species was often misidentified as *S. tranquebarica*. However, *S. serrata* can be easily distinguished by the two prominent spines on the carpus of its chelipeds, bluntly pointed frontal teeth and the conspicuous hexagonal markings on limbs.

Scylla olivacea (Herbst, 1796)

Synonyms: *Cancer olivaceus* Herbst, 1794: 157, pl. 38, fig. 3; *Scylla serrata* (not Forskal, 1775) Estampador, 1949: 99, pl. 1, fig. 1, Serene, 1952: 134, fig. 1C, pl.1, fig.3, pl.2, figs. 3,C, Joel and Raj, 1980: 39, figs. 2, 4, 6, 8, 10 a-b. *Scylla olivacea* Keenan *et al.*, 1998: 233, figs. 7D, 8D, 9D, 14., Apel and Spiridonov, 1998: 314, Jeng *et al.*, 1998, Ng, 1998c: 1118 (key), 1127, fig. Sakai K., 1999: 40.

Materials examined: 127 males (95-115 mm CW) and 92 females (95-107 mm CW) from all the 15 sampling stations of the study area.

Diagnostic features: Carapace smooth, grayish green in colour, fingers and the last segments of the walking legs pale orange. Frontal margin cut into rounded lobes. Anterolateral margin of carapace cut into 9 broad teeth. Chelipeds large, propodus inflated. Species is characterised by the presence of single spine on the distal half of outer

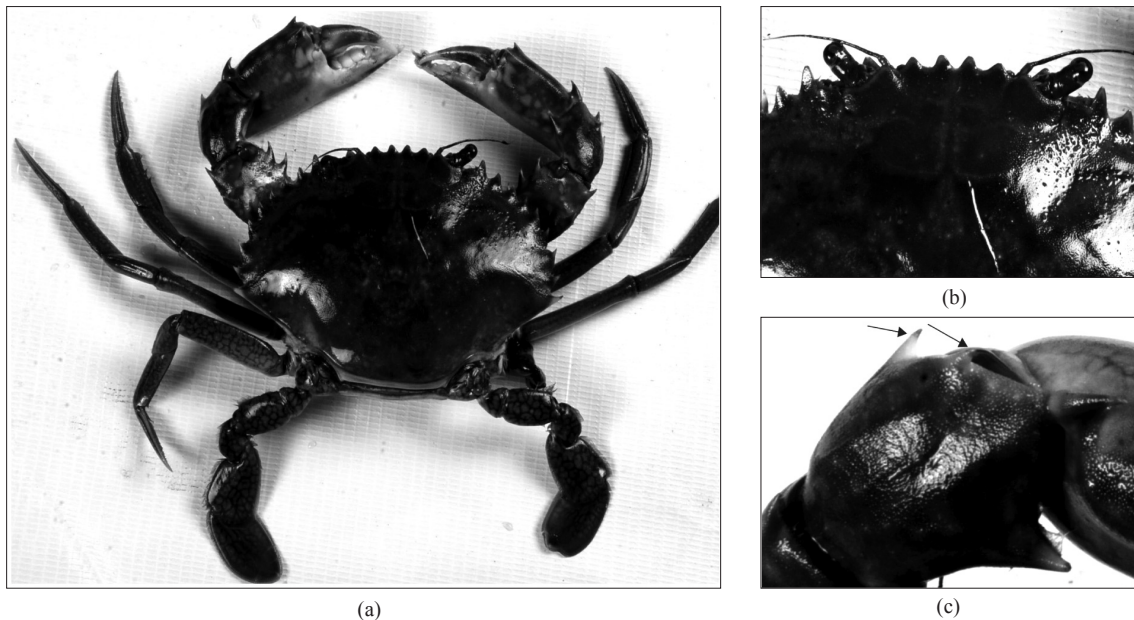


Fig. 4. a: *Scylla serrata*, b: Anterolateral margin of carapace cut into 9 narrow teeth, c: Two prominent sharp spines present on the distal half of outer margin of the carpus of cheliped (Magnification: 2535 * 1244, 400 dpi)

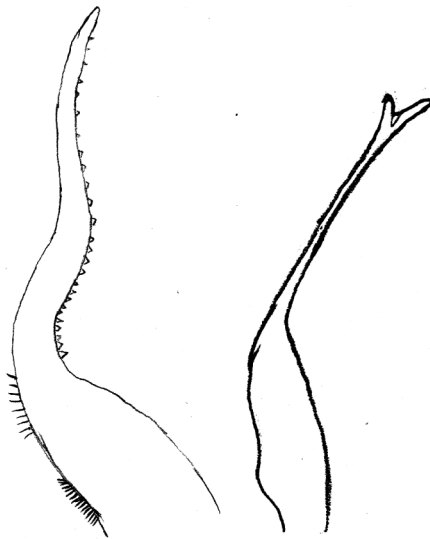


Fig. 5. Camera lucida drawings of first and second male pleopods of *S. serrata*

margin of carpus of cheliped. Palm of cheliped exhibits a pair of prominences on the dorsal margin behind the insertion of the dactyl. Inner prominence larger than outer one. Hexagonal markings weak or absent (Fig. 6)

