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A new species of *Ilyoplax* (Decapoda, Brachyura, Dotillidae) from Gujarat, India



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Introduction

Brachyuran crabs belonging to the genus Ilyoplax (Stimpson 1858) are commonly found on the intertidal mudflats distributed from the temperate to tropical Indo-Western Pacific region. Although, currently the genus consists of 27 well established species (Davie and Naruse 2010; Fatemi et al 2011; Kitaura and Wada 2006; Ng et al 2008), the genus has not been studied in detail for its taxonomy. Earlier, Serène and Lundoer (1974) studied the taxonomy of the genus based on the male gonopod structure and distributed all the identified species into three different groups. Recently, Kitaura et al (1998) and Kitaura and Wada (2006) studied the taxonomy of the genus using molecular tools and identified three distinct lineages in the genus. The taxonomy and diversity of brachyuran crabs belonging to family Dotillidae Stimpson, 1858 found in coastal areas of India have been studied in detail by few workers (Alcock 1900; Kemp 1919). So far, a total of 11 species and four genera belonging to the family Dotillidae have been reported from India (Alcock 1900; Kemp 1919). Out of these 11 species, only two species belonging to genus Ilyoplax i.e. Ilyoplax gangetica (Kemp 1919) and Ilyoplax stapletoni (de Man 1908) are reported

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ABSTRACT

A new species, *Ilyoplax sayajiraoi*, belonging to the family Dotillidae is described from Gujarat state, India. It differs from its closely related species, *Ilyoplax stevensi* and *Ilyoplax frater* by differences in shape and proportions of the carapace, shape, and setae arrangement pattern on chela and morphologies of male and female abdomen. The details on the morphological differences are presented in this study. Copyright © 2015, National Science Museum of Korea (NSMK) and Korea National Arboretum (KNA).

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from India (Alcock 1900; Kemp 1919). Species belonging to genus *llyoplax* are smaller in size but occur in large numbers on the sandy and muddy shores and they play a significant role in the ecology of the habitat (Nishihira 1984; Snowden et al 1991). The species belonging to a particular genus also exhibit typical behavior patterns including a chela waving display which provided the basis for many behavioral experiments related to the reproductive and courtship aspect of the species, as well being one of the important characters for species identification (Kitaura and Wada 2006; Kosuge et al 1994; Wada and Wang 1998).

The new species reported here was collected as a part of the research project "Documentation of crustacean biodiversity of Gujarat" (Sponsored by Gujarat State Biodiversity Board, Government of Gujarat, India) of 2014–2015 undertaken by us at Marine Biodiversity and Ecology Laboratory, Department of Zoology, Faculty of Science, The M. S. University of Baroda, Vadodara, Gujarat, India. The details of morphological characters of the new species are given in the paper.

Materials and methods

The specimens of the species were collected from the coastal areas of Kamboi (22° 12' 59" N; 72° 36' 59" E) located on the extreme interior of Gulf of Khambhat closer to the lower estuarine region of the Mahi Sagar River on the western side of Bharuch District of Gujarat state, India. The coastal areas of the sampling site support a mudflat habitat. The type of material used for the present

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study is deposited in the Zoology Museum, Department of Zoology, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, India. The general terminologies follow Davie and Naruse 2010. The measurements are provided for the carapace width (CW) and carapace length (CL). Male G1 refers the male first gonopod. All of the measurements were taken using digital Vernier calipers (0.01 mm accuracy).

Systematic accounts

Family Dotillidae Stimpson, 1858 Subfamily Dotillinae Stimpson, 1858

Genus Ilyoplax Stimpson, 1858

Ilyoplax sayajiraoi sp. nov.

(Figures 1–3)

