

A new record of *Scylla olivacea* (Decapoda, Brachyura, Portunidae) from Goa, central west coast of India – A comparative diagnosis

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Taxonomic studies on mud crabs (*Scylla*) reveal considerable ambiguity in species identification owing to overlap of morphological characters. Present study consists a new record of *S. olivacea* along with a comparative diagnosis with *S. serrata* from the region. Further, minor phenotypic variations in the present *S. olivacea* specimens could be attributed to geographical isolation from existing populations.

[Keywords: New record, *Scylla*, morphometry, Goa, India]

Introduction

Mud crabs of the genus *Scylla* de Haan, 1833 (Decapoda, Brachyura, Portunidae) are common inhabitants of mangrove-vegetated estuaries throughout the Indo-Pacific region¹. Taxonomic studies^{2,3} revealed ambiguity in the taxonomy and identification of *Scylla* species. Keenan *et al.*³ employed twenty three morphological parameters and twenty seven ratios to identify four distinct species (*S. serrata* (Forskål, 1775), *S. olivacea* (Herbst, 1796), *S. tranquebarica* (Fabricius, 1798), and *S. paramamosain* Estampador, 1949), and provided a key to identify them.

Taxonomic studies of mud crabs along Indian coasts^{2,4,5,6,7,8,9,10,11,12,13,14} suggested the occurrence of two species, *S. serrata* and *S. tranquebarica* and one subspecies, *S. serrata* from Indian waters. Joel & Raj² reported two species namely *S. serrata* and *S. tranquebarica* from the Pulicat Lake, East coast of India. Present observations on community structure of demersal resources for two years (January, 2006 to April, 2008), revealed differences in mud crab specimens. A comparative assessment among various congeners further revealed a new record of *S. olivacea* from the west coast of India.

Materials and Methods

The coastal region of Goa (Fig. 1) harbours thickly vegetated mangrove habitats. It is located among narrow inter-tidal mudflats along the banks of estuaries and shores of estuarine islands of the

Mandovi-Zuari estuarine complex¹⁵. Mangrove habitats function as nursery grounds for juveniles of mud crabs, and provide food and shelter for adult stages of mud crabs^{16,17}. Sixty nine trawls were undertaken in the present study (Fig. 1) to assess the diversity and total community structure of demersal fish fauna. Nine trawls were taken from estuaries in May and December, 2005, September and October, 2006 and May, September & December of 2007. Above study was done along the navigational channel off the Mormugao port trust region and the southern region of Mormugao Bay (between 15°24'N, 73°48'E and 15°27'N, 73°51'E). One trawl was taken from the Aguada Bay in February, 2007. Offshore trawls were undertaken from January to April, 2006 and from December, 2006 to February, 2008. These were taken between latitudes 15°29'6"N and 15°33'15.2"N and longitudes 73°40'6"E and 73°51'11"E. Trawl nets with mesh sizes of 15 mm (mouth end) and 9 mm (cod end) were towed at a speed of 16 knots (4 km.h-1). Offshore trawls were operated for 1 to 3 hours, whereas the estuarine trawls were towed for a maximum of 1 hour, due to interference from irregular bottom topography. Trawl catch obtained was immediately examined for species composition by taking five sub-samples. Uncommon (or rare) specimens were sorted separately and temporarily preserved in ice. Beach seines were operated for sample collection in the estuarine embayment (one along Betim (15°30'18"N 73°49'52"E) in December 2005. Whereas two were operated in the

