

SPATIAL DISTRIBUTION OF INTERTIDAL HERMIT CRAB (DECAPODA: ANOMURA) TOGETHER WITH GASTROPOD SHELL AVAILABILITY AND UTILIZATION PATTERN ON THE SOUTHERN COAST OF GULF OF KACHCHH, GUJARAT, INDIA

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ABSTRACT

The present study was about to understand utilization of gastropod shells by hermit crabs in intertidal area of four different sites of southern Gulf of Kachchh, Gujarat, India. Intertidal areas of sites endowed with various microhabitats such as sandy beach, mud flats, mangrove vegetation, narrow creek, live and dead corals and rocky substrate. The study was conducted during December, 2012 to May 2013 and observation were made through line transect method. Some of the specimens were taken out for identification and confirmation. Five species of hermit crab viz., *Clibanarius padavensis*, *Clibanarius zebra*, *Diogenes* sp., *Pagurus longicarpus* *Pagurus* sp. were recorded for the study site. The distribution of the species was found to be restricted to a specific site, except, *Pagurus longicarpus*. Maximum density was recorded of *Pagurus longicarpus*, (20.97 indv/m²), followed by *Pagurus* sp. (19.29 indv/m²), *Diogenes* sp. (15.62 indv./m²), *Clibanarius zebra* (2.32 indv./m²) and *Clibanarius padavensis* (1.68 indv./m²). These five species used shells of total 27 Gastropod species and among them *Pagurus longicarpus* used maximum number (n=18) of shells of Gastropod species. The shells utilization by *Clibanarius padavensis* and *Clibanarius zebra* (p>0.05, Chi-square = 147.21, df=11) was due to availability. Likewise, shell utilization by *Pagurus* sp. and *Pagurus longicarpus* (p<0.05, Chi-square = 18.08, df=8) is due to shell availability. In contrary, *Diogenes* sp. has choice at certain level (p=0, Chi-square = 330.14, df=14).

KEYWORDS : Hermit crab, Gastropod shells, Intertidal area, Gulf of Kachchh

Hermit crabs, belonging to superfamily Paguroidea of Anomura, are decapod crustaceans (McLaughlin et al., 2010; McLaughlin and Turkay, 2011). Unlike other decapod crustaceans that have fully hardened exoskeletons, hermit crabs have soft abdomens, devoid of calcified abdomen (Barnes, 2003), that make them more susceptible to predation and desiccation (Billock and Dunbar, 2008). This attribute requires them to protect their abdomens, usually within empty gastropod shells (Billock and Dunbar, 2008). Their niche ranges from deep ocean floors to terrestrial habitats and from the poles to the tropics (Gage and Tyler, 1991; Brodie, 1998; Dunbar, 2001). Intertidal habitats are particularly vulnerable to changes in temperature and salinity and hermit crab species vary in their tolerance of these changes (Coffin, 1958; Dunbar and Coates, 2004).

The use of gastropod shells has allowed hermit crabs to survive in a wide variety of environmental conditions. As hermit crabs grow, they require larger shells. The availability of empty shells at any given place depends on the relative abundance of gastropods and hermit crabs, matched for size (Provenzano, 1960).

Very low information was available on crabs of Gulf of Kachchh, Trivedi et al., (2012) prepared a baseline of crabs, but the study includes only brachyuran crabs not hermit crab. The study of hermit crab was done by Trivedi et al., (2013) but it was restricted to Saurashtra and other coast of Gujarat. The present study is to provide the distribution of hermit crabs species and their interaction with gastropods.

Study Area

The present study was conducted in southern part of Gulf of Kachchh, (GoK) Jamnagar district in Gujarat State, India. Four different intertidal areas were selected in the GoK for the study (Map-1).

Site-I

Intertidal area of Vador Sikka: It is located in the middle of southern GoK on 22°26'34.81"N latitude and 69°48'55.84"E longitude. The area is with sandy beach and partially covered with mud flats and mangrove vegetation and narrow creek were prominent in which 10-20 cm water remains at low tide.

