

# New records of *Epixanthus frontalis* and *Heteropanope glabra* (Decapoda: Brachyura: Oziidae, Pilumnidae) for Goa, India, with identification keys of their respective genera

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Two rock crabs, *Epixanthus frontalis* and *Heteropanope glabra*, are reported for the first time from Goa, west coast of India. Detailed scanning electron microscopy (SEM) photographs of the male first gonopods of both these species are provided for the first time. Identification of these species using available published literature is difficult. Hence, identification keys to all the species of the two genera, *Epixanthus* and *Heteropanope*, based on extensive comparisons of their respective congeneric species, are prepared for the first time.

**[Key words:** *Epixanthus frontalis*, *Heteropanope glabra*, male gonopods, identification key]

## Introduction

The bay and estuarine waters of Goa, on the west coast of India, are known to harbor diverse habitats<sup>1,2</sup>. Simultaneously, maritime activities in the region pose a potential threat to the coastal ecosystems and the resident biota, however, making it pertinent to create a baseline data of epibenthic fauna for the region<sup>3</sup>.

Brachyuran crabs belonging to the Families Oziidae and Pilumnidae are morphologically similar with a “xanthoid” carapace (transversely ovate/hexagonal carapace with arched antero-lateral margins, inconspicuous rostrum and deflexed frontal margin), square-cut buccal cavern and transversely folding antennules<sup>4</sup>. The Family Oziidae (stone crabs) contains 7 genera and 33 species<sup>5</sup>. Among the oziids, *Epixanthus* is the third largest genus (represented by 5 species) following *Ozius* (13) and *Eupilumnus* (9)<sup>5</sup>. Pilumnidae is a large family of hairy crabs containing 5 subfamilies, 63 genera, 385 species and 4 sub-species<sup>5</sup>. *Heteropanope* is a small genus represented by 4 species<sup>5</sup>. Crabs of both these families inhabit intertidal regions as well as deeper coastal waters of tropical and sub-tropical seas<sup>6,7</sup>. Present study reports new records of *Epixanthus frontalis* (H. Milne Edwards 1834) and *Heteropanope glabra* Stimpson 1858 from Goa, India. SEM photographs of male first gonopods (G1) are provided for the first time. Further, identification keys to all the extant species of *Epixanthus* and *Heteropanope* are prepared for the first time.

## Materials and Methods

The present sampling site is an estuarine rocky shore at Cancra (15° 27'N, 73° 50'E; Fig. 1) located

on the northern bank of the Zuari Estuary, Goa, central west coast of India. Preliminary observations of the site revealed that crabs lived under moist rocks in well-drained sediment mixed with broken shells. Sampling was carried out on four occasions at mid and low tide levels from July to December 2012. Initially, beach rocks were upturned to locate the crabs. Altogether, 34 oziid and 18 pilumnid crabs were picked and placed in plastic containers. At the laboratory, they were washed under running tap water to remove debris or sediment attached to the body parts. Subsequently, they were photographed with a 7.2 mega pixel digital camera (SONY DSC S750, 3X optical zoom). The specimens preserved in 5% buffered formalin (buffered with hexamethylenetetramine to prevent fragmentation of appendages) were stored in pre-labelled transparent plastic bottles and deposited as reference vouchers at the Marine Biology laboratory, Department of Marine Sciences, Goa

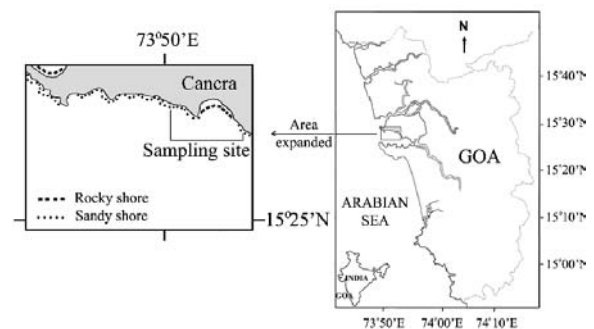


Fig. 1—Map of study area indicating sampling site

University.

*Morphology and morphometric analyses*

Minute morphological details of the crabs were recorded with an Olympus PEN E-PL1

Cheliped dactyl length; FMSH – Frontal median spine height; FW – Frontal width of carapace; IL

Table 1. Morphological parameters and morphometric ratios for *Epixanthus frontalis* (n=34) and *Heteropanope glabra* (n=18)

