PORCELLANID CRABS FROM GOA, EASTERN ARABIAN SEA (CRUSTACEA: DECAPODA: PORCELLANIDAE)

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We report here 10 species of Porcellanidae sampled along the coast of Goa, India, each of which is described and figured. *Polyonyx splendidus* is registered for the first time outside the type region, and *Petrolisthes coccineus* is registered for the first time for the Arabian Sea. Accordingly, the porcellanid fauna of the western coast of the Indian subcontinent now consists of 16 species, including two endemics, *Polyonyx hendersoni* and *P. splendidus*. For the Indian Ocean, 9 species are here reported as endemic. We provide a key for the identification of all species so far reported for the western coast of the Indian subcontinent.

Key words: Crustacea, Anomura, Porcellanidae, Goa, Arabian Sea, taxonomy, biogeography

INTRODUCTION

The Porcellanid fauna of the coast of Goa remains unknown despite earlier studies conducted at different locations of the East Arabian Sea, e.g. Ratnagiri (Sankolli 1963a,b, 1966), along the west coast of India and coast of Pakistan (Tirmizi *et al*. 1982, 1989). Towards the goal of studying the occurrence, habitat and distribution of the species on the coast of Goa, we conducted fieldwork in the rocky region of Bogmolo in the vicinity of Marmugoa harbour, including St. George Island, and of Anjuna for ten days in December 2006.

MATERIAL AND METHODS

Crabs were collected during low tide by snorkelling and scuba diving up to 12 m depth, and preserved in 75% ethanol. Collected specimens were brought to the National Institute of Oceanography (NIO), Biological Oceanography Division, Dona-Paula, Goa, for identification. For each species we included: (1) the taxonomic history including a list of synonyms, (2) number and sex of specimens collected, (3) habitat characteristics and distribution, and (4) a scientific drawing of habitus (using a camera lucida). This information is followed by a taxonomic key to the species of the western coast of the Indian subcontinent.

RESULTS

Systematic account

***Ancylocheles gravelei* (Sankolli, 1963)** (Fig. 1)

Pachycheles sp.: Gravely, 1927: 140, pl.20, fig.9.

Porcellana gravelei: Sankolli, 1963a: 280, fig.1; Sankolli, 1966: 304, fig.5; Haig, 1965: 108; Haig, 1972: 447

Ancylocheles gravelei: Haig, 1978: 777; Haig, 1981: 275; Tirmizi, *et al*., 1982: 4 (key), fig.11; Tirmizi *et al*., 1989: 35, fig.22; Morgan, 1990: 28

Material examined: 4♂, 5♀, Bogmolo Beach, St. George Island, under rocks, mid-tide, 0.5 m.

Description: Carapace about as long as broad, subquadrate. Dorsal surface smooth, laterally slightly rugose, anterior regions well-marked. No epibranchial spine. Front broad, sinuously transversal or evenly rounded. Orbits moderately deep, inner orbital angle produced into rounded edge, outer orbital angle produced into small tooth.

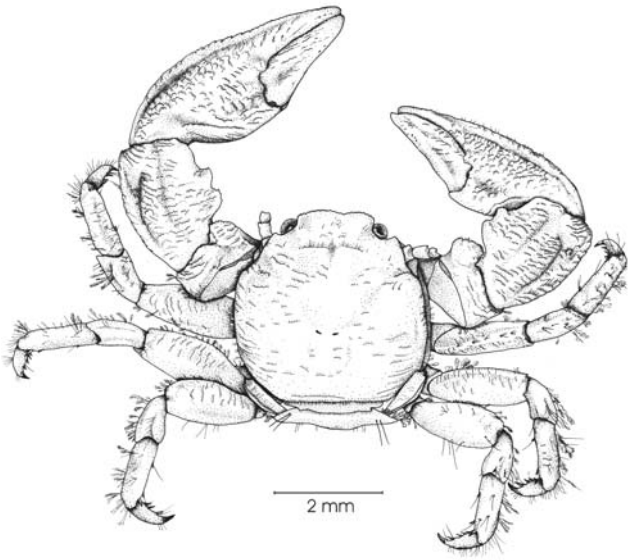

Fig. 1: *Ancylocheles gravelei* (Sankolli, 1963), male, Goa, Bogmolo, St. George Island

Eyes moderately large. Movable segments of antennae granulous without larger projections.

Chelipeds subequal; merus with a large, denticulate lobe at antero-proximal edge, carpus about 1½ times as long as broad, anterior margin with two large teeth on proximal half; dorsal surface granular with two longitudinal crests, outer border strongly convex; palm granular with a broad longitudinal ridge, extending onto pollex, outer border convex or distally nearly straight.

Walking legs slender, moderately granular with scattered, simple setae, dactylus with four movable spinules on inner border.

Habitat: The species is abundant in the lower intertidal area, and inhabits interstices of stones and rubble overgrown by sponges and other fouling organisms.

Distribution: *A. gravelei* shows a disjunctive distribution in the Indian Ocean, and is known from Pakistan, the western Indian coast and West Australia.

***Enosteoides ornatus* (Stimpson, 1858)** (Fig. 2)

Porcellana ornata: Stimpson, 1858: 242; Stimpson, 1907: 188; Gordon, 1931: 526, 529, fig.1; Miyake, 1943: 118, figs.42, 43; Sankolli, 1966: 302, fig.4; Kim & Choe, 1968: 1, pl.1, fig.1, fig.1; Morton & Morton, 1983: 272, 274, 299, figs.12.9: 4, 12.20: 3

Porcellana corallicola: Haswell, 1882: 759; Johnson, 1970: 32, figs.3q, r

Petrolisthes corallicola: Miers, 1884: 271, pl.29, fig.c

Enosteoides ornatus: Haig, 1978: 709; Haig, 1981: 271; Markham, 1982: 329; Tirmizi *et al*., 1982: 4; Tirmizi *et al*., 1989: 37, fig.23; Haig, 1992: 305, fig.2; Yang & Sun, 1992: 209, fig.15; Yang & Naiyanetr, 1997: 9, fig.5; Hsieh *et al*., 1998: 335, figs.32b, 33; Komai, 2000: 361