Type. Holotype: J, ZL-AR-CR-76 (CW 9.4 mm, CL 6.3 mm), Kamboi (22⁰ 12' 59" N; 72⁰ 36' 59" E), Gujarat, India, mudflat habitat, 11th April, 2014 (Jignesh Trivedi and Gunjan Soni). Paratype: 53, (ZL-AR-CR-76 [1-5]) (CW 8.7 mm, CL 5.9 mm; CW 9.1 mm, CL 6.1 mm; CW 6.5 mm, CL 4.7 mm; CW 6.7 mm, CL 4.9 mm; CW 8.2 mm, CL 5.2 mm) and two 9 (ZL-AR-CR-76 [6-7]) (CW 12.3 mm, CL 9.0 mm; CW 12.1 mm, CL 8.8 mm), Kamboi, 14th May, 2014 (leg. Gunjan Soni and Dhruva Trivedi); 23, (ZL-AR-CR-76 [8-9]) (CW 6.4 mm, CL 4.2 mm; CW 5.7 mm, CL 3.6 mm), 39, (ZL-AR-CR-76 [10–12]) (CW 12.1 mm, CL 8.7 mm; CW 12.2 mm, CL 8.9 mm; CW 12.5 mm, CL 8.5 mm), Kamboi, 15th August, 2014 (leg. Kauresh Vachhrajani, Jignesh Trivedi, and Gunjan Soni); 33, (ZL-AR-CR-76 [13-15]) (CW 8.4 mm, CL 5.9 mm; CW 7.7 mm, CL 3.6 mm; CW 7.3 mm, CL 5.7 mm) and 3º, (ZL-AR-CR-76 [16-18]) (CW 11.0 mm, CL 8.2 mm; CW 12.3 mm, CL 8.6 mm; CW 10.7 mm, CL 8.0 mm), Kamboi, 21st December, 2014 (leg. Kauresh Vachhrajani, Jignesh Trivedi, Dhruva Trivedi, and Gunjan Soni).

Comparative material. Ilyoplax frater (Kemp 1919). 1*d*, ZL-AR-CR-79, (CW 7.4 mm, CL 5.2 mm), Beyt Dwarka (22° 46′ 72″ N; 69° 11′ 54″ E), Gujarat, India, mudflat habitat, 13th November, 2014 (Jignesh Trivedi and Gunjan Soni); 1*d*, (ZL-AR-CR-79 [1]), (CW 6.3 mm, CL 4.1 mm), Beyt Dwarka (22° 46′ 72″ N; 69° 11′ 54″ E), Gujarat, India, mudflat habitat, 17th November, 2014 (leg. Jignesh Trivedi, Gunjan Soni, and Richa Pareek).



Figure 1. *Ilyoplax sayajiraoi* sp. nov. Holotype ZL-AR-CR-76, male [carapace width (CW) 9.4 mm, carapace length (CL) 6.3 mm]. (Line bar indicates 1 cm).



Figure 2. Ilyoplax sayajiraoi sp. nov.: A, in life and B, mudflat habitat of Kamboi.

Description. The carapace is transversely oblong, with the anterior breadth one and a half times the length; the upper surface of the carapace is slightly convex on both sides and moderately sculptured (Figure 3A). The anterolateral border is slightly and evenly convex, the breadth in the middle decidedly larger than the breadth between orbital angles. An inconspicuous median furrow starts from the frontal region and ends in the middle of the gastric region, one large grove about one third of the breadth of the carapace defines the posterior limit of the gastric region. A shallow depression is present parallel to the orbital region on both sides; the depression excavates near the median furrow. On the branchial regions, small tubercles bearing setae are arranged in four rows. The anterior row is small and indistinct and made up of one or two tubercles, the second row is distinct with two to four tubercles, the third row is made up of six to eight tubercles, the most posterior row is longest, bearing 6-10 tubercles, and the last row is much more transverse than longitudinal and if the row continued forward, the line so formed would pass through the proximal part of the orbits. A sharp, perfectly transverse and straight ridge is present above the posterior carapace margin. The front is obliquely deflexed and the apex broadly rounded. The lateral border is slightly constricted near the base, and the front breadth is one sixth or one seventh of the anterior breadth of the carapace.

Orbits are slightly oblique, not transverse. The upper orbital border is beaded, with the distal portion beaded with large tubercles; it excavates near the base of the front and is distinctly concave in the outer half. The lower orbital border is finely crenulated. On the floor of the orbits, a ridge runs parallel to the lower border of the orbits throughout the length. The outer orbital angle consists of an acute tooth directed outwards; a tuft of setae is



Figure 3. Ilyoplax sayajiraoi sp. nov.: A, carapace dorsal view, B, male chela outer view, C, male chela inner view, D, third maxillipeds, E, second walking leg outer view, F, cheliped carpus inner view, G, male abdomen, H, female abdomen, I, male G1, and J, male G1 apical lobe.

present near the base of the tooth. A small notch is present behind the outer orbital angle, which runs down with a series of minute tubercles. The lateral margins are defined by a sharp crest bearing long setae. The epistome is short with a narrow triangular median tooth.