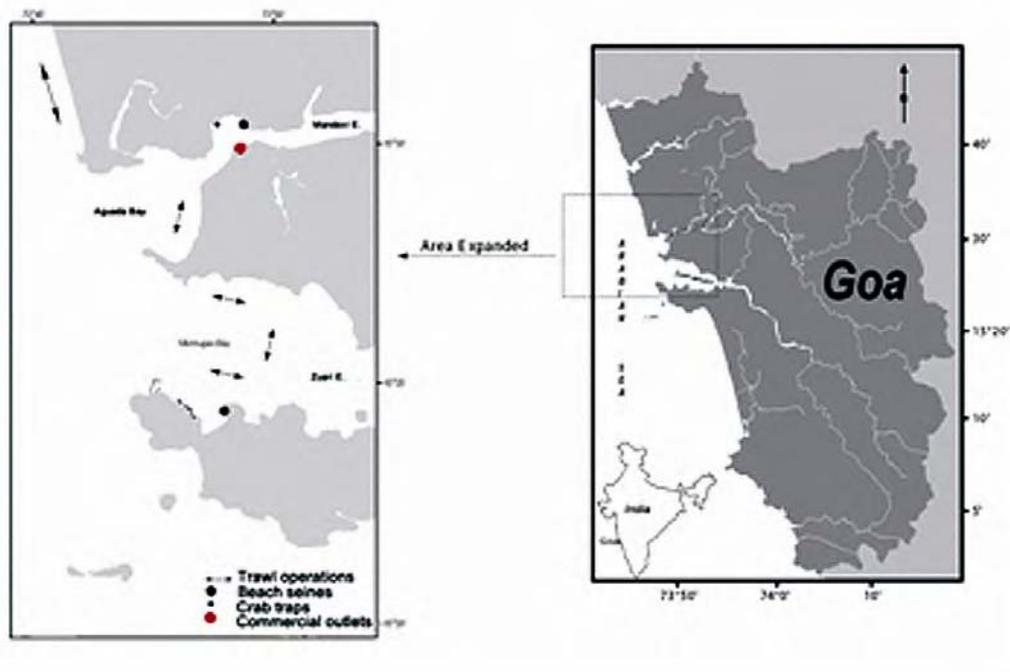


Fig. 1—Map of study area indicating sampling sites

vicinity of Mormugao Port Trust (15°24'16"N 73°48'56"E; Fig. 1) in December 2005 and September 2006 for one hour each, as trawl nets could not be operated. Crab traps were also employed to obtain samples from the estuarine embayment. In addition, crab specimens were obtained from commercial outlets over an extended duration as per availability of large-sized crabs. All biological samples were temporarily preserved in ice and a detailed morphological study of these was carried out in the laboratory.

Morphology and morphometric analyses

Mud crab samples (N = 31) were primarily identified using phenotypic criteria such as morphology, colouration and armature of carapace and appendages. Subsequently, morphometric parameters (N = 23) were measured and morphometric ratios (N = 27) derived from these following Keenan *et al.*³. In addition, illustrated descriptions of the male gonopod (G1) of these crabs were carried out. Based on the observed differences in morphological characters among the mud crabs, they were categorized into two species.

Abbreviations

The following abbreviations are used: ICW – Internal carapace width; FMSH – Frontal median spine height; FW – Carapace frontal width;

ICS – Inner carpus spine; OCS – Outer carpus spine. Terminology used in the morphological description of mud crabs follows Keenan *et al.*³.

Statistical analysis

Student's t-test was carried out to test the null differences between *S. serrata* and *S. olivacea* with respect to three morphometric ratios namely ICS/OCS, FMSH/FW and FW/ICW.

Results

Preliminary morphological examination of mud crab specimens (N = 31) as suggested by Keenan *et al.*³ revealed two species namely *Scylla serrata* and *S. olivacea* (Figs 2 - 7).

S. serrata (Forskål, 1775) – present study

Material examined.

One male, Betim, 13 Dec. 2005, coll; 4 males, Panaji market, 27 Sept. 2007, coll; 2 females, Mandovi estuary, 27 Sept. 2007, coll; 1 male, 1 female, Panaji market, 16 Jan. 2008, 1 male, Panaji market, 12 Mar. 2008, 1 male, Panaji market, 15 Mar. 2008.

General description.