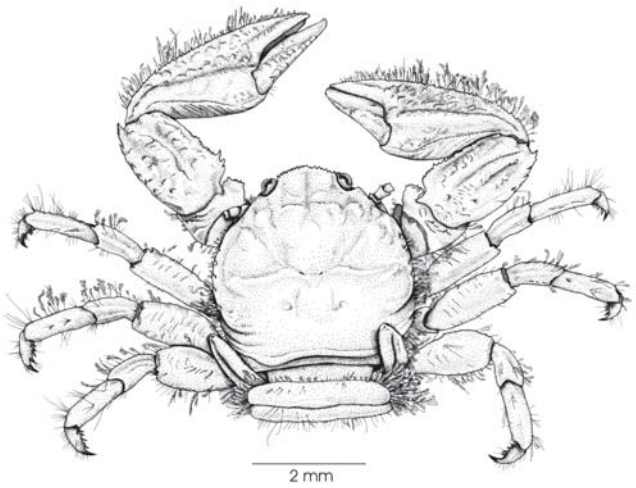

Fig. 2: *Enosteoides ornatus* (Stimpson, 1858), female, Bogmolo, St. George Island, Goa

Material examined: 1♂, 2♀, Anjuna Beach, 1.0-1.5 m, under rocks; 8♂, 10♀, Bogmolo Beach, St. George Island, 5 m, under rocks.

Description: Carapace as long as broad, ovate, epibranchial edges slightly pronounced, rounded. Dorsal surface uneven, granular; regions well-defined. Front projecting beyond eyes, triangular in dorsal view, denticulate. Orbits moderately deep, outer orbital angle weakly pronounced. Side walls covered with long, plumose setation. Eyes small. First and second movable segments of antenna short, granulate, third one simple.

Chelipeds robust, subequal in size; merus with prominent, denticulate lobe at antero-proximal edge; carpus about 2 times as long as broad, anterior border denticulate, proximally forming irregular sharp tooth; dorsal surface with three longitudinal crests, outer margin with a row of sharp teeth, the distal one forming a spine-tipped prominent edge; surface of palms with longitudinal crest, outer margin spinulated, with a fringe of long feathered setae.

Walking legs slender, covered with scattered, long, feathered setae; carpus of leg 1 with antero-distal spine; dactylus with five movable spines.

Habitat: Haig (1981) reported the species from the intertidal area under stones, and on coral heads to 54 m depth. We found the species sporadically on the coast of Goa from the lower intertidal to 8 m depth.

Distribution: The species is known from Pakistan and the western Indian coast, eastward through the Bay of Bengal, and from West Australia. In the western Pacific, the species has been reported from the Gulf of Thailand through the South China Sea, Taiwan Strait and southern Japan, and from eastern Australia.

***Pachycheles natalensis* (Krauss, 1843)** (Fig. 3)

Porcellana natalensis: Krauss, 1843: 58, pl.4, figs.1, 1a-c; Stimpson 1858: 228

Pisosoma natalensis: Paul'son, 1875: 88, pl.11, fig.5; (English translation, 1961: 94, pl.11, fig.5)

Pachycheles sculptus: Ortmann, 1894: 29; Nobili, 1906a: 136; Nobili, 1906b: 67

Pachycheles natalensis: Stimpson, 1907: 186; Riddell, 1911: 263; Balss, 1915: 8; Ramadan, 1936: 25; Barnard, 1950: 472, figs. 87a-f; Barnard, 1955: 4; Haig, 1964: 371; Haig, 1966a: 286 (key), 289; Haig, 1966b: 43; Haig, 1966c: 53; Sankolli, 1966: 300, fig.3; Lewinsohn, 1969: 150, fig.33; Lewinsohn, 1979: 50; Tirmizi *et al*., 1982: 2 (key), fig.1, pl.1; Tirmizi *et al*., 1989: 4, figs.1, 2; Werding & Hiller, 2007: 4, fig.3

Pisosoma sculpta: Gravely, 1927: 124, pl.20, fig.8

Material examined: 3♂, 4♀, Anjuna Beach, 1.0-1.5 m,

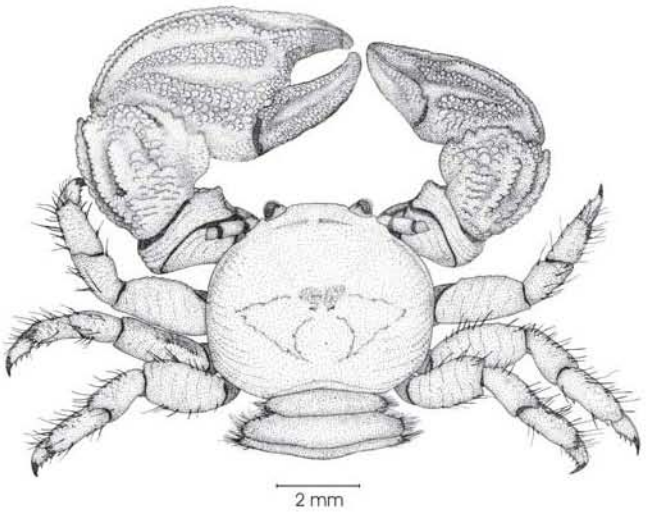

Fig. 3: *Pachycheles natalensis* (Krauss, 1843), male, Red Sea, Egypt (from Werding & Hiller, 2007)

mid-low tide, under rocks; 6♂, 6♀, Bogmolo Beach, low tide, under rocks.

Description: Carapace generally somewhat broader than long, subovate, convex. Dorsal surface smooth, regions poorly defined. Front inclined, rounded from above or moderately trilobate. Orbits well-defined, outer orbital angle forming a blunt tooth. Lateral walls formed by anterior trapezoid plate covering two thirds of wall, another large, subquadrate plate covering posterior area.

Eyes medium-sized. First movable segment of antenna with conical tubercle; second and third somewhat granulated; flagellum 1½ as long as carapace, sparsely setose.