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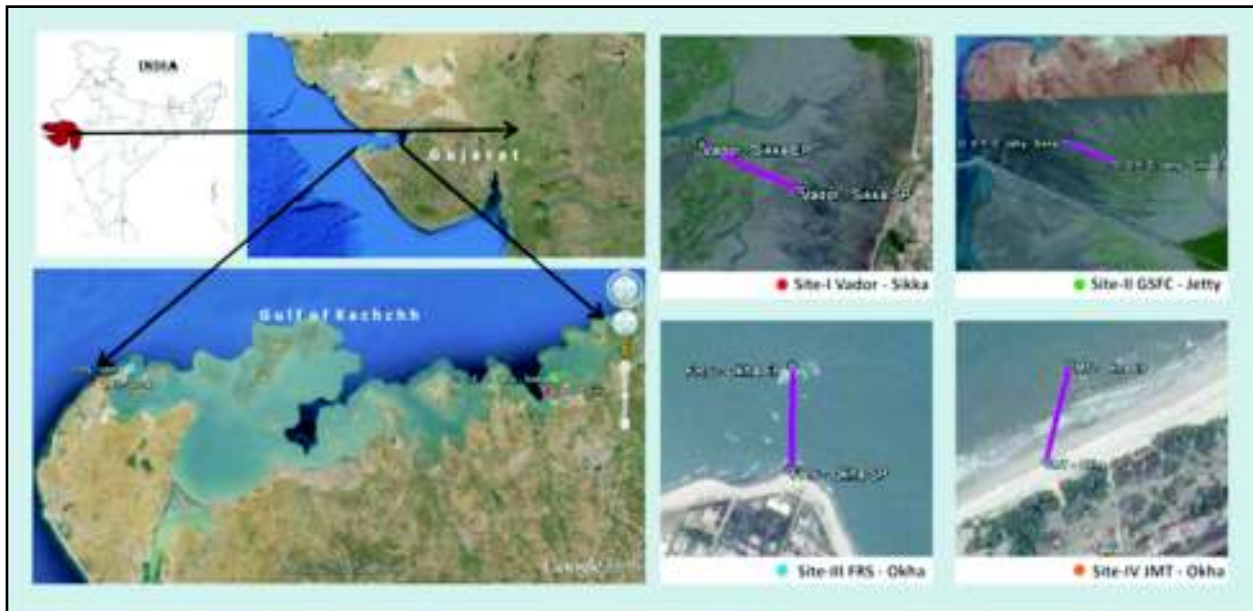


Figure 1 : Map Depicts the Study Site With Reference to the State Along With Transects

Site-II

Intertidal area of G.S.F.C. Jetty Sikka: The site is also located on middle of southern Go Kon 22°27'43.38"N latitude and 69°49'12.01"E longitude. The area has mangroves patches, mudflats and dead corals. Seaward side the area is endowed with live corals.

Site-III

Intertidal area near Fishery Research Station Okha: The site is located at western side of southern GoKat 22°28'47.36"N latitude and 69° 04'42.45"E longitude. Sandy and rocky habitats constitute the study site.

Site-IV

Intertidal area near Jangleshwar Mahadev Temple Okha : The site is located at the western side of southern GoKat 22°27'18.00"N latitude and 69° 01'59.00"E longitude. The area is with sandy habitat along with rocky substrates. The site has also tidal pools and crevices.

METHODOLOGY

The study was carried out in two modes. a) In one mode, the hermit crabs were studied for shell utilization along with their occurrence. For shell utilization pattern, the hermit crabs were collected and taken out from the shell for further identification. b) In second mode, the hermit crabs were studied for only occurrence and distribution without

removing and disturbing animals from its natural habitats. The field work of the study was carried out between December, 2012 and May 2013. To study the occurrence of hermit crabs and gastropod species utilization, quadrat survey was carried out on baseline which was laid perpendicular to the coastline from high tideline to low tideline in all the sites. The length of baseline varies from site to site depending on the extent of exposure during low tide. The length of transect at site - I was 677m (113 quadrates), site II 535m (90 quadrates), site III 229m (39 quadrates) and at site IV 83m (14 quadrates). Along each baseline quadrat of 1 m² were laid at interval of 5 meters. Observations were carried out mainly from high tide line towards low tide line during running low tide. From each quadrat, Gastropods and shells occupied with hermit crab were counted. From the all sites the specimens of hermit crabs were picked up by handpicking method. Then the specimens were put in an isolated area within its natural habitats and wait for the crab to come out from the shell for harmless observation. As the crabs came out, immediately photographs and sketches of visible parts were made at the site. For the confirmation of the species 25 specimens were collected and further crabs were taken out to the shells.

