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SHORT COMMUNICATION

DIVERSITY AND NEW RECORDS OF INTERTIDAL HERMIT CRABS OF THE GENUS *CLIBANARIUS* (CRUSTACEA: DECAPODA: DIOGENIDAE) FROM GUJARAT COAST OFF THE NORTHERN ARABIAN SEA, WITH TWO NEW RECORDS FOR THE MAINLAND INDIAN COASTLINE

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DIVERSITY AND NEW RECORDS OF INTERTIDAL HERMIT CRABS OF THE GENUS *CLIBANARIUS* (CRUSTACEA: DECAPODA: DIOGENIDAE) FROM GUJARAT COAST OFF THE NORTHERN ARABIAN SEA, WITH TWO NEW RECORDS FOR THE MAINLAND INDIAN COASTLINE

OPEN ACCESS

Pradip Kachhiya¹, Jatin Raval², Paresh Poriya³ & Rahul Kundu⁴



^{1,2,3,4} UGC-Center of Advanced Study, Department of Biosciences, Saurashtra University, Rajkot, Gujarat 360005, India
¹pradipkachhiya@gmail.com, ²drjatinraval@gmail.com, ³pareshporiya@gmail.com, ⁴rskundu@sauuni.ernet.in (corresponding author)

Abstract: The present study reports seven hermit crab species of the genus *Clibanarius*, viz., *C. infraspinus*, *C. longitarsus*, *C. rhabdodactylus*, *C. rutilus*, *C. signatus*, *C. virescens*, and *C. zebra*, from the intertidal zone of Gujarat State on the west coast of India. With the exception of *C. zebra*, the remaining six species are the first records from the west coast of India, and two species, *C. rutilus* and *C. rhabdodactylus* are new records from mainland India. All the recorded species were found inhabiting rocky, sandy and muddy intertidal habitats. We have appended the diagnostic descriptions and live coloration of all species based on the observations of our voucher specimens. Comments are provided where they differ slightly from the published records of that species, enriching the available identification keys for the intertidal hermit crabs of the Indian Ocean.

Keywords: Anomura, diversity, hermit crabs, first records, Gujarat coast, intertidal.

Nearly 1,100 species of hermit crab are currently recognized worldwide and new species are frequently being added (McLaughlin et al. 2010; Komai et al. 2013; Lemaitre 2014). The diversity of hermit crabs belonging to the genus *Clibanarius* have been reported from the Indian waters by a number of researchers (Miers 1884; Alcock 1901; Alcock 1905; Chopra & Das 1940; Kamalaveni 1950; Khan & Natarajan 1984; Desai & Mansuri 1989;

Thomas 1989; Lemaitre 1999; McLaughlin 2002; Siddiqui & Kazmi 2003; Siddiqui & McLaughlin 2003; Siddiqui et al. 2004; Rahayu 2007; Ramesh et al. 2009; Naderloo et al. 2012; Kachhiya 2014; Lemaitre 2014). Recently, *C. virescens* was newly reported from the east coast of India by Ravinesh & Bijukumar (2013). Intertidal hermit crabs of the west coast of India are least documented and only two known species (*C. zebra* and *C. nathi*) were studied for population ecology (Desai & Mansuri 1989; Vaghela & Kundu 2012). The Saurashtra coastline of Gujarat State provides diverse coastal habitats, with substratum types ranging from rocky, sandy to muddy areas of intertidal and subtidal, which can be expected to harbour diverse hermit crab populations. In the present study, the intertidal zones of the entire Gujarat coast of India except the Gulf of Kachchh was extensively surveyed, to explore the diversity of hermit crabs belonging to the genus *Clibanarius* (Family: Diogenidae).

MATERIALS AND METHODS

The present study was conducted across Gujarat State, on the northwestern coast of India which lies