Carapace broader than long, with prominent H-shaped groove present on cardiac region (Fig. 2a). Frontal margin (excluding inner supra-orbital angles)

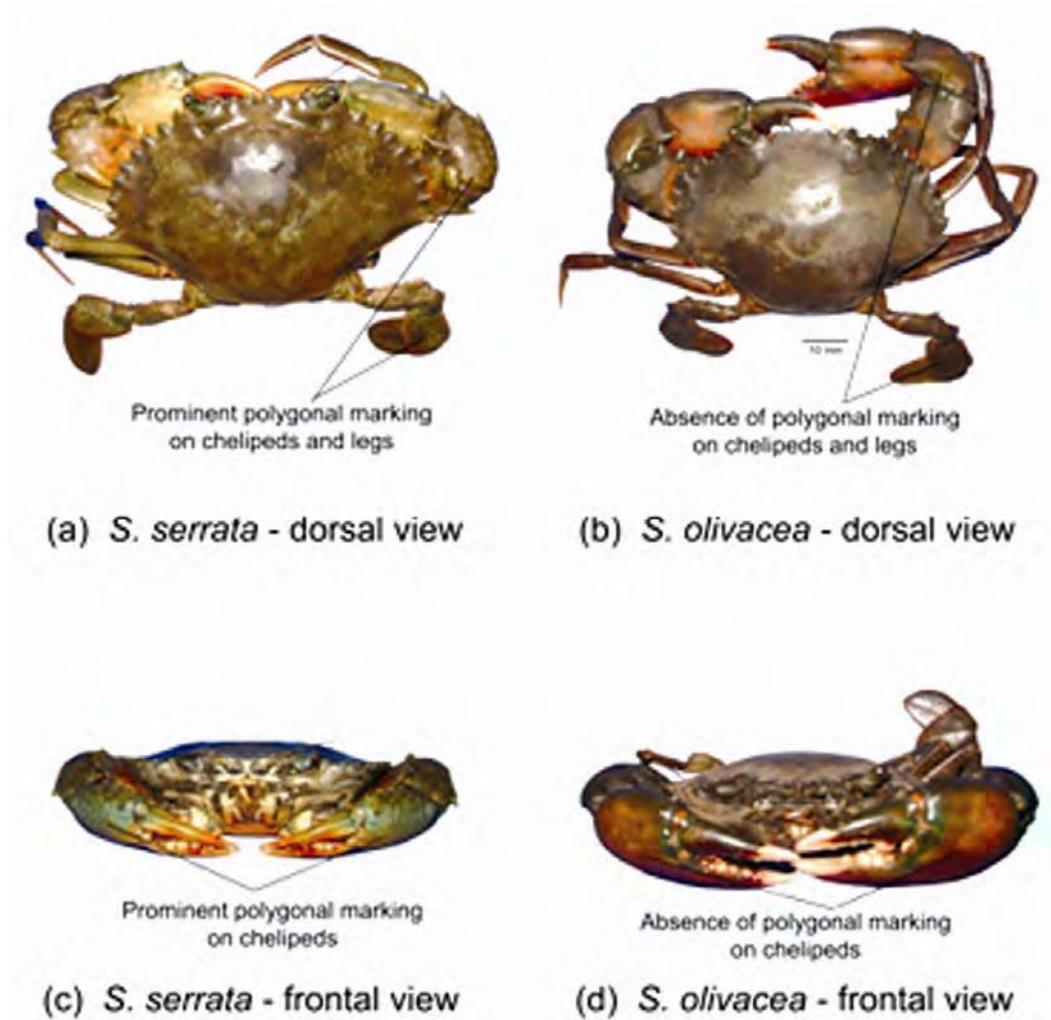


Fig. 2—Dorsal view of carapace (a) *S. serrata* (b) *S. olivacea*; Frontal view of carapace (c) *S. serrata*, (d) *S. olivacea*