The identification was confirmed based on photographs, drawings and character description and

Table 1 : Occurrence of Hermit Crabs at Different Sites

Site	<i>Clibanarius padavensis</i>	<i>Clibanarius Zebra</i>	<i>Diogenisis sp.</i>	<i>Pagurus longicarpus</i>	<i>Pagurus sp.</i>
I	-	-	-	+	-
II	+	+	-	-	-
III	-	-	+	-	-
IV	-	-	-	+	+

comparing them with the illustrative keys (Sethuramalingam and Khan, 1991). For further confirmation of species, all the details of the specimens were compared with the information available on Marine Species Identification Portal website (www.species-identification.org.com) and National Institute of Oceanography web site on Marine Fauna Information (Jeyabaskaran and Wafar, 2002). The classification of crabs was adopted from WORMS website (www.marinespecies.org). Data were statistically analyzed by Chi-square Test.

RESULTS AND DISCUSSION

During the present study, total 5 species of Hermit Crabs were recorded from four locations. Of the total five species, three species could be identified up to species level and two species could be identified up to genus level only. A species, *Uca sp.*, was recorded in Pirotan Island, in Gulf of Kachchh, by Ramamoorthy et al., (2012) but the present study area does not have distribution of the species. The distribution of the species was found to be restricted to a specific site, except, *Pagurus longicarpus* that was recorded from two sites (Table 1). Density of crab species was also varied from site to site. Of the five species, maximum density was recorded of *Pagurus longicarpus*, i.e. 20.97 indv/m² which was recorded from site I and site IV only. Density of the species was higher at site IV (18.00 indv/m²) compare to site I (2.97 indv/m²). Second highest was of *Pagurus sp.* i.e. 19.29 indv/m² which occurred only at site IV. *Diogenisis sp.* was recorded from only site III with density of 15.62 indv/m². The member of same genus *Clibanarius padavensis* and *Clibanarius zebra* were recorded at site II only and density were 1.68 indv./m² and 2.32 indv./m² respectively. Above results revealed that the distribution of the crab species is site specific. The distribution of *Clibanarius* was found to be at site II. The site is endowed with mangrove, muddy substrate. Many

studies revealed that the species of *Clibanarius* mostly found in such habitats. Reay and Haig (1990) and Dwi Listyo Rahayu (2003) describe that species of *Clibanarius* were recorded mostly from the mangrove area, hard substrate. Ahmed and Khan (1971) from Siddiqui and Kazmi (2003) recorded *Clibanarius padavensis* is from muddy and sandy shores of Indo-Pacific; Pakistan to Singapore; East Indies; Australia; New Caledonia. Davie (2002) also supports the distribution of this species to low intertidal, muddy-sand, sea grass and shallow sub tidal areas.

All these five species of crabs were found to be using shells of total 27 Gastropod species of phylum Mollusca falling under 11 families (Table 2) from the sample area. Of the five crab species, maximum gastropod species were used by *Pagurus longicarpus* (n=18 species), followed by *Diogenisis sp.* (n=13 species) and *Pagurus sp.* (n=13 species). *Clibanarius padavensis* and *Clibanarius zebra* were used 11 and 10 gastropods species respectively.