The buccal cavity is completely closed by third maxillipeds; the ischium of third maxillipeds is sub quadrate in shape with an anterior border lined by setae (Figure 3D). The merus is shorter than the ischium and broader than the long, -shaped furrow present interiorly; the outer grove of the ^ shape turns upwards and forms a median furrow which runs towards the apical portion of the ^ shape. The surface of the merus is smooth. The exopod is concealed under the maxillipeds and furnished with a long slender flagellum.

The chelipeds of the male are strong, slender, well developed and longer than the female chelipeds; the length of the chelipeds is less than twice the length of the carapace. The merus is trigonal with microscopically beaded edges. The merus bears tympanum on the outer side and other large tympanum on the inner side; the outer side tympanum is not always present. The carpus is short, smooth, and without a tooth on the inner aspect; the inner margin of the upper surface is crested and beneath it, a tuft of short setae is present (Figure 3F). Fingers are similar in length with the upper border of palm (Figure 3B); in the inner phase of the palm, a longitudinal row of setae is present beneath the upper border. Four finely beaded carinae run backward from the tip of the fixed fingers on to the palm. The median two carinae run parallel and disappear before reaching the middle of the lower surface of the palm, the inner most carinae curve upwards across the inner surface; the outer most run along the lower part of the outer border until the proximal end of the palm (Figure 3C). The gap between the carinae is without any tubercles; the rest of the surface, including most of the outer part of the palm, is smooth. The dactylus is slightly longer than the fixed finger; the distal half of the lower border of the dactylus and the upper border of the fixed finger bear a crest of minute teeth.

The chelipeds of females are weak and more slender than those of males; fingers are twice the length of the upper border of the palm. The carpus is small and the upper border is ridged and bears long setae. The palm is crested above with long setae. The upper and lower margins of the dactylus bear long setae; the upper margin of the fixed finger also bears long setae. There is no denticulation on the dactylus and palm. Only two carinae present run backward from the tip of the fingers on to the palm; the carinae enclosing the lower flattened surface bear long setae. The fingers gap wide near the base.

The third walking leg is the longest at two and a half times the length of the carapace. Well defined tympana are present on the upper and lower surfaces of the merus of the first two pairs and the lower part of the last two pairs. In the first two pairs, on the dorsal surface a crenulated ridge runs parallel to the upper border of the proximal half of the merus; the edges of the merus are microscopically beaded. The carpus and propodus of the second and third pair bear two carinae on the superior face; the dactylus is flattened and shorter than the propodus. In a large male, a dense patch of tomentum is present on the second walking leg extending from the middle of the carpus to the distal third of the propodus (Figure 3E); in young individuals, no traces of tomentum are observed. The basal segments of walking legs bear plumose setae.

All of the segments of the male abdomen are distinct (Figure 3G). The second segment of the abdomen is narrower than the first, the third and fourth segments are rounded at the sides, the

third segment is a little broader than fourth, the fourth segment is a little longer than the third, the breath of the fifth segment is less than the half breadth of the fourth segment, and the fifth segment is slightly constricted near its proximal half. The sixth segment is less than twice as broad as long, and the seventh segment is triangular in shape, broad rather than long, and more widely rounded distally. The female abdomen (Figure 3H) is much broader than that of the male, but comparatively narrow at the base; the seventh segment is triangular in shape.

The male G1 is slender, tapering distally (Figure 3I). The distal part of the apical lobe is deflexed outward (Figure 1J); long setae are present on the outer surface and a few long setae are present along the inner part, near the distal region.

Coloration. The carapace of the species is olive green in fresh specimens, while the carapace color in preservation is grayish. The abdomen of males and females is off white or cream in color. The palm of the male cheliped is pinkish purple up to the proximal half,

Table 1. The morphological differences between Ilyoplax sayajiraoi sp. nov., Ilyoplax stevensi (Kemp 1919), and Ilyoplax frater (Kemp 1919).