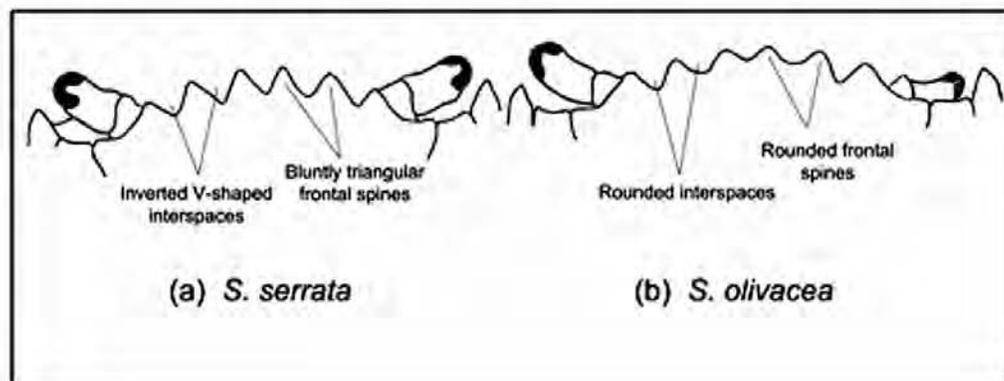


Fig. 3—Frontal margin of carapace of *S. serrata* (a) coloured photograph, (b) line diagram and *S. olivacea* (c) coloured photograph, (d) line diagram

with four bluntly pointed spines with slightly concave margins and separated by inverted-V shaped interspaces, their height approximately 0.06 times frontal width measured between orbital sutures (Fig. 3a,b). Antero-lateral margins of carapace longer than postero-lateral margins, divided into nine sharp spines. Chelipeds massive, smooth, longer than legs; merus with three spines on anterior margin and two on posterior margin; carpus with acute spine at inner angle and two prominent spines at outer angle (Fig. 4a); propodus with strong spine at carpus articulation and two well developed spines on dorsal margin behind insertion of the dactyl (Fig. 4a). Four pairs of pereopods, first three pairs similar, fourth pair natatorial. Colouration varied, olive green to dark brown with randomly scattered polygonal patterning (Fig. 2a), ventral surface of abdomen cream colour (only female abdomen with polygonal patterning; Fig. 5a), chelipeds and legs with conspicuous polygonal patterning (Fig. 2a,c). G1 with long distal portion, comparatively broader than in *S. olivacea* (Fig. 6a–b), ends in short, sharply pointed tip; outer margins of apex slightly convex (Fig. 6b–c); chromatophores absent. Details of morphometric

measurements (range, mean and standard deviation) are provided in Table 1. It is pertinent to note that these crabs share the character “Palm of chelipeds with pair of distinct spines on dorsal margin behind insertion of the dactyl” (Fig. 4a) with three species (*S. serrata*, *S. tranquebarica* and *S. paramamosain*) described by Keenan *et al.* (1998).

S. olivacea (Herbst, 1796) as described by Keenan *et al.*³

Frontal lobe spines low (mean height approximately 0.03 times frontal width measured between medial orbital sutures), rounded with shallow interspaces. Antero-lateral carapace spines broad, with outer margin convex. Carpus of chelipeds usually with one small blunt prominence (may be spinous in juveniles) ventro-medially on outer margin; reduced second spine may be present dorso-distally in juveniles and young adults. Palm of cheliped usually with a pair of blunt prominences on dorsal margin behind insertion of the dactyl, inner larger than outer; may be spinous in juveniles and young adults.

Chelipeds, legs and abdomen all without obvious polygonal patterning for both sexes. Colour varies from red through brown to brown/black depending on habitat.” In addition to morphological characters, Keenan *et al.* (1998) used three morphometric ratios namely, ICS/OCS, FMSH/FW and FW/ICW to distinguish *S. olivacea* from its congeners. The ratios assigned to *S. olivacea* are 0.006 ± 0.035 , 0.029 ± 0.005 , and 0.415 ± 0.017 , respectively.

S. olivacea – present study

Material examined.

One male, Mormugao Port Trust, 8 May, 2005, coll; 1 female, Potential fishing ground off Goa, 25 Feb 2006, 1 female, Potential fishing ground off Goa, 27 Mar 2006, 1 male, 1 female, Potential fishing ground off Goa, 26 Sept 2006, 4 males, Panaji market, 16 Jan. 2008, 7 males, 4 females, Panaji market, 15 Mar 2008.