Clibanarius padavensis and *Clibanarius zebra* used shells of same gastropod species except shells of *Cerithideopsis cingulata* which was used by only *Clibanarius padavensis*. There is no significant difference of shell species utilization by both *Clibanarius padavensis* and *Clibanarius zebra* (p> 0.05, Chi-square = 9.73, df = 10) (Figure 1). Moreover, value of dominance (Table 2), 0.19 reveals that no one is dominating on each other. As both species were observed at site II only, a hypothetical test was applied between live gastropods density and occupied gastropod density. It was inferred that shell preference by both species did not find significant difference at site II (p> 0.05, Chi-square = 147.21, df = 11). Thus, shell utilization by both species may be based on availability of the gastropod species.

Similarly, *Pagurus longicarpus* used all 13 species of gastropods which were also used by *Pagurus sp.*, however, additional shells of five species were used by

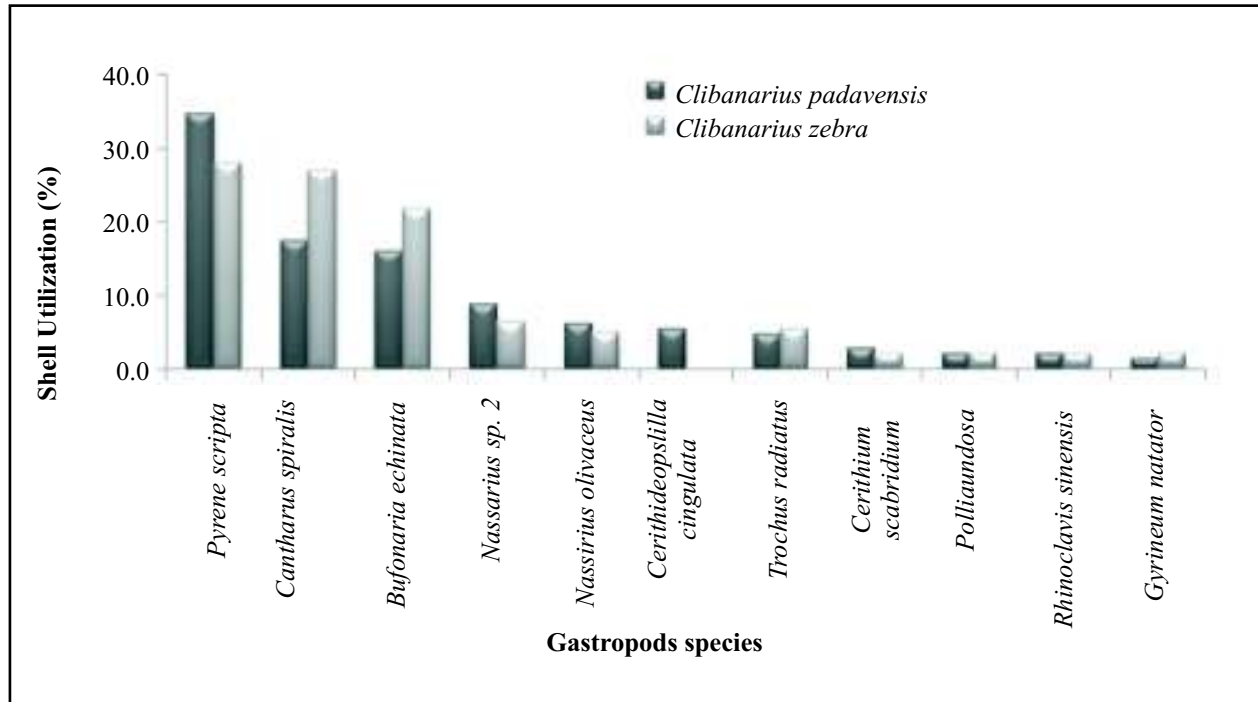


Figure 1: Utilization of Shells of Different Gastropod Species by *Clibanarius padavensis* and *Clibanarius zebra* at Site-II

Pagurus longicarpus viz., *Cerithideopsis cingulata*, *Mitrella blanda*, *Trochus radiatus*, *Turbo* sp., and *Umbonium vestiarium* (Figure 2).