First male pleopod with a single patch of thick and prominent setae. Tip of second male pleopod is bilobed. Unlike *S. serrata*, the pleopods are found to possess setation on the inner margin of the posterior region (Fig. 7).

Remarks: *S. olivacea* being smaller species, was initially misidentified as *S. serrata*. However, this species can be easily distinguished from *S. serrata* by its frontal margin (rounded frontal teeth) and cheliped armature (single prominent spine on the carpus of the chelipeds).

Key to the species of *Scylla* found in Cochin Backwaters

1. Carpus of the cheliped with single spine on the outer margin.....2
 Carpus of the cheliped with two prominent spines on the outer margin.....3
2. Frontal lobes rounded with shallow interspaces. Palm of cheliped with a pair of spine like prominences on the dorsal margin behind the insertion of the dactyl, inner larger and spinous and outer small and blunt. hexagonal pattern weak or absent.....*Scylla olivacea*
3. Frontal lobes bluntly pointed. Anterolateral margin cut into 9 narrow teeth. Hexagonal markings very conspicuous on all the limbs.....*Scylla serrata*

Results of the present study revealed that the mudcrab species that are being identified as *S. serrata* from Cochin Backwaters is *S. olivacea* and the species which is generally identified as *S. tranquebarica* is in fact *S. serrata*.

Discussion

The species identification of mudcrabs belonging to the genus *Scylla* has been controversial for many years.

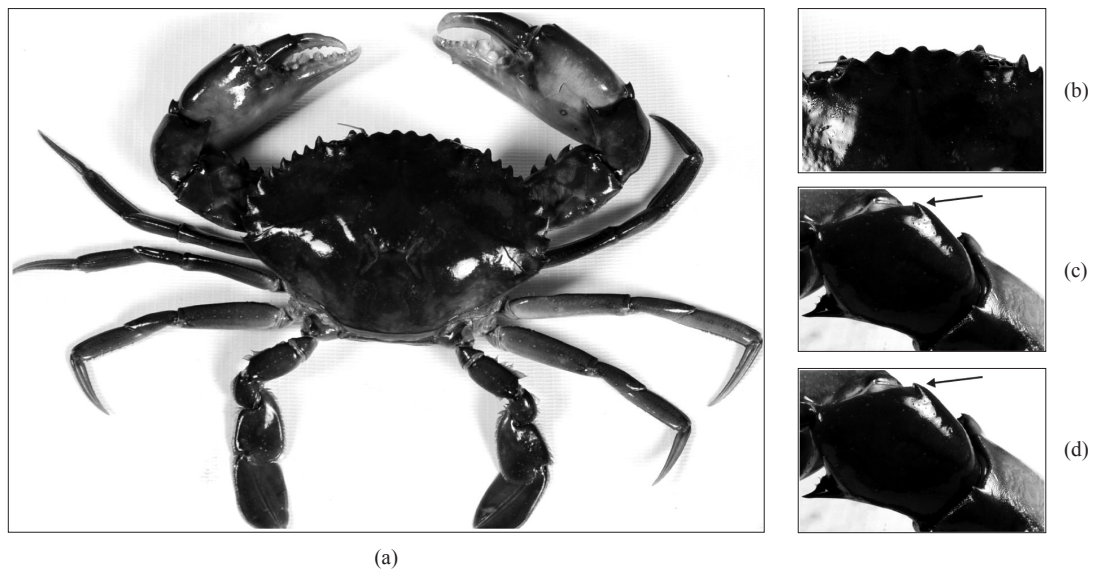


Fig. 6. a : *Scylla serrata*, b: Anterolateral margin of carapace cut into 9 broad teeth, c: Single spine present on the distal half of outer margin of the carpus of cheliped, d: Palm of cheliped with a pair of prominences on the dorsal margin behind insertion of the dactyl (Magnification: 2535 * 1244, 400 dpi)