llyoplax sayajiraoi sp. nov.	Ilyoplax stevensi (Kemp, 1919) (Kemp 1919)	Ilyoplax frater (Kemp, 1919) (Fatemi et al 2011; Kemp 1919)
Lateral borders are slightly and evenly convex, thus the breadth of the middle surface is slightly more than the anterior breadth. 4 rows of tubercles present on the branchial region. Only the first row is indistinct and made up of 2 tubercles. The direction of the last row is much more transverse than longitudinal. If the last row continued, the line so formed would cross the proximal part of orbits on the opposite side. A small notch is present behind the tooth change on the opposite and	Lateral borders are straight and only convex posteriorly, thus the breadth of the middle surface is slightly less than the anterior breadth. 3 rows of tubercles are present on the branchial region. The first 2 rows are indistinct and made up of 1 or 2 tubercles. The direction of the last row is as much longitudinal as transverse. If the last row continued, the line so formed would cross the proximal part of the front. A small notch is present behind the tooth shaped outer orbital angle.	Lateral borders are slightly and evenly convex, thus the breadth of the middle surface is slightly more than the anterior breadth. 3 rows of tubercles are present on the branchial region. The first 2 rows are indistinct and made up of 1 or 2 tubercles. The direction of the last row is much more transverse than longitudinal. If the last row continued, the line so formed would cross the outer end of orbits on the opposite side. A small notch is not present behind the tooth shaped outer orbital angle.
The breadth of the front is 1/6 or 1/7 of the anterior breadth of the carapace. The lateral borders are slightly constricted near the base.	The breadth of the front is 1/11 or 1/12 of the anterior breadth of the carapace. The lateral borders are slightly constricted near the base.	The breadth of the front is one sixth or one seventh of the anterior breadth of the carapace. The lateral borders are not constricted near the base.
The outer half of the orbits is distinctly concave.	The outer half of the orbits is perfectly straight.	The outer half of the orbits is conspicuously concave.
Chelipeds of males are strong, slender, well developed, and much stouter than those of females. The fingers are more or less equal to the length of the upper border of the palm. The palm is slender in shape. The upper margin of the inner surface of the carpus is crested and beneath it there is a tuft of short setae. The space between 4 carinae running backwards from the tip of the fixed finger (inner face) on to the palm is not filled with any type/size of tubercles. The dactylus is slightly longer than the fixed finger. Dentition is present in the distal half of the dactylus. Small dentition is present on the distal half of the fixed finger. Long setae are not present on the lower border of the fixed fingers.	Chelipeds of males are weak and only slightly stouter than those of females. The fingers are 1.5 times longer than the length of the upper border of the palm. The palm is slender in shape. The upper margin of the inner surface of the carpus is crested and beneath it there is a thick tuft of very long setae. The space between 4 carinae running backwards from the tip of the fixed finger (inner face) on to the palm is filled with extremely minute tubercles. The dactylus is equal in length with the fixed finger. Dentition is present in the proximal half of the dactylus. Fixed finger is without dentition. Long setae are present on the lower border of the fixed fingers.	Chelipeds of males are strongly developed, much deeper, and longer than those of females. The fingers are slightly longer than the length of the upper border of the palm. The palm is swollen in shape. The upper margin of the inner surface of the carpus is crested and beneath it there is a thick tuft of very long setae. The space between 4 carinae running backwards from the tip of the fixed finger (inner face) on to the palm is filled with extremely minute tubercles. The dactylus is equal in length with the fixed finger. Dentition is present throughout the length of the dactylus with a large tooth present in the center of the dactylus. Small dentition is present on the distal half of the fixed finger. Long setae are not present on the lower border of the fixed finger
border of the fixed fingers. The edges of the merus are beaded.	The edges of the merus are spinulose.	of the fixed fingers. The edges of the merus are beaded.
Large tomentum present on the carpus and propodus of the 2^{nd} walking leg. The 3^{rd} segment is broader than the 4^{th} . The 5^{th} segment is $< 1/_2$ the breadth of the fourth segment. The 6^{th} segment is less than twice as broad as it is long.	Large tomentum present on the carpus and propodus of the 2^{nd} walking leg. The 3^{rd} and 4^{th} segments are the same in breadth. The 5^{th} segment is more than the half breadth of the 4^{th} segment. The 6^{th} segment is twice as broad as it is long	Large tomentum not present on the carpus and propodus of the 2 nd walking leg. The 3 rd and 4 th segments are same in breadth. The 5 th segment is $> 1/_2$ breadth of the 4 th segment. The 6 th segment is twice as broad as it is long.
	<i>Ilyoplax sayajiraoi</i> sp. nov. Lateral borders are slightly and evenly convex, thus the breadth of the middle surface is slightly more than the anterior breadth. 4 rows of tubercles present on the branchial region. Only the first row is indistinct and made up of 2 tubercles. The direction of the last row is much more transverse than longitudinal. If the last row continued, the line so formed would cross the proximal part of orbits on the opposite side. A small notch is present behind the tooth shaped outer orbital angle. The breadth of the front is 1/6 or 1/7 of the anterior breadth of the carapace. The lateral borders are slightly constricted near the base. The outer half of the orbits is distinctly concave. Chelipeds of males are strong, slender, well developed, and much stouter than those of females. The tingers are more or less equal to the length of the upper border of the palm. The palm is slender in shape. The upper margin of the inner surface of the carpus is crested and beneath it there is a tuft of short setae. The space between 4 carinae running backwards from the tip of the fixed finger (inner face) on to the palm is not filled with any type/size of tubercles. The dactylus is slightly longer than the fixed finger. Dentition is present on the distal half of the dactylus. Small dentition is present on the lower border of the fixed fingers. The edges of the merus are beaded. Large tomentum present on the carpus and propodus of the 2 nd walking leg. The 3 rd segment is broader than the 4 th . The 5 th segment is less than twice as broad as it is long.	Hyoplax savajiraoi sp. nov.Hyoplax stevensi (Kemp, 1919) (Kemp 1919)Lateral borders are straight and only convex convex, thus the breadth of the middle surface is slightly less than the anterior breadth. 4 rows of tubercles present on the branchial region.4 rows of tubercles present on the branchial region.Lateral borders are straight and only convex posteriorly, thus the breadth of the middle surface is slightly less than the anterior breadth. 3 rows of tubercles are present on the branchial region.10 rolly the first row is indistinct and made up of 2 tubercles.The first 2 rows are indistinct and made up of 1 or 2 tubercles.11 the last row continued, the line so formed would cross the proximal part of the front. A small notch is present behind the tooth shaped outer orbital angle.12 tuberclesThe breadth of the front is 1/10 rol 1/12 of the anterior breadth of the corapace.12 tubercles of males are strong, slender, well developed, and much stouter than those of females.13 the fingers are more or less equal to the length of the upper border of the palm. The palm is slender in shape. The upper margin of the inners surface of the carpus is crested and beneath it there is a tuf of short steae.14 re space between 4 carinaer running backwards from the tip of the fixed finger.15 det fingers. The adgreg of the emus are beadted. Large tomentum present on the distal half of the fixed finger. Long seta are nor present on the lower border of the fixed finger. Long seta are nor present on the lower border of the fixed finger. Long seta are nor present on the lower border of the fixed finger. Large tomentum present on the carpus and produs sit is long.14 s