Sr. No.	Body part	Morpho-logical parameter	<i>E. frontalis</i> (n = 34) $\mu \pm \sigma$ (mm)	<i>H. glabra</i> (n = 18) $\mu \pm \sigma$ (mm)	Morpho-metric ratios	<i>E. frontalis</i> (n = 34) $\mu \pm \sigma$	<i>H. glabra</i> (n = 18) $\mu \pm \sigma$	
1	Carapace	CW	28.39 ± 4.51	8.55 ± 1.17	CW/CL	1.69 ± 0.03	1.50 ± 0.06	
		CL	16.80 ± 2.54	5.71 ± 0.77	ALA/PLA	1.35 ± 0.21	1.50 ± 1.52	
		PWC	9.91 ± 2.09	3.86 ± 0.72	PLA/CW	0.38 ± 0.04	0.37 ± 0.07	
		FW	8.99 ± 1.16	3.15 ± 0.64	FW/CW	0.32 ± 0.02	0.36 ± 0.59	
		ALA	14.21 ± 2.04	3.00 ± 0.54	PWC/CW	0.35 ± 0.04	0.45 ± 0.05	
		PLA	10.78 ± 2.26	3.09 ± 0.69	FMSH/FW	0.04 ± 0.02	-	
		FMSH	0.37 ± 0.12	-	DFMS/FW	0.16 ± 0.03	-	
		DFMS	1.50 ± 0.19	-	AW/ M	0.18 ± 0.02	0.25 ± 0.03	
						CW F	0.27 ± 0.03	0.27 ± 0.03
						SW/CW	0.30 ± 0.02	0.26 ± 0.30
2	Third maxilliped	SW	8.54 ± 1.54	3.12 ± 0.51				
		AW M	7.84 ± 1.99	2.24 ± 0.32				
		F	4.97 ± 1.10	2.24 ± 0.39	ML <sub>3m</sub> /MW	0.84 ± 0.09	0.76 ± 0.05	
		ML <sub>3m</sub>	2.23 ± 0.38	0.71 ± 0.10	IL/IW	1.87 ± 0.11	1.37 ± 0.12	
3	Major cheliped	MW	2.66 ± 0.43	0.94 ± 0.14	IL/ML <sub>3m</sub>	1.91 ± 0.19	1.66 ± 0.09	
		IL	4.22 ± 0.65	1.19 ± 0.18				
		IW	2.26 ± 0.38	0.87 ± 0.12				
		DL <sub>ch</sub>	10.06 ± 1.91	3.34 ± 0.63	ChL/CL	2.80 ± 0.21	2.09 ± 0.20	
		PL <sub>ch</sub>	20.76 ± 4.08	5.11 ± 1.43	DL <sub>ch</sub> /PL <sub>ch</sub>	0.19 ± 0.02	0.68 ± 0.13	
4	Minor cheliped	PD	8.86 ± 1.97	3.46 ± 0.76	PD/PL <sub>ch</sub>	0.43 ± 0.05	0.69 ± 0.12	
		ML <sub>ch</sub>	7.40 ± 1.37	2.67 ± 0.38	ML <sub>ch</sub> /PL <sub>ch</sub>	0.36 ± 0.04	0.55 ± 0.12	
		ChL	47.07 ± 8.51	11.97 ± 2.30				
		DL <sub>ch</sub>	9.98 ± 1.75	2.58 ± 0.49	ChL/CL	2.39 ± 0.20	1.77 ± 0.10	
		PL <sub>ch</sub>	17.78 ± 2.90	3.50 ± 1.21	DL <sub>ch</sub> /PL <sub>ch</sub>	0.56 ± 0.02	0.78 ± 0.17	
5	Pereiopods 2-5	PD	5.29 ± 0.78	2.31 ± 0.41	PD/PL <sub>ch</sub>	0.30 ± 0.02	0.70 ± 0.17	
		ML <sub>ch</sub>	6.94 ± 1.22	2.20 ± 0.32	ML <sub>ch</sub> /PL <sub>ch</sub>	0.39 ± 0.03	0.67 ± 0.16	
		ChL	40.49 ± 6.83	10.19 ± 1.49				
		PrL 2	22.82 ± 3.56	9.74 ± 1.38	PrL/ 2	1.36 ± 0.05	1.71 ± 0.11	
		3	23.11 ± 3.56	10.33 ± 1.38	CL 3	1.36 ± 0.06	1.81 ± 0.09	
	4	24.56 ± 3.70	10.05 ± 1.34	4	1.45 ± 0.08	1.18 ± 0.03		
	5	20.45 ± 3.17	8.44 ± 1.15	5	1.21 ± 0.08	1.48 ± 0.08		

M – male

F – female

$\mu$  – mean

$\sigma$  – standard deviation

attached to Olympus SZX16 high class stereomicroscope. Morphometric parameters were measured using digital calipers (Absolute Digimatic Digital Caliper, 150 mm) with an accuracy of 0.01 mm. Subsequently, scanning electron microscope (SEM) photography of G1 was carried out to ascertain the identity and distinctiveness of the species. Altogether 20 morphometric parameters were measured and 17 ratios were derived from these parameters (Table 1). In addition, diagrams of the diagnostic features of the crabs were drawn using Adobe Photoshop CS5.

Terminology used in the taxonomic description of the specimens followed Padate *et al.*<sup>1</sup>.