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ज्ञान-विज्ञान विमुक्तये

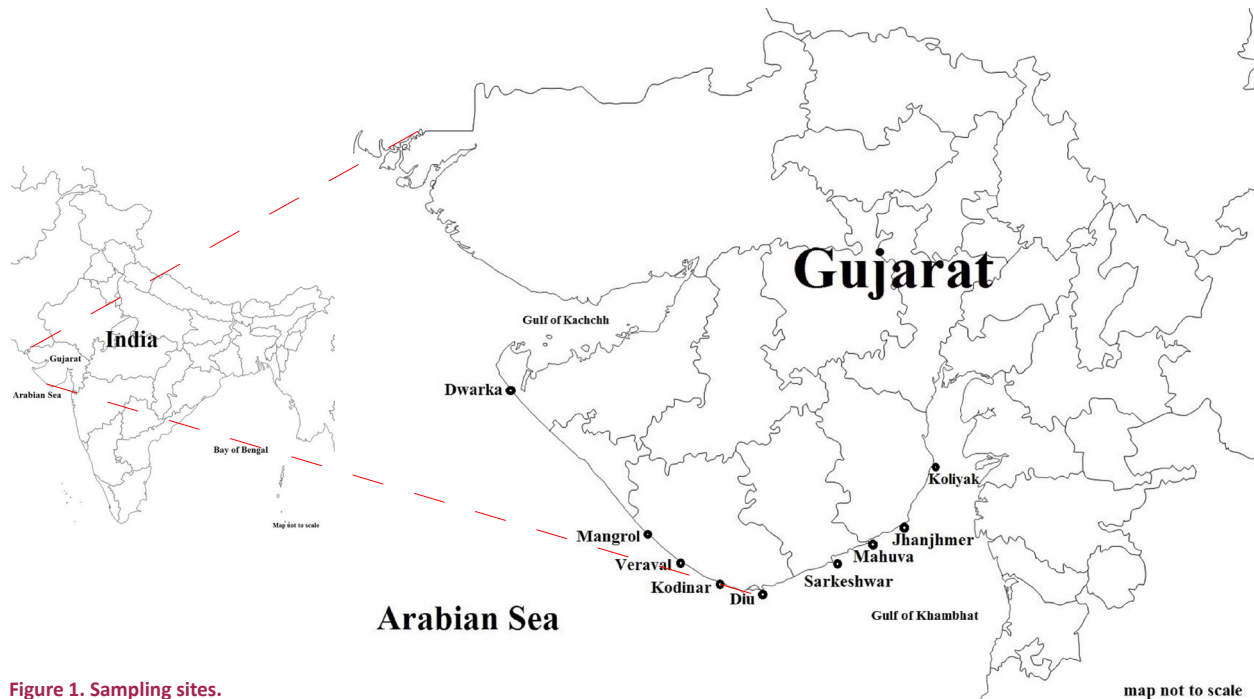


Figure 1. Sampling sites.

in the northern Arabian Sea. Nine intertidal localities were sampled from July 2013 to August 2014 (Fig. 1). The locations are Dwarka (22.233889 N & 68.966111 E), Mangrol (21.113056 N & 70.091944 E), Veraval (22.916944 N & 70.348056 E), Kodinar (Muldwarka) (20.758611 N & 70.656667 E), Diu (20.701389 N & 70.916667 E), Sarkeshwar (20.835556 N & 71.300278 E), Mahuva (21.067222 N & 71.814444 E), Jhanjmer (21.181111 N & 72.065 E), and Koliyak (21.596944 N & 72.287778 E). The coastline surveyed acts as the connecting link between two major gulfs of India, i.e., Gulf of Kachchh and Gulf of Khambhat, and has rocky, sandy, muddy and mixed type of coastline. The intertidal coast was surveyed at least once a month during the lowest tides. In situ photographs of live specimens were taken and voucher specimens of each species were collected for identification. Specimens were stored in 90% ethanol. Voucher specimens were deposited in the Museum of Department of Biosciences, Saurashtra University, Rajkot, India. The identification keys and terminology used in the diagnosis of species were as per Siddiqui & McLaughlin (2003), McLaughlin et al. (2007), and Komai et al. (2013).

RESULTS AND DISCUSSION

Seven species of hermit crabs of the genus *Clibanarius* (Family: Diogenidae), namely, *Clibanarius infraspinus* (Hilgendorf, 1869), *C. longitarsus* (De Haan, 1849), *C. rhabdodactylus* (Forest, 1953), *C. rutilus* (Rahayu,

1999), *C. signatus* (Heller, 1861), *C. virescens* (Krauss, 1843) and *C. zebra* (Dana, 1852), were observed from the sampling sites covering the entire Gujarat coast of India (excluding coastal areas of the Gulf of Kachchh). It is noteworthy to mention here that all these hermit crab species were found to be common along the studied coastline. In contrast, we didn't find *C. nathi* in the study area despite its mention in the earlier studies in the 1980s. This may be a result of an identification problem and worth investigating in the future; however, most of the species observed in the present study have not been reported from this region so far. The reasons for this are rather unclear. Lack of sampling may certainly be considered as a contributing factor, but it is also possible that any recent shifts in the habitat range in response to climatic change, adaptation and migration, might have influenced the diversity of hermit crabs of this region (Vaghela & Kundu 2012). The taxonomy, diagnoses, and distribution of the recorded hermit crabs are shown below.