Distribution of *Pagurus* sp. was restricted to site IV but *Pagurus longicarpus* distributed at site IV as well as site I. *Pagurus longicarpus* is the sole species at the site I hence, no chances of competition with any other Hermit crab species. However, there is significant difference between density of live gastropod species and occupied gastropod species at site I ($p < 0.05$, Chi-square = 18.08, $df = 8$). Thus, shell utilization by *Pagurus longicarpus* may not be based on availability of the gastropod species at site I.

However, at site IV, there is significant difference of shell species utilization by both *Pagurus longicarpus* and *Pagurus* sp. (Chi-square = 35.54, $df = 12$, $p < 0.05$). The shells of *Cerithium scabridium*, *Ergala taxcontracta* were utilized in more numbers by *Pagurus longicarpus*, in contrary, *Cantharus spiralis* and *Bufonaria echinata* were utilized only by *Pagurus* species (Figure 2).

As both species were observed only at site IV a hypothetical test was applied between live gastropods density and occupied gastropod density. It was inferred that shell preference by both species did not find significant difference at site IV ($p > 0.05$, Chi-square = 45.44, $df = 12$). Thus, shell utilization by both species is based on availability of the gastropod species.

Diogenes sp. is also sole Hermit Crab found at Site III, in addition, the species was not recorded from other three sites. A total of 13 gastropod species were used by the *Diogenes* species at the site. Of which, *Cerithium scabridium*, *Drupella rugosa* and *Astraliu stell* are were the most utilized gastropod species by the crab (Figure 3). Considering the availability of gastropod species, there is significant difference between live gastropods density and occupied gastropod density ($p = 0$, Chi-square = 330.14, $df = 14$). So, there were chances of preference of shells.

Present study revealed the distribution of crab species which was found restricted to specific site. The site studied was composed of many different micro habitats