Chelipeds large, robust, different in size, surface of carpus and manus nearly smooth or covered with large granules arranged in three longitudinal crests in carpus, and forming two similar crests along outer margin of chela; carpus about as long as broad or barely longer, anterior border with three or four teeth decreasing in size distally; outer margin of palm convex, fingers gaping in major cheliped, usually with tuft of setae in gape of larger chela, meeting for entire length in minor cheliped. Walking legs stubby, moderately granulated and with scattered, simple setae; dactylus with three movable spines.

Telson five-plated; males with a pair of pleopods.

Habitat: The species was found regularly in the deeper intertidal zone inhabiting interstices of stones and rubble held together by sponges.

Distribution: *P. natalensis* is restricted to the western Indian Ocean, including the Red Sea, along the coast of the Arabian Sea. On the African coast it is distributed southward to Mozambique including Madagascar.

***Petrolisthes boscii* (Audouin, 1826)** (Fig. 4)

Porcellana boscii: Audouin, 1826: 89; Heller, 1861a: 24; Heller, 1861b: 256

Petrolisthes boscii: Stimpson, 1858: 227; Paul'son, 1875: 87, 88; Henderson, 1893: 427; Ortmann, 1897: 284; McCulloch, 1913: 353, fig.53; Balss, 1913: 29, pl.1, fig.4; Balss, 1915: 7; Gravely, 1927: 140; Hale, 1929: 68; Ramadan, 1936: 24; Miyake, 1937: 211, fig. 1, pl.12, fig.2; Miyake, 1943: 90, figs.23, 24; Vatova, 1943: 15; Haig, 1964: 360; Haig, 1965: 99; Sankolli, 1966: 296, fig.1; Haig, 1966c: 51; Sarojini & Nagabhushanam, 1968: 153, pl.1, fig.3; Lewinsohn, 1969: 132, figs.27a-e; Johnson, 1970: 13; Nakasone & Miyake, 1971: 8; Mustaquim, 1972: 154, fig.2; Ahmed & Mustaquim, 1974: 174; Hogarth, 1988: 1101; Tirmizi *et al*., 1982: 2, fig.3; Tirmizi *et al*., 1989: 10, figs.5a-h; Haig, 1992: 312, figs.8a-c; Yang & Sun, 1992: 197, figs.2a-c, 3a-e; Yang & Naiyanetr, 1997: 5; Komai, 2000: 364; Werding & Hiller, 2007: 7, 8, fig.5

Petrolisthes amakusensis: Miyake & Nakasone, 1943: 173, figs.1-3

Petrolisthes rugosus: Miers, 1884: 270

Porcellana (*Petrolisthes*) *boscii*: de Man, 1888: 217

Material examined: 12♂, 15♀, Bogmolo Beach, under rocks, low-tide; 1♂, 1♀, Bogmolo Beach, St. George Island, 5 m, under rocks; 2♂, 2♀, Anjuna Beach (North), under rocks, 1.0-1.5 m, low tide.

Description: Carapace slightly longer than broad, inversely cordate, evenly rounded along branchial margins; surface with inconspicuous, interrupted transverse, plications; one epibranchial spine present. Front sinuously triangular with longitudinal depression; orbitae shallow, without supraocular spine, postorbital angle rectangular, without tooth. Eyes

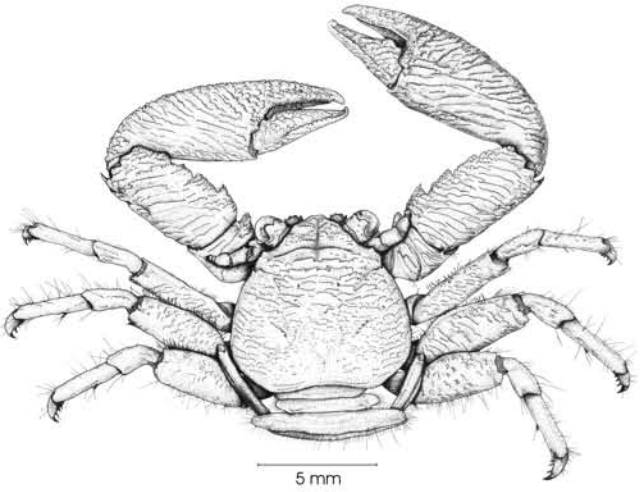

Fig. 4: *Petrolisthes boscii* (Audouin, 1826), male, Bogmolo, St. George Island, Goa

moderately large. Basal segments of antennulae with some transverse rugae, anterior margin with teeth. First movable segment of antennae with serrated, spine-tipped lamellar lobe; second and third segments slightly rugose.

Chelipeds subequal, surface with piliferous striations, merus rugose with serrated lobe on anterior margin; carpus two times as long as broad, armed on anterior margin with two or three broad, serrated teeth proximally, the first one spine-tipped; posterior margin slightly convex, armed distally with a strong spine, followed by two smaller ones. Chelae broad, with transverse striations, outer margin evenly rounded, spineless.

Walking legs rugose; all segments with irregularly wide-set, feathered and simple setae; Merus spineless with an exception of a small posterodistal spine on legs 1 and 2, carpus spineless; propodus with terminal triplet of movable spines on ventral border and an additional one at mid level; dactylus large with three movable spinules on inner border.

Habitat: Lewinsohn (1969) reported *P. boscii* from shallow water to 18.3 m depth, from rocks, boulders and corals. We found it among boulders in the deeper intertidal and the subtidal, where it appears to be the most abundant porcellanid species.

Distribution: West Indian Ocean, including the Red Sea, and along the coast of the Arabian Sea through the Bay of Bengal. In the Pacific from the Gulf of Thailand, Indonesia and Japan. Also in tropical Australia.