General description

The specimens obtained during the present study and those resembling *S. olivacea* are described as “Carapace broader than long, with prominent H-shaped groove present on cardiac region (Fig. 2b). Frontal margin (excluding inner supra-orbital angles) with four rounded spines separated by rounded interspaces, their height approximately 0.026–0.066 times frontal width measured between orbital sutures (Fig. 3c,d). Antero-lateral margins of carapace longer

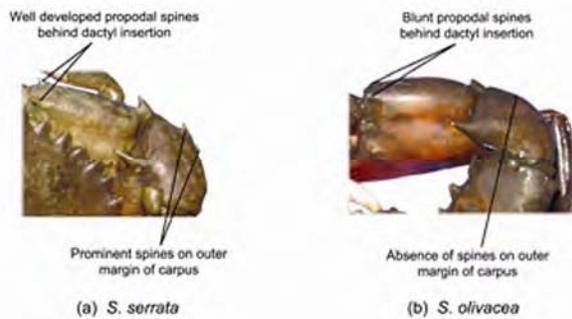


Fig. 4—Right cheliped (a) *S. serrata*, (b) *S. olivacea*

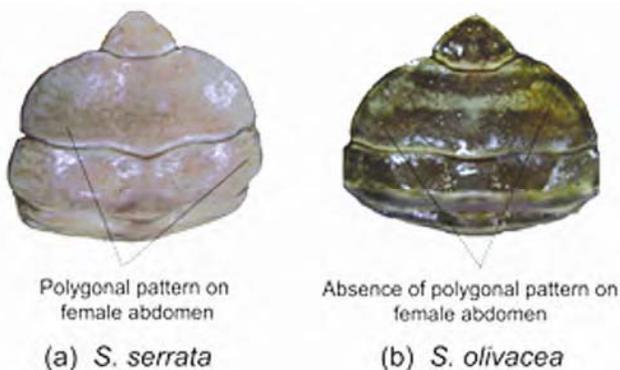


Fig. 5—Female abdomen (a) *S. serrata*, (b) *S. olivacea*

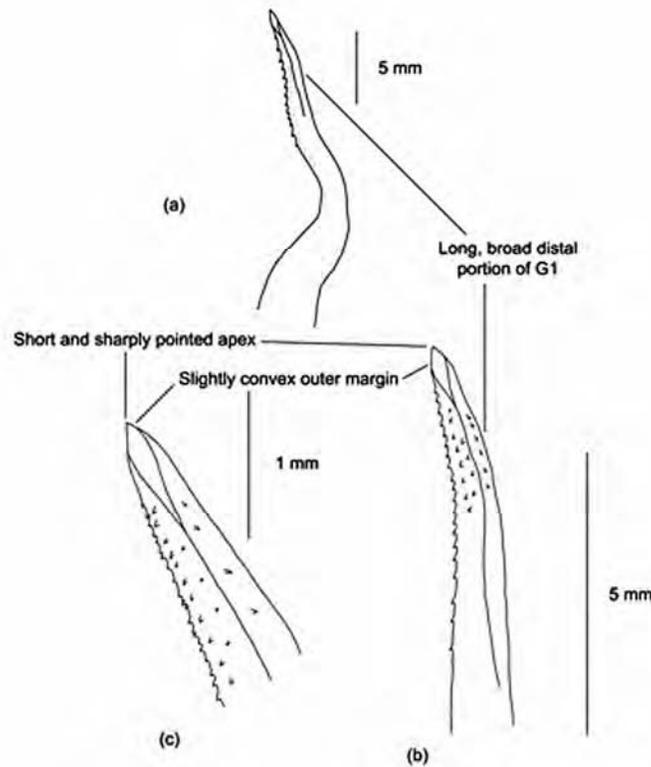


Fig. 6—Male gonopod (G1) of *S. serrata* (a) entire, (b) distal tip, (c) enlarged view of distal tip

Table 1—Range, mean and Standard deviation of morphometric ratios of *S. serrata* (N = 11) and *S. olivacea* (N = 20) obtained during the present study