whereas the distal half is white. The color gets darker in the inner phase. The fingers are white in color.

Distribution. The species is currently known from its type locality Kamboi ($22^{\circ} 12' 59''$ N; $72^{\circ} 36' 59''$ E) which is a coastal village located on the extreme interior of Gulf of Khambhat closer to the lower estuarine mudflat region of the Mahi Sagar River on the western side of the Bharuch district of Gujarat State, India.

Habitat. The species occupies the intertidal mudflat habitat (Figure 2B), where its distribution is restricted to the upper intertidal area. The species is burrowing in nature and its density ranges from 15 burrows/m² to 25 burrows/m². The burrow diameters of the species range from 5 mm to 11 mm, and the burrow depth ranges from 15 cm to 40 cm.

Etymology. The specific epithet *sayajiraoi* is named in honor of the founder of Baroda Collage Sir Sayajirao Gaikwad III, Maharaja of the erstwhile state of Baroda, Gujarat.

Discussion

Serène and Lundoer (1974) have provided the identification keys for the species belonging to the genus *Ilyoplax* based on the morphology of the male G1. According to keys provided by them, the present species falls in Group III, which also includes species like *Ilyoplax stevensi* and *I. frater*. The present species is very close to *I. stevensi* and *I. frater*, which were described by Kemp (1919), based on the material collected from the coastal area of Karachi, Pakistan. Although, *I. stevensi* and *I. frater* are very close to the present species, there are several significant morphological differences which separate the present species from other two closely related species. These significant morphological differences are listed below (Table 1).

In addition to the abovementioned differences, the female abdomen of both the species also showed major differences. The different segments of the female abdomen in the present species are broader then the female abdomen of *I. stevensi*.

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