***Petrolisthes coccineus* (Richardson *et al*., 1839)** (Fig. 5)

Porcellana coccinea: Richardson *et al*., 1839: 87, pl.26, figs.1, 2; Dana, 1852-53: 423

Petrolisthes coccineus: Laurie, 1926: 14; Miyake, 1943: 59, figs.3, 4; Haig, 1966b: 46, (key); Kensley, 1970: 114, fig.8; Haig, 1983: 280; Haig, 1992: 313, fig.9; Hsieh *et al*., 1998: 303, fig.16; Yang & Sun, 1990: 3, pl.3

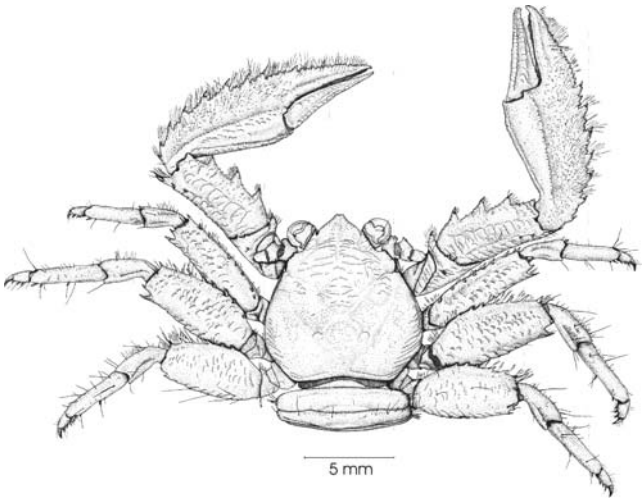

Fig. 5: *Petrolisthes coccineus* (Richardson *et al.*, 1839), male, Bogmolo, St. George Island, Goa

Petrolisthes barbatus: de Man, 1893: 296, pl.7, figs.4, 4a; Ortmann, 1894: 28; Ward, 1942: 63

Petrolisthes pubescens: Balss, 1913: 30, pl.1 fig.2

Petrolisthes nipponensis: Miyake, 1937: 213, fig.22, pl.12 fig.1

Material examined: 3♂, 2 juv. Bogmolo Beach, under rocks, low tide.

Description: Carapace slightly longer than broad, evenly rounded along branchial margins, inversely cordate. Surface with faint, transverse plications on cardiac region and along posterior lateral margins; one epibranchial spine present. Front narrow, sinuously triangular with longitudinal depression; orbitae shallow, supraocular spine strong, postorbital angle blunt. Eyes large. Basal segment of antennulae with some transverse rugae, anterior margin with teeth. First movable segment of antennae with serrated, spine-tipped, lamellar lobe; second produced forwardly, forming a serrated, edged tooth; third segment slightly rugose.

Chelipeds subequal, merus rugose with spine-tipped projection on anterior margin; distal border with a pair of spines, a third one upon surface; carpus about two-and-a-half times as long as broad; surface with two rows of scale-like, flattened granules, one forming a shallow longitudinal crest along midline, the second along posterior margin; anterior margin with three serrated spine-tipped teeth; posterior margin slightly concave, distal edge armed with a pair of strong spines, followed by two weaker ones. Chelae flat, surface with a row of granules forming a longitudinal ridge; area towards outer margin with scattered granules and scattered, feathered setae. Outer border with a row of strong, spine-tipped teeth.

Walking legs rugose, with scattered, simple, feathered setae; anterior margin of merus with a row of strong spines; a pair of large posterodistal spines on merus of legs 1 and 2, a smaller one on leg 3; carpus of leg 1 with anterodistal spine; propodus with terminal triplet of movable spines on ventral border, with one or two, additional ones; dactylus large with three movable spinules on inner border.

Habitat: Haig (1983) reported the species from shallow water to 1.2 m in the Seychelles. According to Miyake (1943), the species occurs between tide marks under rocks. We found few specimens in two locations under large boulders.

Distribution: *P. coccineus* shows an extremely large distributional range from the coast of Mozambique through scattered locations in the Indian Ocean, and the western Pacific to the Easter Island. Its occurrence on small and distant oceanic islands is remarkable. In the Indian Ocean, it is reported from the Seychelles, Chagos Archipelago and Nicobar

Islands; in the Pacific from Ogasawara, the Mariana Islands, Hawaii, the Tuamotu Archipelago and Easter Island. Additionally, it has been reported from Indonesia and Taiwan. The finding from India is the first record from continental Asia.

***Petrolisthes lamarckii* (Leach, 1820)** (Fig. 6)

Pisidia lamarckii: Leach, 1820: 54

Petrolisthes lamarckii: Stimpson, 1858: 227; Miers, 1884: 557; Stimpson, 1907, pl.22 fig.2; Ortmann, 1894: 26; Borradaile, 1898: 464; Miyake, 1942: 342, figs.7, 8; Miyake, 1943: 98, fig.29; Barnard, 1950: 477 figs.89 a-d; Haig, 1964: 362; Haig, 1966b: 47; Mustaquim, 1972: 154, fig.3; Haig, 1979: 124; Haig, 1983: 283; Kropp, 1983: 100; Yang, 1983: 3, pl.4; Tirmizi *et al*., 1982: 10, fig.4; Hogarth, 1988: 1101; Tirmizi *et al*., 1989: 12, figs.7, 8; Haig, 1992: 315, fig.11; Hsieh *et al*., 1998: 326, fig.28

Petrolisthes lamarcki: Doflein & Balss, 1913: 162

Petrolisthes lamarcki: Laurie, 1926: 140; Taylor, 1968: 170

Porcellana dentate: H. Milne Edwards, 1837: 252

Porcellana pulchripes: White, 1847: 129

Porcellana speciosa: Dana, 1852-53: 417; Dana, 1855: pl.26, fig.8; Balss, 1913: 30 *Petrolisthes dentatus*: Rathbun, 1910: 314

Porcellana bellis: Heller, 1865: 76.

Material examined: 4♂, 3♀ Anjuna Beach, intertidal; 2♀, Anjuna Beach, intertidal; 14♂, 20♀, Bogmolo Beach, under rocks, intertidal 1 m.