#### Abbreviations

The following abbreviations are used: ALA – Antero-lateral arc length; AW – Abdominal width; CL – Carapace length; ChL – Total cheliped length; CW – Carapace width; DFMS – Distance between frontal median spines; DL<sub>ch</sub> –

– Third maxilliped ischium length; IW – Third maxilliped ischium width; ML<sub>3m</sub> – Third maxilliped merus length; ML<sub>ch</sub> – Cheliped meral length; MW – Third maxilliped merus width; PD – Cheliped propodal depth; PL<sub>ch</sub> – Cheliped propodal length; PLA – Postero-lateral arc length; PrL – Total pereiopodal length; PWC – Posterior width of carapace; SW – Sternal width.

#### Results

##### Family Oziidae Dana, 1851

Genus *Epixanthus* Heller, 1861

*Epixanthus* Heller, 1861: 321<sup>8</sup>. Type species *Epixanthus kotschii* Heller, 1861.

##### Diagnosis

Carapace very broad, transversely oval. Dorsal surface with regions obscurely marked. Antero-lateral margins long, strongly arched, sharp and crested, usually regularly fissured or dentate. Front broad, slightly deflexed, cut into four teeth or lobes. Antennules fold transversely. Antennae with broad and short basal article, in contact with

front; flagellum in the orbital hiatus. Chelipeds unequal in both sexes, massive; fingers long, pointed; fingers of the smaller cheliped remarkably long and slender, as long as the palm<sup>9</sup>.

#### Distribution

Indo-West Pacific<sup>10,11</sup> and Atlantic<sup>12</sup> regions.

#### Remarks

The genus *Epixanthus* represents five valid species namely *Epixanthus corrosus* A Milne Edwards 1873, *Epixanthus dentatus* (White 1848), *Epixanthus frontalis* (H. Milne Edwards 1834), *Epixanthus hellerii* A Milne Edwards 1867 and *Epixanthus subcorrosus* De Man 1891<sup>5</sup>. These species were differentiated on the basis of morphological characters (profile of dorsal carapace, armature of the antero-lateral margins of carapace, and surface texture of carapace regions and chelipeds) obtained from published morphological descriptions<sup>12,13,14,15,16</sup>.

#### Key to the species of the genus *Epixanthus* Heller, 1861

- 1 Antero-lateral margins of carapace divided into five lobes.....2.
  - Antero-lateral margins of carapace divided into four lobes.....3.
- 2 Antero-lateral margins of carapace deeply divided into five sharp teeth.....*E. dentatus*.
  - Antero-lateral margins of carapace indistinctly divided into five lobes.....*E. corrosus*.
- 3 Dorsal surface of carapace strongly convex.....*E. hellerii*.
  - Dorsal surface of carapace transversely flattened, slightly curved longitudinally.....4
- 4 Antero-lateral margins and sub-hepatic regions of carapace slightly rugose and uneven; upper surface of carpus and upper margin of propodus distinctly rugose and uneven.....*E. subcorrosus*.
  - Antero-lateral margins and sub-hepatic regions of carapace minutely granular; upper surface of carpus and upper margin of propodus smooth.....*E. frontalis*.

*Epixanthus frontalis* (H. Milne Edwards, 1834)  
(Table 1, Figs 2–4)

*Ozius frontalis* H. Milne Edwards, 1834: 406–407<sup>15</sup> (type locality: Tranquebar, India)

*Epixanthus kotschii* Heller, 1861: 325<sup>8</sup>.

*Epixanthus frontalis* (H. Milne Edwards, 1834) Heller, 1861: Alcock, 1898: 185<sup>10</sup>.

*Epixanthus frontalis* (H. Milne Edwards, 1834): Chhapgar, 1957: 35, pl. 10, figs g–i<sup>6</sup>.

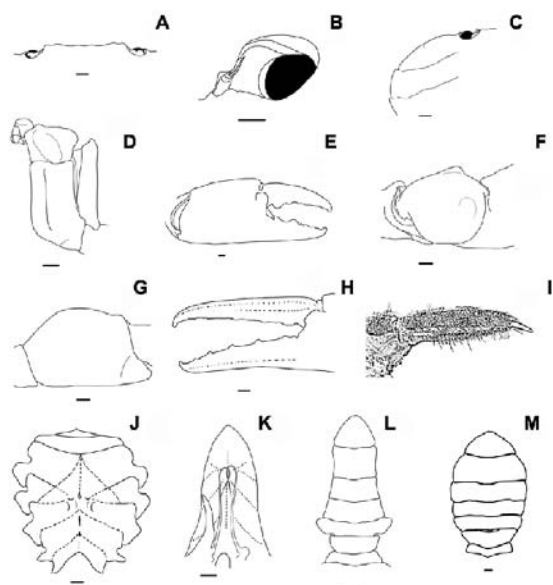
Material examined: Cancra, Goa (N = 34). 19.44–37.72 mm CW

#### Diagnosis

Dorsal surface of carapace transversely flattened, slightly curved longitudinally. Antero-lateral margins divided into four lobes. Antero-lateral margins and sub-hepatic regions minutely granular; upper surface of carpus and upper margin of propodus smooth. G1 slightly curved, broad at base, tapers towards distal tip. Patch of squamiform spines almost encircling G1, except on its inner border; two subdistal rows of spines along prominent ridges on outer border, progressively increase in size posteriorly. Short row of setae located between these. Inner border with two parallel rows of 3–5 large spines, which progressively increase in size toward posterior end.