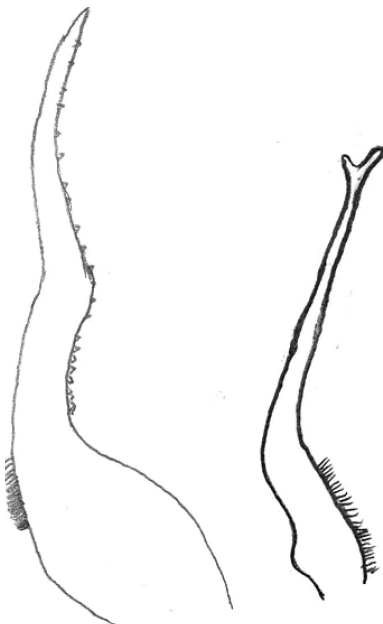


Fig. 7. Camera lucida drawings of first and second male pleopods of *S. olivacea*

(Fuseya, 1998). Estampador (1949) classified mudcrabs into three species and one variety, *S. serrata*, *S. oceanica*, *S. tranquebarica* and *S. serrata* var. *paramamosain*, based on external morphology. In accordance with Estampador's findings, Serene (1952) also recognised the existence of four forms in Vietnam. However, Stephenson and Campbell (1960) regarded the four forms as a single species and suggested that the morphological differences may be the result of environmental changes. Fushimi

(1983) reported the presence of three forms of mudcrabs in Hamana Lake. Oshiro (1988) recognised three species from Japan, which is in agreement with Fushimi (1983). The genetic variability analysis carried out by Fuseya and Watanabe (1996) determined that the three species, *S. serrata*, *S. tranquebarica* and *S. oceanica* are clearly distinguishable. Keenan *et al.* (1998) made a revision of the genus *Scylla* occurring in the Red Sea and throughout the Indo-Pacific. He employed molecular methods, besides morphometry and morphological characters for the identification and recognised four species of *Scylla* viz., *S. serrata*, *S. tranquebarica*, *S. olivacea* and *S. paramamosain*.

Taxonomical significance of the first two pairs of male pleopods and the third maxillipeds have been recognised by several crab taxonomists (Stephenson and Campbell, 1960; Joel and Sanjeevaraj, 1983; Sethuramalingam and Ajmal Khan, 1991; Fuseya, 1998). The first male pleopods were found to be varying in *S. serrata* and *S. tranquebarica* (Joel and Sanjeevaraj, 1983). Fuseya (1998) examined the first and the second male pleopods of *S. serrata*, *S. tranquebarica* and *S. oceanica* and found them clearly distinguishable. Keenan *et al.* (1998) stated that the shapes of first male pleopods are similar in the *Scylla* spp. examined, but there are some minor variations, which could be discerned in the present study. The first pleopods of the males in both species were found to be similar in shape, but variations were observed in the pattern of setation, which was in agreement with the findings of Keenan *et al.* (1998). Likewise, the second pleopods of the males in both species

were also similar in shape but variations were observed in setation. The second pleopod of male *S. olivacea* exhibited setation on its inner margin while that of *S. serrata* lacked any such setation. Although the third maxillipeds have been observed to be an important taxonomic tool in the identification of closely related species of crabs, in the present study no significant variations were observed between *S. serrata* and *S. olivacea*.

The confusion in identification has led to the proliferation of available names for mudcrabs, and this in turn has led to the inconsistent use of names among authors (Keenan *et al.*, 1998). Mudcrabs with single spine on the outer margin of the carpus of the cheliped were considered to be *S. serrata* and those with two spines were considered to be *S. tranquebarica* by Joel and Sanjeevaraj (1983), Kathirvel and Srinivasagam (1992) and Fushimi and Watanabe (1999). However, according to Radhakrishnan and Samuel (1982), Keenan *et al.* (1998) and Sangthong and Jondeung (2006), *S. serrata* possesses two spines on the outer margin of the carpus of the cheliped. *S. tranquebarica* are also found to possess two spines, while *S. olivacea* and *S. paramamosain* possess only single spine (Keenan *et al.*, 1998; Sangthong and Jondeung, 2006). The observations of Keenan *et al.* (1998) are considered valid and generally accepted by crab taxonomists as well as by FAO (Ng, 1998) since he has given concrete evidence on the basis of morphological, morphometric and molecular analyses. Based on the taxonomic key proposed by Keenan *et al.* (1998) it can be concluded that the two species of mudcrabs found to exist in Cochin Backwaters are *S. serrata* and *S. olivacea*. Shaji *et al.* (2006) also stated that *S. serrata* and *S. olivacea* are the most common species occurring in India. Quite recently, Mandal *et al.* (2014 a, b) and Balasubramanian *et al.* (2014) confirmed through reliable molecular techniques that the most common species of mudcrabs occurring in Indian waters are *S. serrata* and *S. olivacea*.

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