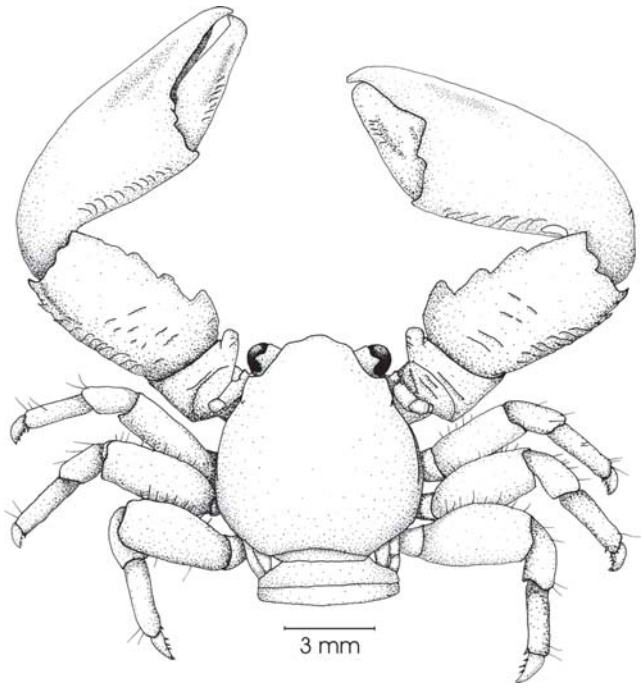

Fig. 6: *Petrolisthes lamarckii* (Leach, 1820, male, Indian Ocean, Kenya (from Werding & Hiller, 2007)

Description: Carapace about as long as broad, ovate, weakly convex front to back and transversely, lateral margins evenly rounded. Dorsal surface slightly rugose, regions moderately marked. A single epibranchial spine present, sometimes obsolescent, especially in larger specimens. Front moderately broad, sinuously triangular, with a longitudinal depression. Orbits shallow, no supraocular spine, outer orbital angle not produced. Lateral walls complete, with some longitudinal ridges.

Eyes moderately large. First movable segment of antennae with serrated, lamellar lobe; second with large tubercle, third nearly smooth.

Chelipeds subequal, robust, surface rugose or granulate; merus rugose with serrated lobe on anterior margin; carpus two times as long as broad, covered with granules, anterior margin armed with three low, wide-set teeth, decreasing in size distally, posterior margin armed with a row of large, flattened granules, the distal two produced into spines; palm broad, covered with scattered granules, outer margin moderately convex.

Walking legs rugose, anterior margin fringed with feathered setae; anterior margin of merus spineless; a posterodistal spine on merus of legs 1 and 2; dactylus with three movable spinules on inner border.

Habitat: *P. lamarckii* occurs in the uppermost level of the intertidal, frequently under large, steady boulders.

Distribution: The species shows a large distributional range in the Indo-West Pacific, and has been recently reported from the Red Sea, with two females found by Werding and Hiller (2007) in an old collection by C.B. Klunzinger in 1877. While the specimens of Klunzinger were from El Quseir, we recently found several individuals near Dahab in the Gulf of Aquaba (Werding and Hahn, unpublished). However, a reliable distributional picture of the species cannot be confirmed before the *P. lamarckii* – complex is critically reviewed (see discussion below).

Discussion: When Kropp (1983) reviewed the *P. lamarckii* complex he created *P. borradailei* to receive specimens morphologically close to *P. lamarckii*, but distinguishable by the absence of epibranchial spines. This author described the presence of a "distinctive line of irregularly spaced, pale orange dots" in all *P. borradailei* specimens. We observed such an arrangement of orange dots in numerous specimens from the Red Sea (unpublished data), all showing well-formed epibranchial spines, thus clearly belonging to *P. lamarckii*. On the other hand, some specimens from Goa exhibit a row of irregular whitish or pale yellow dots, and in several individuals the epibranchial spines are

poorly defined or lacking. Thus, the presence or absence of epibranchial spines seems to be a variable character among populations or even within a local population. Consequently, the differences between *P. borradailei* and *P. lamarckii* are not clear and *P. borradailei* might be a junior synonym of *P. lamarckii*.

***Pisidia dehaanii* (Krauss, 1843)** (Fig. 7)

Porcellana dehaanii: Krauss, 1843: 59, pl.4 figs.2, 2a-c; Barnard, 1947: 378; Barnard, 1950: 467, figs.88 e-h; McNae & Kalk, 1958: 83, 126; Kensley, 1969: 153; Kensley, 1970: 105

Pisidia dehaanii: Haig, 1960: 209; Sankolli, 1965: 3; Sankolli, 1966: 305, fig.6; Haig, 1966c: 48; Sarojini & Nagabhushanan, 1968: 161, pl.II, fig.6; Mustaquim, 1972: 153, fig.1; Haig, 1978: 707; Lewinsohn, 1979: 52; Haig, 1981: 276; Tirmizi & Yaqoob, 1982: 15, fig.9, 27, pl.9; Hogarth, 1988: 1102; Tirmizi & Yaqoob, 1989: 27, figs.17, 18

Material examined: 1♂, 2♀ (ov.), Bogmolo Beach, under rocks, 0.5-1.0 m, low tide.

Description: Carapace about as long as broad, ovate. Dorsal surface rough, regions well-marked, with a pair of tufts formed by feathered setae on protogastric ridges, epibranchial edges pronounced, rounded, no epibranchial spine; two spines on branchial margin. Front with three prominent, rounded lobes, separated by deep clefts, median lobe considerably longer than lateral ones. Orbits shallow, outer orbital angle acuminate. Basal segment of antennulae with forwardly-directed, spine-tipped lobes; first and second movable segments of antennae finely granular, bearing one or two small spines, flagellum about 1½ times as long as carapace.

Chelipeds different in size; merus with anterodistal, flattened trapezoid lobe; carpus about 2 times as long as broad, slightly rugose, anterior and posterior margin convex, dorsal surface with a shallow, longitudinal crest, larger chela broad, slightly rugose, outer margin convex; smaller cheliped similar with slightly concave outer margin.

Walking legs moderately long, slender, slightly rugose, with scattered setae; dactylus with three movable spinules on inner border.

Habitat: Haig (1981) referred to the ecology of the species as "intertidally among rocks and weeds". On the coast of Goa we only found scattered small specimens in interstices of stones and rubble agglomerated by sponges in the lower intertidal.

Distribution: *Pisidia dehaanii* is an endemic to the Indian Ocean, and was reported from the South African coast as far south as 32° S, northward from the Persian Gulf, and from both coasts of India.