Fig. 2—*Epixanthus frontalis* (Photographs):  
(A) Dorsal view; (B) Ventral view.



Scale bar: 1 mm

Fig. 3—*Epixanthus frontalis* (Line diagrams):

- (A) Fronto-orbital margin of carapace; (B) Orbit; (C) Antero-lateral margin of carapace; (D) Third maxilliped (left); (E) Major cheliped – dactylus and propodus; (F) Major cheliped – carpus; (G) Major cheliped – merus; (H) Minor cheliped – dactylus; (I) Pereiopod – dactylus; (J) Female sternum indicating position of gonopores; (K) Male sternum indicating positions of G1 and G2; (L) Male abdomen; (M) Female abdomen.

### Description

Carapace transversely oval, broader than long; dorsal surface pitted, transversely flattened and longitudinally slightly convex; regions ill-defined. Slight median depression on anterior branchial region; gastro-cardiac grooves weakly defined. Low, fine sinuous ridges originating from last two antero-lateral teeth extend across branchial region of that side. Posterior margin narrow. Dorsal surface brown with a violet tint, more pronounced towards anterior section (Fig. 2A); ventral surface of sternum and abdomen light brown (Fig. 2B).

Frontal margin of carapace corrugated, faintly rugulose, deflexed ventrally (Fig. 3A). Antennules long, cylindrical, fold transversely. Front narrow, distinctly divided into four small, flattened teeth including two closely placed median teeth and two lateral teeth. Frontal margin separated from lightly granulated supra-orbital margin by an obtuse angled shoulder. Orbits open at intero-ventral angles. Eyes globular (Fig. 3B). Basal antennal segment sub-rectangular, located inside orbital hiatus. Antennal flagellum relatively short, segmented (Fig. 3B). Outer orbital angle slightly bent, confluent with first antero-lateral tooth. Faint sutures at outer and ventral orbital margins. Sub-hepatic and pterygostomial regions of carapace pitted.

Antero-lateral margins rounded, cut into four flattened finely granular lobes including external orbital angle, separated by inconspicuous grooves (Fig. 3C). First antero-lateral tooth broad, flattened, confluent with outer orbital angle; second tooth a broader lobe; third tooth slightly smaller than second, blunt tipped, directed anteriorly; fourth tooth smallest, with prominent blunt tip, directed anteriorly at a narrower angle than preceding teeth (Fig. 3C). Carapace widest between the fourth pair of antero-lateral teeth. Postero-lateral margins converging, straight, narrow, shorter than antero-lateral margins.

Buccal cavity quadrangular. Endostomial ridges very prominent, extend to anterior boundary of buccal cavity. Third maxillipeds cover entire buccal cavern. Basis of third maxilliped roughly quadrilateral, its anterior indentation accommodates exopod. Exopod long, cylindrical, flagellate, does not reach anterior margin of merus. Lateral margins of exopod slightly rough. Ischium longer than broad, with oblique median longitudinal groove, its inner margin slightly serrated, covered by dense short pubescence. Merus roughly quadrilateral, shorter than ischium, broader than long, with rough margins. Two oblique shallow ridges traverse merus. Palp (dactylus, propodus and carpus) subequal to ischio-merus, inserted antero-internally on merus. Surfaces of all segments pitted. Long bristles also present on the palp (Fig. 3D).

Chelipeds (first pair of pereopods) massive, unequal. Right cheliped (major) larger, more robust, longer than carapace. Fingers pointed, dactylus slightly curved, leaves a wide gaping between fingers (Fig. 3E). Dactyl length greater than two-thirds propodal length; occlusal surface with one large molariform basal tooth followed by 4 smaller teeth; distal half lacks teeth. Pollex (fixed finger) straight with slightly deflexed blunt tip; occlusal surface with one rounded basal tooth comparatively smaller than its dactylus counterpart, followed by rounded tooth separated from it by a notch; 3–4 smaller teeth distally. Propodus swollen, slightly rugose, dorsal margin slightly rounded. Propodal depth lesser than its length (Fig. 3E). Carpus rounded, rough, with strong blunt tooth on inner margin (Fig. 3F). Merus short, rough, almost three-fifths of propodus, trihedral in shape, with blunt subdistal lobe (Fig. 3G). Smaller cheliped similar to larger one, but less massive. Both fingers long, slender, straight with slightly curved tips crossing each other (Fig. 3H); no gaping between fingers. Occlusal surface of dactylus sharp, with 3–4 flattened teeth, that of pollex with 4–5 triangular,

distinct and sharply edged teeth which decrease in size distally; proximal tooth slightly flattened. Dactyl outer (dorsal) surface with two longitudinal grooves interrupted at regular intervals; upper groove commences behind dactylus tip, extends to the dorsal surface of dactyl base; second groove ends slightly below the first groove. Longitudinal groove on pollex extends from tip to base, interrupted at regular intervals (Fig. 3H). Cheliped fingers blackish brown coloured. Dorsal and outer surfaces of other segments brown with violet tint (Fig. 2A); ventral surface light brown (Fig. 2B).