Order: Decapoda
Infraorder: Anomura
Superfamily: Paguroidea
Family: Diogenidae

1. *Clibanarius infraspinus* Hilgendorf, 1869 (Image 1A)

Material examined: SUBIO-ZAMDDD11.2, Ci 2-31,



Image 1. Hermit crab species: **A - *Clibanarius infraspinatus***; **B - *Clibanarius longitarsus***; **C - *Clibanarius rhabdodactylus***; **D - *Clibanarius rutilus***; **E - *Clibanarius signatus***; **F - *Clibanarius virescens***; **G - *Clibanarius zebra***.

male, 24.iv.2014, Koliyak, Bhavnagar, Gujarat, India, 21.596944 N & 72.287778 E, coll. J. Raval. (18 males & 12 females; average chephalothorax size 13.8mm; Table 1) specimens were collected from Dwarka, 09.ix.2013, Mangrol 10.ix.2013, Veraval 31.x.2013, Diu 03.xi.2013, Sarkeshwar 28.ii.2014, and Koliyak 24.iv.2014.

Diagnosis and Remarks: Chelipeds equal with whitish colored tubercles. Ambulatory legs have yellowish-orange stripes bordered in red on lateral surface of merus and carpus. However, the stripes were found on both side of dactyls and propodus. Chelipeds and ambulatory legs have terminal black tips. Two colour forms were observed during its life stage; the general coloration of the juveniles was greenish or brownish light orange while, that of adults was yellowish-orange. Large (10cm) individuals were occasionally observed. This is the first record of *C. infraspinatus* from the west coast of India. This species was previously reported from the Red Sea, Indian Ocean, Thailand, northern Australia, Indonesia, Singapore, Vietnam, Philippine Islands, Taiwan and Japan (Lemaitre 1999).

2. *Clibanarius longitarsus* De Haan, 1849 (in De Haan, 1833–1850) (Image 1B)

Material examined: SUBIO-ZAMDDC9.1, Cl 1-15, male, 28.ii.2014, Sarkeshwar, Jafrabad, Gujarat, India, 20.835556 N & 71.300278 E, coll. P. Kachhiya. (10 males & 5 females; average chephalothorax size 16.7mm, Table 1) specimens were collected from Sarkeshwar on 28.ii.2014, Mahuva on 20.iv.2014 and Koliyak on 24.iv.2014.

Diagnosis and Remarks: Ocular peduncles, chelipeds and ambulatory legs have dark brown longitudinal stripes on lateral surface over their entire length. Chelipeds subequal, right one slightly longer and broader. Dorsomesial margins of carpi each with one prominent spine. Ventral margins of dactyls of ambulatory legs have a row of very small spines. This species is known to exhibit colour variations (Fize & Serene 1955; Ball & Haig 1972; Morgan 1987). The colour of the observed species in the present study was dark brown. It is the first record of *C. longitarsus* from the west coast of India. This species was previously reported from the Red Sea, Indian Ocean, northern Australia, Thailand, Indonesia, Taiwan and Japan (Lemaitre 1999).

3. *Clibanarius rhabdodactylus* Forest, 1953 (Image 1C)

Material examined: SUBIO-ZAMDDC5.1, Cr 1-40, female, 31.x.2013, Veraval, Gujarat, India, 22.916944 N & 70.348056 E, coll. P. Kachhiya. (22 males & 18 females; average chephalothorax size 14.7mm, Table 1) specimens were collected from Dwarka on 09.ix.2013, Mangrol on 10.ix.2013, Veraval on 31.x.2013, Kodinar on 01.xi.2013, Diu on 03.xi.2013, Sarkeshwar on 28.ii.2014, and Jhanjhmer on 22.iv.2014.