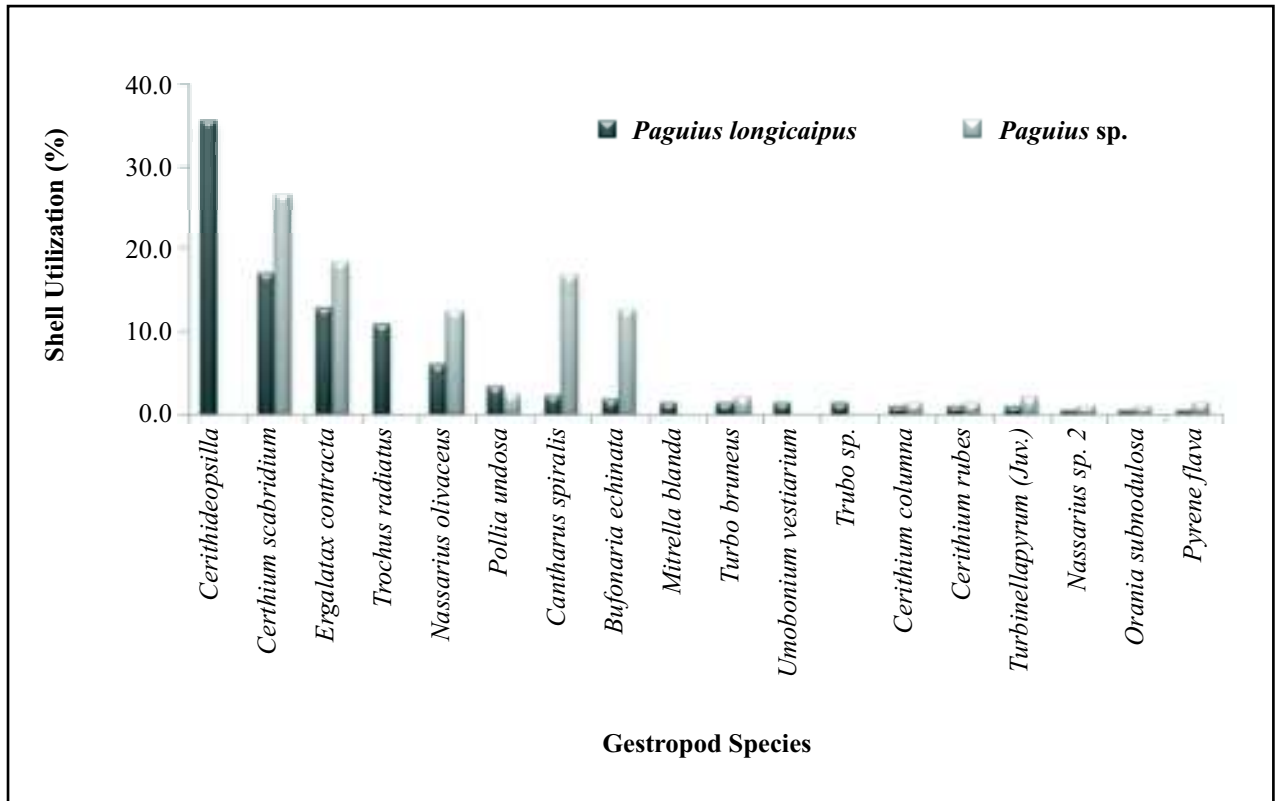


Figure 2 : Utilization of Shells of Different Gastropod Species by *Pagurus longicaipus* and *Pagurus sp.* at site I and IV

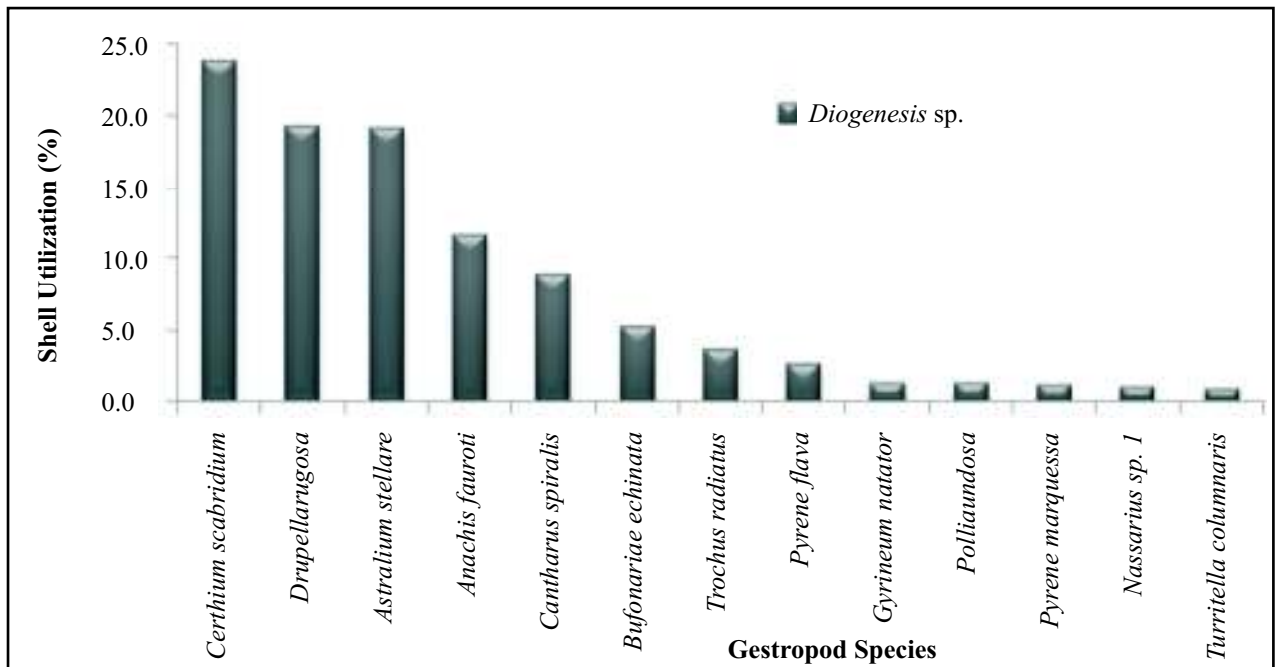


Figure 3 : Utilization of Shells of Different Gastropod Species by *Diogenes sp.* at Site III