Pereiopods 2–5 slender, unarmed, shorter than major cheliped, covered with relatively long scattered setae, denser on propodi and dactyli. Pereiopods 2, 3 subequal in length, pereopod 4 marginally longer, pereopod 5 shortest. Pereiopods 2–5 dactyli almost equal in length to lower margin of the corresponding propodi, terminate in acute chitinous tips (Fig. 3I). Dorsal colouration brown, ventral light brown (Fig. 2A, B).

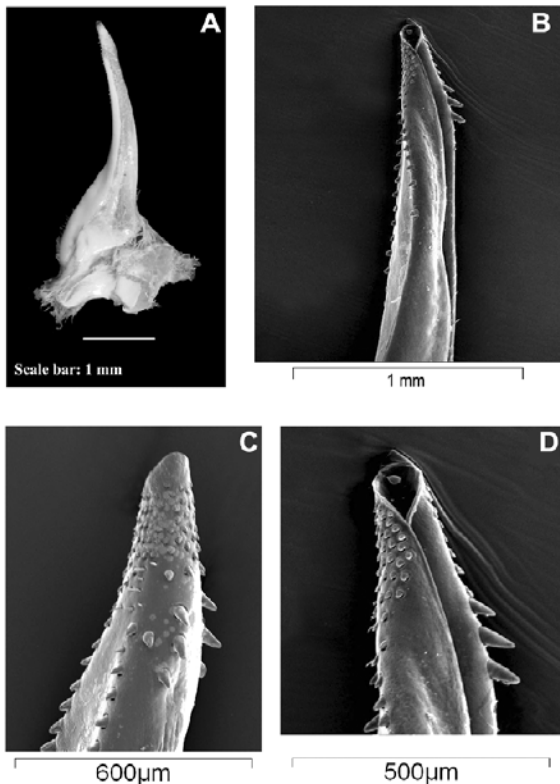


Fig. 4—*Epixanthus frontalis*: (A) Photograph of entire G1; SEM photographs of G1: (B) Distal half; (C) Outer border of distal tip; (D) Inner border of distal tip.

Thoracic sternum pitted, narrow, 8 segmented (Fig. 3J, K). Sternal sutures continuous through

sterno-abdominal cavity (Fig. 3J, K). Female gonopores on sternal segment 6. Male abdomen relatively narrow, comprises 7 distinctly separate segments (Fig. 3L). Abdominal segments 1–2 of similar width; segment 3 widest, 4–5 of similar length, tapering, segment 6 longest. Telson (segment 7) about as wide as long at base, tip bluntly pointed (Fig. 3L). Female abdomen narrow, with 7 separate segments (Figs 2B, 3M). Abdominal margins densely pubescent with few scattered setae along sutures. Colouration light brown (Fig. 2B).

G1 slightly curved, broad at base, tapers towards distal tip (Fig. 4A), coxal in position. Two subdistal ridges extend posteriorly approximately half the distance towards G1 base (Fig. 4B, C). Patch of squamiform spines almost encircle G1, except on inner border (Fig. 4 B, C, D) followed by two rows of spines, each occupying subdistal row on outer border (Fig. 4 B, C). These spines progressively increase in size posteriorly and extend approximately one-thirds distance away from G1 tip. In addition, a short row of setae is located between the spiny ridges on outer border (Fig. 4C). Inner border with two parallel rows of 3–5 large spines, that progressively increase in size towards the posterior (Fig. 4B, C, D). G2 longer than G1 (Fig. 3K).

#### *Habitat and Habit*

On moist sandy substratum mixed with broken discoloured shells, under loose stones and cobbles at high and mid tide levels. Defensive mechanism includes scampering for protection or stay still on being exposed.

*Family Pilumnidae* Samouelle, 1819

Genus *Heteropanope* Stimpson, 1858

*Heteropanope* Stimpson, 1858: 33<sup>16</sup>. Type species *Heteropanope glabra* Stimpson, 1858.

#### *Diagnosis*

Front broadly bilobed, each lobe being convex; no lateral lobule distinct from supraorbital angle. Antero-lateral margin cut into four teeth or lobes, which may be pointed but not spinous, first tooth a broad lobe confluent with the outer orbital angle. Sternite 8 not visible laterally beside male abdomen. Male abdomen with 7

segments; G1 slender, sinuous, with recurved tip<sup>18</sup>.

#### Distribution

Indo-West Pacific<sup>6,10,18</sup> and eastern Atlantic<sup>7</sup> regions.