***Pisidia gordoni* (Johnson, 1970)** (Fig. 8)

Porcellana (allied to *serratifrons*): Miers, 1884: 277

Porcellana serratifrons: Henderson, 1888: 110 (part); Grant & McCulloch, 1906: 39, 40; Nobili, 1906b: 75; Sankarankutty, 1963: 278, fig.3; McNeill, 1968: 34

Porcellana spinulifrons: Gordon, 1931: 530, figs.4C, 5

Pisidia cf *spinulifrons*: Haig, 1965: 105, 106

Pisidia spinulifrons: Sankolli, 1966: 307, fig.7

Porcellana (*Pisidia*) *gordoni*: Johnson, 1970: 29, fig.3

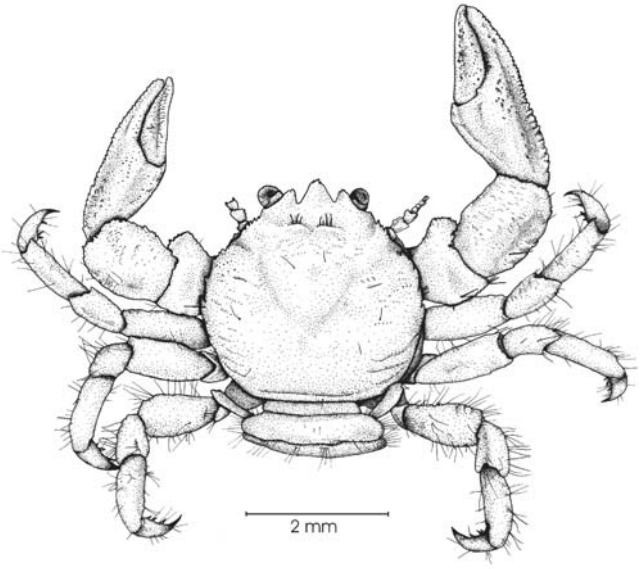

Fig. 7: *Pisidia dehaanii* (Kraus, 1843), male
Bogmolo, St. George Island, Goa

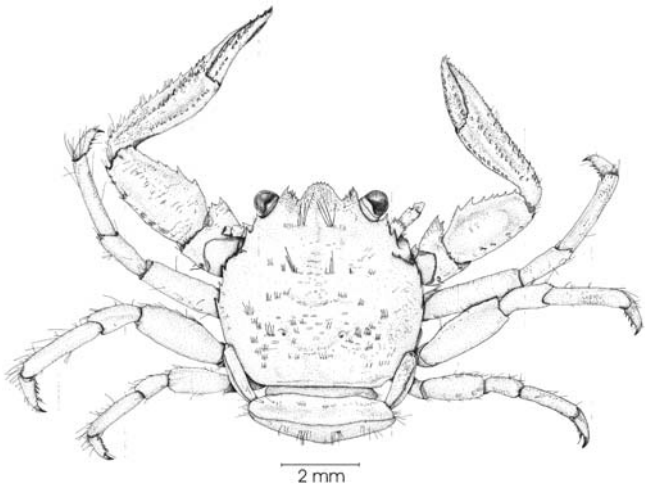

Fig. 8: *Pisidia gordoni* (Johnson, 1970), male
Bogmolo, St. George Island, Goa

Pisidia gordoni: Haig, 1973: 283; Haig, 1978: 707; Haig, 1981: 277; Tirmizi *et al*., 1989: 34, fig.21; Morgan, 1990: 32; Yang & Sun, 1990: 4, figs.5, 6; Haig, 1992: 318, fig.14; Komai, 2000: 366; Siddiqui & Kazmi, 2003: 88

Material examined: 6♂, 8♀, Bogmolo Beach, St. George Island, under rocks, 5 m, mid-low tide.

Description: Carapace slightly longer than broad, subovate. Dorsal surface rough, regions well-marked; epibranchial edges rounded, fringed with some smaller spinules; no prominent epibranchial spine. Front with three lobes, median lobe considerably broader than lateral ones, lateral lobes spine-tipped. Eyes large, orbits well-defined, outer orbital angle produced into a sharp spine, followed by another one of the same size. First and second movable segments of antennae finely granular, flagellum about 2 times as long as carapace.

Chelipeds slender, different in size, merus with spiny anterodistal projection, carpus more than two times as long as broad, slightly rugose, anterior margin convex, with irregular acute tooth; chelae with three longitudinal crest with rows of acute tubercles, except in larger cheliped of large animals.

Walking legs long and slender, slightly rugose, with scattered setae; dactylus with four movable spinules on inner border.

Habitat: Small specimens were found scattered in the lower intertidal, and large adults occurred regularly under stones in depths between 6-10 m. Haig (1966c) reported it at 50 m depth.

Distribution: The species is an endemic to the Indian Ocean and has been reported from Delagoa Bay, Mozambique, Madagascar and Pakistan. The findings from Goa are the first record from the Indian coast and represent a considerable range extension.

***Polyonyx hendersoni* Southwell, 1909** (Fig. 9)

Polyonyx hendersoni: Southwell, 1909: 117, figs.6-9; Gravely, 1927: 141, pl.20 fig.11; Johnson, 1958: 98, 112; Haig, 1964: 380; Sankolli, 1966: 309, fig. 8; Tirmizi *et al*., 1982: 3, fig.8, pl.VIII; Tirmizi *et al*., 1989: 25, figs.15, 16

Material examined: 3♂, 2♀, Bogmolo Beach, 0.5-1.0 m, low tide, inside white sponge; 1♂, 1♀, Bogmolo Beach, St. George Island, 6 m, inside white sponge.

Description: Carapace rounded, nearly as broad as long, longitudinally convex. Dorsal surface smooth, except for some fine plications on branchial regions; epibranchial angles not produced, regions not defined. Front broad inclined, nearly straight from above. Orbits shallow, outer orbital angles insignificant. Lateral walls complete.