S. No.	Morphometric Ratio	<i>S. serrata</i> (N = 11)		<i>S. olivacea</i> (N = 20)	
		Range	Mean \pm SD	Range	Mean \pm SD
1.	FMSH/FW	0.049–0.077	0.062 \pm 0.009	0.026–0.066	0.045 \pm 0.012
2.	FW/ICW	0.383–0.463	0.424 \pm 0.024	0.397–0.472	0.431 \pm 0.019
3.	ICS/OCS	0.000–5.636	2.155 \pm 1.844	0.000–0.500	0.101 \pm 0.177

than postero–lateral margins, divided into nine sharp spines. Chelipeds massive, smooth, longer than legs; merus with three spines on anterior margin and two on posterior margin; carpus with acute spine at inner angle, outer angle either lacks or may possess rudimentary spines (Fig. 4b); propodus with strong spine at carpus articulation, two reduced spines may be present on dorsal margin behind insertion of the dactyl (Fig. 4b). Four pairs of pereopods, first three pairs similar, fourth pair natatorial. Colouration varied from greenish brown to dark brown and generally devoid of polygonal patterning (Fig. 2b). Some specimens display light yellow polygonal marking on epibranchial region of carapace and chelipeds. Ventral surface of male abdomen cream coloured. Female abdomen characterized by alternating transverse dark

and light green or brownish bands, and lack of polygonal patterning (Fig. 5b). Chelipeds generally devoid of polygonal patterning (Fig. 2b,d), however some specimens display indistinct patterning. Legs devoid of polygonal patterning (Fig. 2b,d). G1 with long and slender distal portion comparatively narrower than in *S. Serrata* (Fig. 7a–b), ends in long, bluntly pointed tip; outer margins of apex convex (Fig. 7b–c).

Chromatophores just below tip of the first pair of abdominal appendages of male give a brownish red appearance in fresh specimens. The brownish red colouration fades in preserved specimens.” Details of morphometric measurements (range, mean and standard deviation) of the new variety of *S. olivacea* are provided in Table 1. It is evident that the present

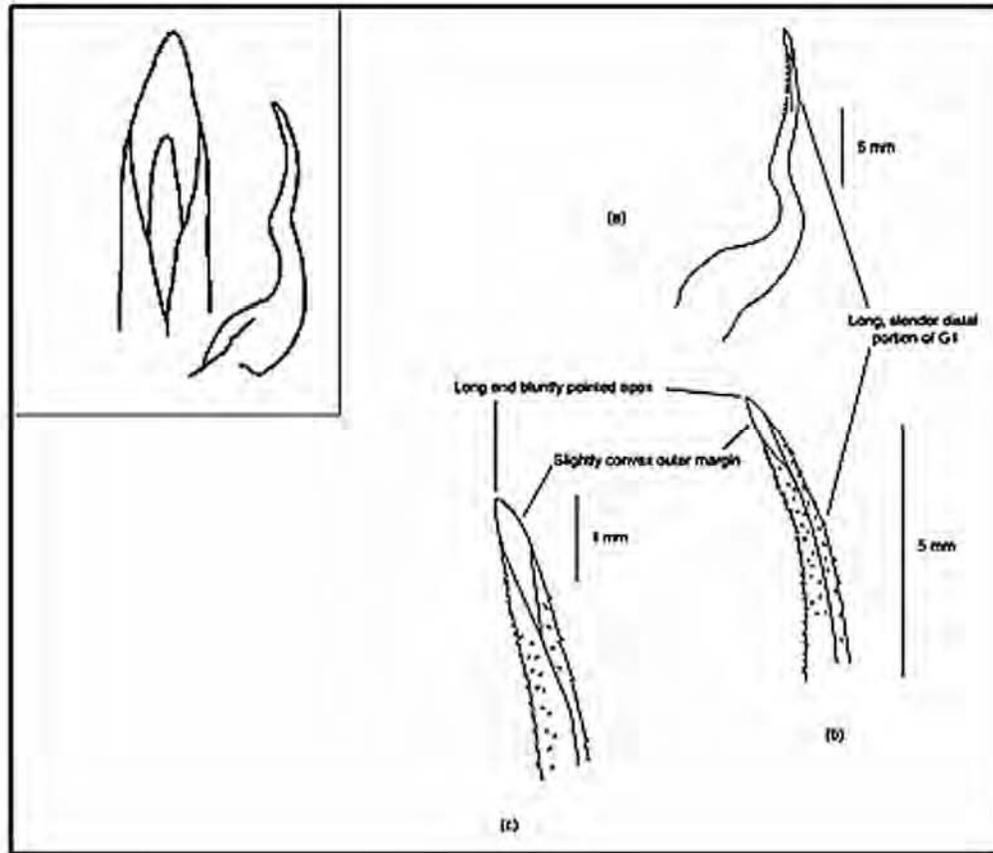


Fig. 7—Male gonopod (G1) of *S. olivacea* (a) entire, (b) distal tip, (c) enlarged view of distal tip; inset on top left margin, G1 of *S. olivacea* – Keenan *et al.*, 1998)