#### Remarks

The genus *Heteropanope* represents four valid species namely *Heteropanope acanthocarpus* Crosnier 1967, *Heteropanope tuberculidens* Monod 1956, *Heteropanope longipedes* Davie 1989 and *Heteropanope glabra* Stimpson 1858<sup>5</sup>. These species were differentiated on the basis of morphological characters (armatures of the antero-lateral margins of carapace and pereopods, and relative length of pereopods) obtained from published morphological descriptions<sup>7,18</sup>.

#### Key to the species of the genus *Heteropanope* Stimpson, 1858

1. Dorsal surface of propodus and merus of pereopods 2–5 armed with denticles, carpus armed with large teeth; fourth antero-lateral tooth truncated.....*H. acanthocarpus*.
- Dorsal surface of propodus and merus of pereopods 2–5 smooth, carpus armed with a subdistal denticle; fourth antero-lateral tooth acute, well developed.....*H. tuberculidens*.
- Dorsal surface of propodus, carpus and merus of pereopods 2–5 smooth.....2.
2. Third antero-lateral tooth flat, wide, as large as the second tooth and separated from it by a narrow notch; pereopods relatively longer, merus length by width ratio is 3.8–3.9.....*H. longipedes*.
- Third antero-lateral tooth rounded, distinctly smaller than the second and separated from it by a wide notch; pereopods relatively shorter, merus length by width is 2.7–3.1.....*H. glabra*.

*Heteropanope glabra* Stimpson, 1858  
(Table 1, Figs 5–7)

*Heteropanope glabra* Stimpson, 1858, 35<sup>17</sup> (type locality: Hong Kong)

*Pilumnopus maculatus* A. Milne Edwards, 1867, p. 277<sup>12</sup>

*Eurycarcinus maculatus* De Man, 1887, p. 44, pl. 2, figs 2, 3<sup>19</sup>

*Eurycarcinus maculatus* (A. Milne Edwards, 1867) De Man, 1887: Alcock, 1898: 212<sup>10</sup>.

Material examined: Cancra, Goa (N = 18). 6.68–10.94 mm CW

#### Diagnosis

Dorsal surface of propodus, carpus and merus of pereopods 2–5 smooth. Third antero-lateral tooth rounded, distinctly smaller than second, separated from it by a wide notch; pereopods relatively shorter, merus 2.7–3.1 times longer than wide. G1 sinuous, with distinct downward subdistal curve, tapers towards tip; distally, a fine row of short fringing setae on the inside curve and along the outer suture line, extends posteriorly up to one-thirds distance from distal tip. 3–4 longer, stouter setae on subdistal curve.

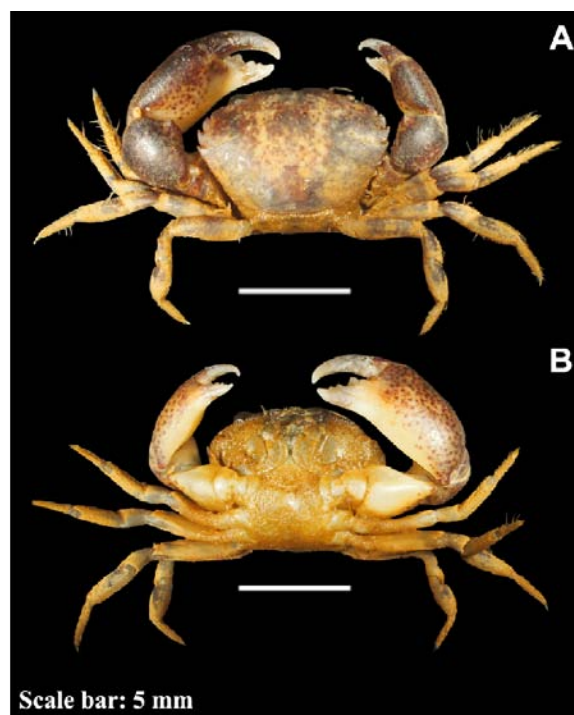


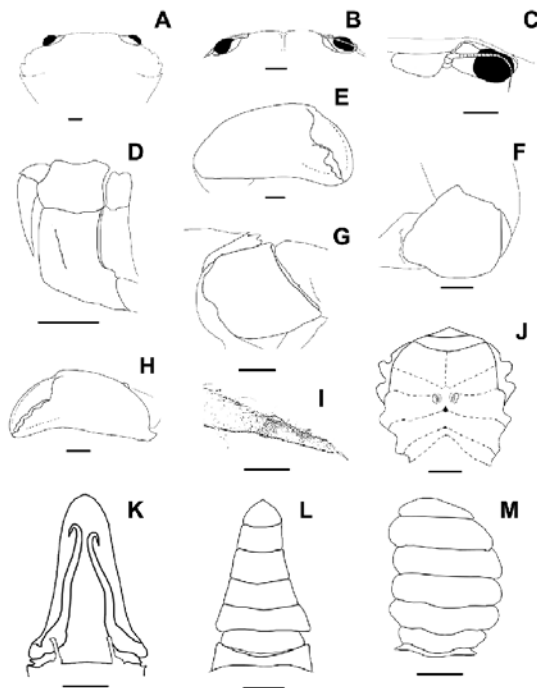
Fig. 5—*Heteropanope glabra* (Photographs):  
(A) Dorsal view; (B) Ventral view.