Diagnosis and Remarks: Cheliped subequal; right slightly bigger. Eye-stalk, shield and walking legs marked with dark-brown stripes. Carapace with four longitudinal bands on the dorsal surface. Merus and carpus of walking legs with three stripes on lateral surface, propodus and dactyls with five stripes; three on lateral surface and two on dorsal surface. It closely resembles *Clibanarius zebra* (Dana, 1852). However, *C. zebra* has no stripe on the dactyl of the ambulatory legs while *C. rhabdodactylus* has prominent stripes on the dactyl (Miyake 1956). *C. rhabdodactylus* has affinities with *C. signatus* from Pakistan, Persian Gulf, Gulf of Oman, Gulf of Aden, and Red Sea (Poupin et al. 2013). But it is distinct by having only one longitudinal stripe on the ocular peduncle and four longitudinal stripes on the cephalic shield (Moradmand & Sari 2007). This species was reported earlier from East Indies and Pacific Ocean, Indonesia and Polynesia (type-locality). This is the first record of this species from the entire mainland Indian coastline.

4. *Clibanarius rutilus* Rahayu, 1999 (Image 1D)

Material examined: SUBIO-ZAMDDC5.5, Cru 5-16, male, 31.x.2013, Veraval, Gujarat, India, 22.916944 N & 70.348056 E, coll. P. Kachhiya. (8 males & 4 females; average chephalothorax size 18.7mm, Table 1) specimens were collected from Dwarka on 09.ix.2013, Mangrol on 10.ix.2013, Veraval on 31.x.2013, Kodinar on 01.xi.2013 and Diu on 03.xi.2013.

Diagnosis and Remarks: Chelipeds sub equal, left slightly larger than right. Carpus of cheliped short, dorsomesial margin with strong spines distally. Dorsal surface of chelipeds and walking legs covered with conical tubercles and setae. Dactylus and fixed finger each with strong corneous claw. Colour in general orange-red. Ocular peduncles bright red without stripe and it bears a white ring at the base of the cornea. This is the first record of this species from mainland Indian coastline. This species was first described from northern Sulawesi, Indonesia by Rahayu (1999).

5. *Clibanarius signatus* Heller, 1861 (Image 1E)

Material examined: SUBIO-ZAMDDC5.2, Cs 2-36, female, 31.x.2013, Veraval, Gujarat, India, 22.916944 N & 70.348056 E, coll. P. Kachhiya. (25 males & 10 females; average chephalothorax size 13.9mm, Table 1) specimens were collected from Dwarka on 09.ix.2013, Mangrol on 10.ix.2013, Veraval on 31.x.2013, Kodinar on 01.xi.2013, Diu on 03.xi.2013, Sarkeshwar on 28.ii.2014 and Jhanjhmer on 22.iv.2014.

Diagnosis and Remarks: Background color of cephalothorax dark gray, with variable orange markings on carapace. Chelipeds subequal, right slightly larger, both shorter and stouter than walking legs. Chelae with a noticeable notch in the cuticle between dactyls and fixed fingers than other *Clibanarius* species. Walking legs with dactyls shorter than propodi; ventral margins of carpus has 5 or 6 small corneous spines. Ocular peduncles and walking legs have black longitudinal stripes. Chelipeds without stripes having white spots on lateral surface. It is the first report of this species from the west coast of India. This species was previously reported from the Persian Gulf, Gulf of Oman, Pakistan, Dhofar, Socotra Island, Gulf of Aden and Red Sea (Lewinsohn 1982; Tirmizi & Siddiqui 1982; Hogarth 1988; Hogarth 1989; Apel 2001; Moradmand & Sari 2007; Simoes et al. 2001;).

6. *Clibanarius virescens* Kruass, 1843 (Image 1F)

Material examined: SUBIO-ZAMDDC5.3, Cv 3-22, male, 31.x.2013, Veraval, Gujarat, India, 22.916944 N & 70.348056 E, coll. P. Kachhiya. (12 males & 8 females; average chephalothorax size 13.5mm, Table 1) specimens were collected from Dwarka on 09.ix.2013, Mangrol on 10.ix.2013, Veraval on 21.x.2013, Kodinar on 01.xi.2013, Diu on 03.xi.2013, Sarkeshwar on 28.ii.2014.

Diagnosis and Remarks: Chelipeds sub equal, right somewhat longer; dorsal surfaces of palms and fixed fingers with strong spines. Lateral surface of chelipeds has prominent irregular white spots. Ocular peduncle has white ring at the base of cornea. Dactyls of walking legs have two yellow prominent rings. This species is distributed in the eastern coast of Africa to Ellice, Indonesia, Thailand, Taiwan, Japan and Fiji Islands. This is the first record of *C. virescens* from the west coast of India though it has recently been reported from the east coast (Ravinesh & Bijukumar 2013).