Eyes small, barely visible from above. First movable

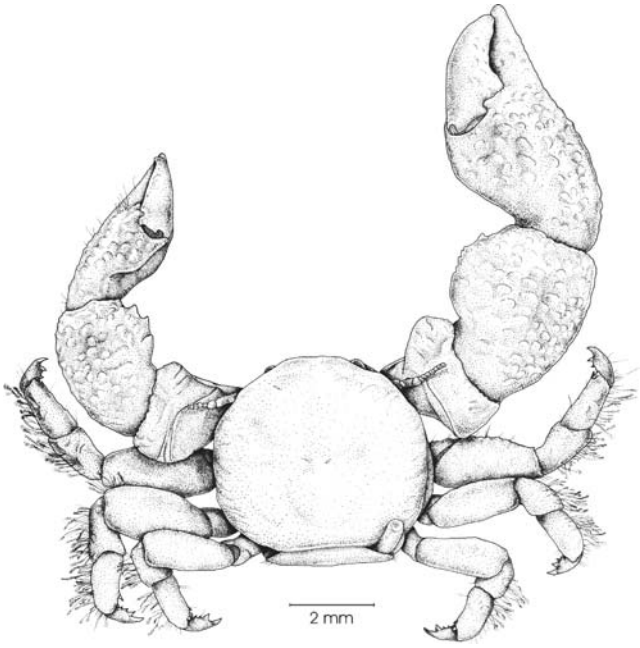

Fig. 9: *Polyonyx hendersoni* Southwell, 1909, male Bogmolo, St. George Island, Goa

segment of antenna subcylindric, short, second more than twice as long as broad, smooth, third smooth; flagellum 1½ times as long as carapace. Basal segment of antennules without prominence.

Chelipeds large, robust, different in size, irregularly covered with rounded, large granules; merus granulated, with some transverse ridges, anterodistal edge produced into large, rounded lobe; carpus 1½ times as long as broad, anterior border produced with three to five irregular tooth; fingers of manus of larger cheliped in large specimens gaping, fingers bent upwards, meeting for entire length in minor cheliped. Outer border of larger chela concave.

Walking legs smooth with long feathered setae on carpus, propodus and dactylus; dactylus with three strong, fixed spines.

Habitat: *P. hendersoni* seems to inhabit exclusively the water ducts of Demospongiae, inside which we found the species, from the intertidal to a depth of 6 m.

Distribution: The species has been reported from Pakistan, the western Indian coast to the south tip, eastward to the Gulf of Mannar, and from Sri Lanka.

Remarks: *Polyonyx hendersoni* belongs to a morphological group within the genus that is different from the *P. sinensis* - group (Johnson 1958), with species generally found within tubes of polychaete worms. Johnson (1958) stated that *P. hendersoni* did not seem to be closely related to any other species. He ascribed this species to the *P. biunguiculatus* group, highlighting that "its nearest affinities are apparently to *P. obesulus*". However, he

mentioned some differences between *P. hendersoni* and other species of *P. biunguiculatus* group, emphasizing on the different form of the meral lobe of the chelipeds, the armature of the chelipeds, the setation of the smaller cheliped, and the different form of the dactyli of the walking legs. *P. hendersoni* forms a clade together with *P. splendidus* Sankolli (see below), which also inhabits sponges.

***Polyonyx splendidus* Sankolli, 1963** (Fig. 10)

Polyonyx splendidus: Sankolli, 1963b: 79, figs.1a-i; Sankolli, 1966: 311, fig. 9

Material examined: 1♂, Bogmolo Beach, 0 m, low tide, in yellow sponge.

Description: Carapace rounded, nearly as broad as long, longitudinally convex. Dorsal surface with some granulation and plications more accentuated in branchial regions; epibranchial angles faintly produced, regions moderately marked. Front broad, somewhat produced beyond eyes, inclined, nearly straight from above or weakly trilobate. Orbits distinct, outer orbital angles insignificant. Lateral walls complete.

Eyes moderately large, visible from above. First movable segment of antenna subcylindric, short, second twice as long as broad, smooth, third smooth; flagellum 1½ times as long as carapace. Basal segment of antennules without protuberance.

Chelipeds large, robust, different in size, covered with scale-like granules, partly arranged in longitudinal ridges on carpus of larger chela; merus granulated, with some transverse ridges, anterodistal edge produced into a large, rounded lobe, spine tipped in some cases; carpus 1½ to 2 times as long as broad, anterior border produced, with two or three spine-tipped teeth; fingers of manus in both chelipeds meeting in entire length, fingers bent upwards; outer border of larger chela straight or slightly concave; outer border and parts of upper surface of carpus and manus covered with dense, feathered setation.

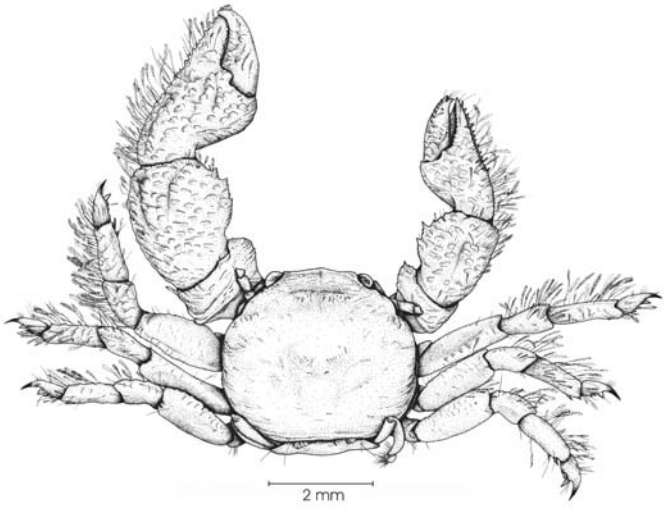

Fig. 10: *Polyonyx splendidus* Sankolli, 1963, male St. George Island, Goa,

Walking legs slender, smooth, with long-feathered setae on carpus, propodus and dactylus; dactylus with three strong, fixed spines.

Habitat: This species has been found by Sankolli (1966) in similar conditions as *P. hendersoni*, and was found by us inside a sponge. Despite intensive efforts to sample this species along the coast in the regions of Anjuna and Bogmolo, we found only one specimen in the duct of a sponge.