#### Description

Carapace subhexagonal, broader than long; dorsal surface smooth, occasionally slightly granular towards margins (Figs 5A, 6A), longitudinally convex and transversely moderately convex; regions ill-defined. Slight depression on anterior branchial region; gastro-cardiac grooves weakly defined. Posterior margin narrow. Dorsal surface light brown, interspersed with dark brownish red blotches that are mostly concentrated on frontal, gastric, hepatic and branchial regions (Fig. 5A).

Frontal margin bilobed, granulated, deflexed ventrally (Fig. 6B, C). Antennules long, cylindrical and fold transversely. Front narrow, row of setae behind it absent. Frontal margin separated from supra-orbital margin by obtuse





Scale bar: 1mm

Fig. 6—*Heteropanope glabra* (Line diagrams):

(A) Fronto-orbital and antero-lateral margins of carapace; (B) Fronto-orbital margin of carapace; (C) Orbit and antenna; (D) Third maxilliped (left); (E) Major cheliped – dactylus and propodus; (F) Major cheliped – carpus; (G) Major cheliped – merus; (H) Minor cheliped – dactylus and propodus; (I) Pereiopod – dactylus; (J) Female sternum indicating position of gonopores; (K) Male sternum indicating positions of G1 and G2; (L) Male abdomen; (M) Female abdomen.

angled shoulder. Orbits open at intero-ventral angles (Fig. 6C). Eyes globular. Basal antennal segment sub-rectangular, located inside orbital hiatus. Antennal flagellum relatively long, segmented (Fig. 6C). Supra-orbital margin lightly granulated, generally lacks indication of median or lateral fissures. Outer orbital angle slightly bent, confluent with first antero-lateral tooth. Sub-orbital margin with more prominent tubercles than supra-orbital margin; they decrease progressively in size from outer orbital angle to basal antennal segment. Well-defined lateral fissure present below outer orbital angle. Sub-hepatic and pterygostomial regionse granular, covered by short setae adjacent to maxillipeds and orbits. Setae increase in size posteriorly, attain feathery form adjacent to cheliped merus.

Antero-lateral margins finely granulated, cut into four teeth, including external orbital angle (Fig. 6A). First antero-lateral tooth is confluent with outer orbital angle, broad, depressed; second

tooth a similarly broad lobe directed anteriorly; third tooth slightly smaller than second, directed anteriorly, separated from it by wide indentation; fourth tooth smallest, directed anteriorly at narrower angle than preceding teeth. Carapace widest between the fourth antero-lateral teeth (Fig. 6A). Postero-lateral margins of carapace are converging, straight, narrow, as long as antero-lateral margins.

Buccal cavity quadrangular. Endostomial ridges faintly defined, extend to anterior boundary of buccal cavity. Third maxillipeds (Fig. 6D) cover entire buccal cavern. Basis of third maxilliped roughly quadrilateral, its downward projection at postero-lateral angles accommodates exopod. Exopod long, cylindrical, flagellate, does not reach anterior margin of merus, with large subdistal tooth on inner margin; lateral margins highly serrated. Ischium longer than broad, with oblique median longitudinal depression, its inner margin crenulated. Merus roughly quadrilateral, shorter than merus, broader than long, with serrated inner and outer margins. Palp subequal to ischio-merus, inserted antero-internally on merus. Finger-shaped dactylus longer than propodus, shorter than ischium, as long as merus. Surfaces of all segments finely granular, covered with short, stout setae. Long bristles also present on inner margins of merus, ischium and palp (Fig. 6D).

Chelipeds massive, unequal. Major cheliped longer than carapace. Fingers pointed, dactylus strongly arched, leaves a wide gaping between fingers (Fig. 6E). Dactylus length greater than two-thirds propodal length; occlusal surface with 2–3 small, low blunt teeth in proximal half, distal half merely sinuous, lacks prominent teeth. Pollex markedly deflexed interiorly, occlusal surface with large proximal molar tooth followed by 2–3 smaller teeth significantly reduced in size distally. Outer (dorsal) surface of dactylus with two longitudinal grooves, interrupted at regular intervals; upper groove commences behind dactyl tip and extends to dorsal surface of dactyl base; second groove ends slightly below first groove. Longitudinal groove on pollex extends from subdistal tooth on occlusal surface to base, interrupted at regular intervals. Propodus swollen, smooth and glabrous, its dorsal margin rounded. Propodal depth lesser than its length (Fig. 6E). Carpus rounded, granulated, with glabrous, strong blunt tooth on inner margin (Fig. 6F). Merus

short, trihedral shaped, approximately two-thirds of propodus (Fig. 6G), its anterior margin distinctly granular proximally, becoming finer distally; its upper posterior margin carinate with a blunt subdistal lobe; lower margin smooth, rounded; its posterior margin proximally covered with narrow fringe of long feathered setae, distally covered with very short scattered setae. Smaller cheliped similar to larger cheliped, but less massive. Both fingers curved, with conspicuous gaping between them (Fig. 6H). Occlusal surface of dactylus sharp, with 3–4 flattened teeth, that of pollex with 4–5 triangular, prominent, sharply edged teeth which decrease in size distally, except for the slightly flattened proximal tooth (Fig. 6H). Cheliped fingers dark brown, may be covered with greyish extraneous material (Fig. 5A, B). Dorsal surface of other segments blackish brown with red spots (Fig. 5A), outer and inner surfaces light brown with red spots (Fig. 5A, B), ventral surface light brown (Fig. 5B).