specimens resemble *S. olivacea* in “lacking two well developed spines on distal half of outer margin of carpus of cheliped”, “frontal lobe spines rounded with shallow interspaces”, “palm of cheliped usually with a pair of blunt prominences on dorsal margin behind insertion of the dactyl”, and “chelipeds, legs and abdomen without obvious polygonal patterning”. However, they differ from *S. olivacea* in the following:

1. Frontal lobe spine height “approximately 0.026–0.066 (0.045 ± 0.012) 183 times frontal width measured between orbital sutures (FMSH/FW)”, as compared to “0.018–0.037 (0.029 ± 0.005)” in *S. olivacea*.
2. “May possess rudimentary inner carpus spine or tubercle (range 0.000–0.500; 0.101 ± 0.177)”, whereas *S. olivacea* “lacks any (range 0.000–0.250; 0.006 ± 0.035)”.
3. “Chromatophores just below tip of the first pair of abdominal appendages of male give a brownish red

Table 2—Results of Student’s t-test indicating differences in morphological ratios between *S. serrata* (N = 11) and *S. olivacea* (N = 20)

S. No.	Morphometric Ratio	t-value ($P = 0.001$)	Df	Critical value
1.	FMSH/FW	4.661	29	3.659
2.	ICS/OCS	3.684	29	3.659

appearance in fresh specimens (faded in preserved specimens).”

Statistical analysis

The Student’s t-test (Table 2) suggests significant differences ($P \leq 0.001$) between *S. serrata* and *S. olivacea* with respect to two morphometric ratios namely FMSH/FW and ICS/OCS.

Discussion

The observations made in the present study along with a comparative diagnosis of the morphological characters of two closely related and ambiguous congeners imply a new record of *S. olivacea* from the

west coast of India and suggest that the population of *Scylla* is represented by two species. These congeners with distinct ecological backgrounds were observed to co-exist in the study area, which emphasizes the complexity of habitats and dynamic nature of the coastal processes within a small area. Further, minor phenotypic variations were observed in *S. olivacea*, which probably reflect regional and habitat-specific differences¹⁸ arising from the prevailing physical and ecological barriers. The physical barriers include the bathymetric setting of the habitats and the prevailing hydrological processes therein. The estuaries of Goa are generally short, narrow, fast flowing¹⁹, lined with thin patches of mangrove vegetation¹⁵ and separated from adjacent estuaries by pocket beaches and rock promontories²⁰. Their small lengths (approximately 50 km each) and wide mouths render these estuaries exposed to coastal processes¹⁹. These estuaries have high discharge rates²¹, semi-diurnal tidal strong influence on the settling time of megalopa larvae recruited to the estuarine environment. Secondly, these natural forces generate turbulence, advective and longitudinal mixing, trap coastal water thereby influencing the rate of sedimentation and erosion of mud flats on which the mangroves grow²². This probably results in patchiness in formation of mud crab habitats. The ecological barriers constitute the tolerance of the species towards fluctuations in environmental variables. The current-enabled vertical stratification of the Mandovi-Zuari estuaries lead to frequent oscillations in the salinity regime within these estuaries¹⁹, and *S. olivacea* being a stenohaline species inhabiting relatively lower saline embayments³ may be forced to remain buried within the substratum or frequently change habitats. Such fluctuations may also affect biological processes such as spawning and larval dispersal. Estampador¹⁸ attributed colour variations among its congener, *S. serrata* populations within similar geographical limits to niche specificity, whereas Overton *et al.*²³ stressed the need to study the role of environmental factors in determining phenotypic variations within a mud crab species.

The present observations demand further investigation into the population genetics of these crabs to provide better understanding of their population structure in the region and phylogenetic relations with similar populations distributed across the known geographical range of this species.

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