Table 2 : Gastropod Species used by Hermit crabs in Gulf of Kachchh

So. No.	Gastropod Species
1	<i>Anachisfauroti</i> (Jousseau, 1888)
2	<i>Astraliumstellare</i> (Gmelin, 1791)
3	<i>Bufonariaechinata</i> (Link, 1807)
4	<i>Cantharus spiralis</i> (Gray, 1839)
5	<i>Cerithideopsillacingulata</i> (Gmelin, 1791)
6	<i>Cerithiumcolumna</i> (Sowerby I, 1834)
7	<i>Cerithium rubes</i> (Deshayes, 1832)
8	<i>Cerithiumscabridium</i> (Philippi, 1848)
9	<i>Drupellarugosa</i> (Born, 1778)
10	<i>Ergalataxcontracta</i> (Reeve, 1846)
11	<i>Gyrineumnator</i> (Röding, 1798)
12	<i>Mitrellablanda</i> (G. B. Sowerby I, 1844)
13	<i>Nassariusolivaceus</i> (Bruguière, 1789)
14	<i>Nassarius</i> sp. 2
15	<i>Nassarius</i> sp.1
16	<i>Oraniasubnodulosa</i> (Melvill, 1893)
17	<i>Poliaundosa</i> (Linnaeus, 1758)
18	<i>Pyrene flava</i> (Bruguière, 1789)
19	<i>Pyrene marquessa</i> (Gaskoin, 1859)
20	<i>Pyrene scripta</i> (Lamarck, 1822)
21	<i>Rhinoclavissinensis</i> (Gmelin, 1791)
22	<i>Trochusradiatus</i> (Gmelin, 1791)
23	<i>Turbinellapyrum</i> (Juv.) (Linnaeus, 1758)
24	<i>Turbo bruneus</i> (Roding, 1798)
25	<i>Turbo</i> sp.
26	<i>Turritellacolumnaris</i> (Kiener, 1843)
27	<i>Umboniumvestiarium</i> (Linnaeus, 1758)

such as muddy, sandy rock substrates. However, each site is inhabited by particular species. Considering the preference of the Gastropod shell, the present study revealed that shell utilization pattern by *Clibanarius padavensis*, *Clibanarius zebra*, *Pagurus* sp. and *Pagurus longicarpus* based on shell availability. In contrary, *Diogenes* sp. has choice at certain level. Many studies also inferred that shell utilization patter is based on availability of shells.

Mantelatto and Garcia, 2000; as well as Reese, (1962) mentioned that survival and population distribution of hermit crabs has relationship with availability of gastropod species, however, some of the factors influence the choice of shell species. Preference of shell species is partially dependent on some of the morphological factors like identity (Young, 1979), size (Vance, 1972), weight (Reese, 1962), degree of damage (Conover, 1978)

Table 3: Diversity Indices of Gastropod Occupied by Hermit Crabs in Different Sites

	Site - I (<i>Paguruslongicarpus</i>)	Site - II (<i>Clibanariuspadavensis</i>), (<i>Clibanarius zebra</i>)	Site - III (<i>Diogenis sp.</i>)	Site - IV (<i>Paguruslongicarpus</i>), (<i>Pagurus sp.</i>)
Total Species of Gastropods utilized by Hermit Crab	8	11	13	13
Number of Shell occupied by Hermit Crab	336	360	609	522
Dominance	0.43	0.19	0.16	0.19
Shannon index	1.26	1.90	2.06	1.96
Simpson index	0.57	0.81	0.84	0.80
Equitability	0.60	0.79	0.80	0.76



Image 1: Hermit crab emerges from shell:
Crab : *Clibanarius padavensis*
Gastropod : *Clibanarius humilis*



Image 2: *Clibanarius zebra*



Image 3: *Clibanarius padavensis*



Image 4: *Paguruslongicarpus*



Image 5: *Pagurus* sp.



Image 6: *Diogenes* sp.

and epibiosis (Jensen, 1970). Study of Reese (1969), Bertness (1982) and Vermeij (1976) emphasized environmental factors such as shell abundance, habitat tidal height and latitude for preference of shell species, and that may also influence in the present study for shell choice.

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