Pereiopods 2–5 slender, unarmed, shorter than major cheliped. Pereiopods 2, 3 subequal in length, pereopod 3 marginally longer than pereopod 4. Pereiopods 2–5 dactyli almost equal in length to lower margin of the corresponding propodi, and terminate in acute chitinous tips. Pereiopods covered with relatively long scattered setae, denser on propodi and dactyli (Fig. 6I). Dorsal colouration brown, ventral light brown, covered with yellowish brown tomentum (Fig. 5A, B).

Thoracic sternum pitted, narrow, 8 segmented (Fig. 6J). Sternal sutures continuous through sterno-abdominal cavity (Fig. 6J, K). Female gonopores on sternal segment 5 (Fig. 6J). Male abdomen relatively narrow, comprises 7 distinctly separate segments (Fig. 6L). Abdominal segments 1–3 of similar width, segments 4–7 of similar length, tapering. Telson about as wide as long at base, tip bluntly pointed. Sternite 8 concealed laterally beneath second abdominal segment. Female abdomen narrow, with 7 separate segments (Fig. 6M). Abdominal margins densely pubescent with few scattered setae along sutures. Abdomen of both sexes covered with yellowish brown tomentum (Fig. 5B).

G1 sinuous, with distinct downward subdistal curve, tapers towards the tip (Fig. 7A), coxal in position. Distally, a fine row of short fringing setae on the inside curve and along the outer suture line, extends posteriorly up to one-thirds distance from distal tip (Fig. 7B). 3–4 longer, stouter setae on subdistal curve (Fig. 7C). G2 shorter than G1 (Fig. 6K).

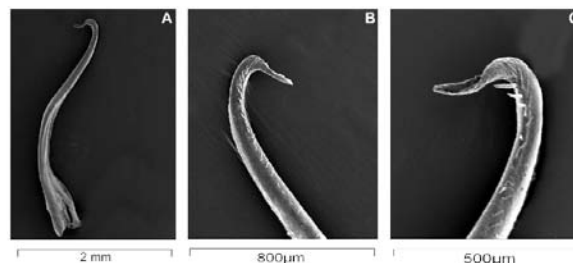


Fig. 7—*Heteropanope glabra* (SEM Photographs): (A) Entire G1; (B) Distal half of G1; (C) Enlarged view of distal half.

#### Habitat and Habit

On moist fine silty substratum, free of broken shells, under loose stones and cobbles at high and mid tide levels. On being exposed, exhibits lack of motion, which serves as camouflage against predators.

#### Discussion

The present study attempts to provide a comprehensive description of two rock crabs namely *E. frontalis* (Family Oziidae) and *H. glabra* (Family Pilumnidae) aided by 20 morphometric parameters 17 ratios and SEM photographs of G1. Original taxonomic descriptions of these two species were concise and lacked illustrations<sup>15,17</sup>. Alcock<sup>10</sup> provided short descriptions of both these species, both lacking illustrations. Chhapgar<sup>6</sup> provided a short description of *E. frontalis* illustrated with line diagrams of a female and G1. Sankarankutty<sup>20</sup> provided only line diagrams of G1 of both the species. It may be noted that Alcock<sup>10</sup> and subsequent carcinologists used the name *Eurycarcinus maculatus* (A. Milne Edwards 1867), a junior synonym of *H. glabra*. Sakai<sup>9</sup> provided a short illustrated description of both these species. The first comprehensive description of *H. glabra* was provided by Davie<sup>18</sup>. Present description of *H. glabra* conforms to that of Davie's, with the exception of lack of setae behind the frontal margin of the carapace.

Published literature on the taxonomy of "xanthoid" crabs belonging to the genera *Epixanthus* and *Heteropanope* is immense and scattered in libraries across the world. Systematic inventorying of valid species described during different eras and from various geographical regions was recently carried out by Ng *et al.*<sup>5</sup>. However, no attempts were made to morphologically compare various congeneric species in these genera. In view of this, identification keys to all the extant species of *Epixanthus* and *Heteropanope* would facilitate field identification of some of these crabs.

The observations made in the present study make it apparent that more detailed investigations



with adequately large data sets would definitely enable to enlighten on their population structure in the region and phylogenetic relations with similar populations distributed across the known geographical range of these species.

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