7. *Clibanarius zebra* Dana, 1852 (Image 1G)

Material examined: SUBIO-ZAMDDC5.4, Cz 4-33, female, 31.x.2013, Veraval, Gujarat, India, 22.916944 N & 70.348056 E, coll. P. Kachhiya. (18 males & 12 females; average Chephalothorax size 11.5mm, Table 1)

Table 1. Average measurement of different body parts of the hermit crab species reported in this study. Data expressed are minimum-maximum range and average values of all the specimen of each species (the number of specimens is shown in brackets).

Body organs	<i>C. zebra</i> (30)	<i>C. longitarsus</i> (15)	<i>C. rhabdodactylus</i> (40)	<i>C. rutilus</i> (12)	<i>C. signatus</i> (35)	<i>C. infraspinatus</i> (30)	<i>C. virescens</i> (20)
Chelipeds	8.6-15.8 14.4	21.6-26.2 24	13.6-16.8 15.8	10.9-14.1 12.7	11.6-15.2 13.8	17.7-23.5 21.9	12.8-15.8 14.2
Walking legs pair 1	17.7-22.6 19.5	35.8-39.4 37.2	24.8-32.4 28.8	17.3-22.7 19.5	18.4-24.2 21	28.7-35.1 32.9	18.3-22.9 21.5
Walking legs pair 2	18.4-23.1 20.6	34.3-37.9 35.5	24.9-28.7 26.7	19.8-23.6 22.2	21.9-24.9 23.3	30.8-35.2 33.6	22.6-25.2 23.4
Pereopod pair 4	6.3-8.1 7.5	10.9-13.7 12.3	6.7-10.1 8.9	5.1-7.3 6.1	5.8-8.4 7.4	9.6-12.4 11.4	6.1-8.4 7.5
Pereopod pair 5	8.2-10.4 9.6	12.9-13.7 14.7	9.8-12.8 11.2	6.9-7.3 6.9	8.9-11.3 10.3	13.7-15.3 14.9	8.2-12.2 10.6
Ocular peduncles	3.8-6.6 5.8	6.4-9.2 8.6	5.7-7.9 6.9	4.2-6.6 5	3.4-5.8 4.6	6.6-8.3 7.6	6.1-7.3 6.6
Antennules	5.7-8.9 7.3	8.8-11.8 10.8	7.6-9.2 8	5.9-7.3 6.7	4.8-6.4 5.6	9.2-10.8 10	6.3-8.5 7.7
Antennas	15.2-22.4 19.6	8.6-12.2 10.8	19.3-23.3 21.1	12.8-18.8 16.4	13.3-17.3 15.6	23.8-28.6 26.8	18.1-22.6 20.3
Abdomen	18.4-24.0 22.4	37.8-44.2 41	14.6-18.2 16.8	22.8-26.2 24.2	18.6-22.8 21.8	29.6-35.2 32.4	13.2-18.6 15.6
Uropod	4.2-5.2 4.8	4.2-4.8 4.4	4.2-4.8 4.4	3.2-3.8 3.6	3.8-5.8 4.6	7.3-11.3 9.8	3.6-4.8 4.1
Telson	3.2-4.6 3.8	2.8-4.4 3.6	4.2-4.8 4.6	3.4-4.2 4	3.4-4.2 3.8	7.2-9.8 8	3.7-4.9 4.3
Carapace	9.3-13.7 11.5	14.9-17.5 16.7	12.9-15.9 14.7	16.9-21.1 18.7	12.3-14.6 13.9	7.8-10.9 9.7	12.8-15.6 14.2
Whole body	32.2-41.8 37.6	51.8-65.6 59.2	33.8-42.2 37.6	38.8-42.8 40.2	37.8-42.2 40	57.2-69.6 66.8	34.4-38.8 36.2

specimens were examined from Dwarka on 09.ix.2013, Mangrol on 10.ix.2013, Veraval on 31.x.2013, Kodinar on 01.xi.2013 and Diu on 03.xi.2013.

Diagnosis and Remarks: Ocular peduncles and chelipeds have no stripes while walking legs has longitudinal stripes on meri, carpus and propodus. Dactyls are without stripes, which is the diagnostic characteristic of this species. Cornea shows fluorescent blue coloration in natural condition which turns to black on preservation. Antennular acicle and antennal peduncles are bluish orange colored. Chelipeds sub equal, merus with a few tubercles on outer surface; carpus, propodus and dactylus with sharp teeth and tubercles on upper surface. This species is distributed only in Indian Ocean as earlier reported from Krusadai Island (Thomas 1989; McLaughlin et al. 2010).

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