Distribution: The species is known only from the original description by Sankolli (1963b) and a later mention by the same author (Sankolli 1966). The former findings are from the coast near Ratnagiri (Maharashtra State), and the present finding extends its distribution southward to Bogmolo Beach, Goa.

Remarks: As mentioned above, *P. hendersoni* and *P. splendidus* seem to form a distinct clade within *Polyonyx*, which probably deserve their own generic status. The present findings of the two species living in sponges confirms our view that the body form and the form of the dactyli of the walking legs constitute adaptations to living in the water ducts of sponges (see discussion in Werding and Hiller 2004). The distribution of the two species seems to be restricted to the Indian subcontinent.

KEY TO THE SPECIES OF THE WESTERN COAST OF THE INDIAN SUBCONTINENT

1 Chelipeds markedly different in size (heterochaely) 2
— Chelipeds (sub) equal (isochaely) 8
2 Front tridentate, lateral margins of carapace with spinules posterior to epibranchial angle 3
— Front rounded, lateral margins of carapace spineless 4
3 Median frontal lobe narrow, chelipeds stout, without acute spines on merus and carpus ..... *Pisidia dehaanii*
— Median frontal lobe broad, chelipeds slender, with acute spines on anterodistal edge of merus and anterior margin of carpus *Pisidia gordoni*
4 Side walls of carapace divided in two parts 5
— Side walls of carapace entire 6
5 Carapace and chelipeds bare of setae..... ..... *Pachycheles natalensis*
— Carapace with dense setation on frontal region, chelipeds densely setose ..... *Pachycheles tomentosus*
6 Carapace subquadrate, broader than long, anterior margin of

carpus of chelipeds entirely convex ..... *Polyonyx loimicola*

— Carapace subquadrate to subovate, as long as broad, carpus of chelipeds denticulated on anterior margin 7

7 Both chelipeds covered with dense, feathered setation, anterior margin of carpus of chelipeds with 2-3 spine-tipped tooth ..... *Polyonyx splendidus*

— Chelipeds at most with short setation, anterior margin of carpus of chelipeds with blunt tooth .. *Polyonyx hendersoni*

8 Carpus of chelipeds with longitudinal crests on upper surface separated by deep grooves 9

— Carpus of chelipeds without longitudinal crests and grooves (but sometimes with granules arranged in longitudinal rows) 10

9 Lateral borders of carapace with a series of sharp spines ... . *Enosteoides ornatus*

— Lateral borders of carapace without spines .... *Ancylocheles gravelei*

10 Surface of carapace and extremities with irregular, rounded granules, front trilobate, carpus of chelipeds with a blunt tooth on antero-proximal edge ..... *Petrolisthes ornatus*

— Surface of carapace and chelipeds smooth to rough or with piliferous striations, front sinuously triangular 11

11 Manus of chelipeds with a longitudinal crest, walking legs with a row of spines on anterior margin of merus .... *Petrolisthes coccineus*

— Manus of chelipeds evenly rounded, walking legs without spines on anterior margin of merus 12

12 Carapace and chelipeds with piliferous striations on upper surface ..... *Petrolisthes boscii*

— Carapace and chelipeds without piliferous striations on upper surface 13

13 Carapace with epibranchial spines ... *Petrolisthes lamarckii*

— Carapace without epibranchial spines 14

14 Chelipeds massive, with three to four shallow tooth on anterior margin of carpus ..... *Petrolisthes rufescens*

— Chelipeds slender, with one proximal tooth on anterior margin of carpus, a second one present on half distance .... *Petrolisthes leptocheles*

DISCUSSION

The porcellanid fauna of the western coast of the Indian subcontinent currently consists of 16 species (Table 1), 10 of which were sampled in the present study. A total of 9 species are endemic to the Indian Ocean, and 2 species, *Polyonyx hendersoni* and *P. splendidus*, seem to be endemic to the eastern Arabian Sea. Of special interest is an assemblage of 4 Indian Ocean endemics present on the coast of Pakistan, *Pachycheles tomentosus*, *Petrolisthes leptocheles*, *Petrolisthes ornatus* and *Petrolisthes rufescens* (the latter two also present on the coast of Kutch), which marks a faunistic break and the

Table 1: Porcellanid species reported from the western coast of the Indian subcontinent in the present study

Species	SAMP	NSAMP	EAS-END	IO-END	IWP
Ancylocheles gravelei (Sankolli 1963)	x			x	
Enosteoides ornatus (Stimpson 1858)	x			x	
Pachycheles natalensis (Krauss, 1843)	x			x	
Petrolisthes boscii (Audouin 1826)	x				x
Petrolisthes coccineus (Richardson *et al*., 1839)	x				x
Petrolisthes lamarckii (Leach 1820)	x			x	x
Pisidia dehaanii (Krauss 1820)	x				
Pisidia gordoni (Johnson 1970)	x				x
Polyonyx hendersoni Southwell, 1909	x		x		
Polyonyx splendidus Sankolli, 1963	x		x		
Pachycheles tomentosus Henderson, 1893		x		x	
Petrolisthes leptocheles (Heller 1861)		x		x	
Petrolisthes ornatus Paul'son 1875		x		x	
Petrolisthes rufescens (Heller 1861)		x		x	
Pisidia delagoae (Barnard 1955)		x		x	
Polyonyx loimicola Sankolli 1965		x			x

EAS: East Arabian Sea, IO: Indian Ocean, IWP: Indo-West Pacific.
END: Endemic species, SAMP: species sampled, NSAMP: not sampled

eastern-most limit of these species. This break could be explained by the water quality of the upper water layer, which is strongly influenced by the monsoon rains on the south coast of Mumbai. Changes in salinity resulting from strong rainfall can particularly affect intertidal species with low tolerance to low salinities.

ACKNOWLEDGEMENTS

We thank Dr. Satish Shetye, Director, NIO, Goa, (CSIR, New Delhi), for his cooperation. This study is a part of the NIO Ballast Water Management Programme of Directorate of General of Shipping, Ministry of Shipping, New Delhi. This is NIO contribution No. 4922.

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