



Biodiversity of hermit crabs in Odisha, east coast and their distribution in other coastal states of India

A Behera^a, S K Padhi^a, S Roy^b, S Patro^{*a} & S Mitra^c

^aDepartment of Marine Sciences, Berhampur University, Bhanjabihar, Odisha – 760 007, India

^bEstuarine Biology Regional Centre, Zoological Survey of India, Gopalpur, Odisha – 761 002, India

^cCrustacea Section, Zoological Survey of India, 27-J. N. Road, Kolkata – 700 016, India

*[E-mail: shesdevpatro@yahoo.com]

Received 11 November 2019; revised 31 December 2020

Hermit crabs are one among the least studied group of the animal kingdom. The diversity of hermit crabs of entire Odisha coast was studied for the first time. Collected primary data and secondary data were compiled to prepare an updated checklist of hermit crabs of Indian coast. A total of seven species of hermit crabs were recorded during the field surveys along Odisha coast. The compilation of secondary data with present primary data revealed occurrence of 114 species of hermit crabs belonging to 27 genera and six families along the Indian coast. Diogenidae was identified as the dominant family. The diversity of hermit crabs is high in the west coast (73 species) as compared to the east coast (65 species). Maximum species diversity is recorded in Tamil Nadu (53 species), Kerala (50 species) and in Andaman & Nicobar Islands (46 species). Twenty three species of hermit crabs inhabit the coastal ecosystems of Odisha. The present study also reports the occurrence of *Clibanarius infraspinus* for the first time from Odisha thus, extending its distributional range along the Indian coast. Among the reported 114 species, only 61 species are included in GBIF with Indian distribution whereas occurrence data is not available for 11 species and 42 species are not likely distributed along Indian coast. The findings of the present study support the occurrence of 61 species (included in Global Biodiversity Information Facility) along the Indian coast and suggest that the occurrence and distribution of remaining 53 species can be confirmed after conducting extensive field surveys.

[**Keywords:** *Clibanarius infraspinus*, Diogenidae, Hermit crabs, New record, Odisha]

Introduction

Among the diverse group of marine organisms inhabiting the inter-tidal and sub-tidal area, hermit crabs, belonging to the superfamily Paguroidea, infra-order Anomura of decapodan crustaceans holds a large share. These organisms are extensively distributed in the tropical as well as sub-tropical region¹. Hermit crabs does not possess any commercial value, however, are significantly important because of their ecological aspects. They play an important role as scavengers in coastal ecosystems thus accelerating the rate of recycling of nutrients and flow of energy in the food chain². Naturally, their planktonic larvae contribute substantially as feed for juvenile fishes with commercial importance and the adult hermit crabs are been fed upon by the predatory fishes³.

Taxonomically, the hermit crabs are classified into five families viz. (i) Coenobitidae: land hermit crabs, (ii) Diogenidae: left-handed hermit crabs, (iii) Paguridae: right-handed hermit crabs, (iv)

Parapaguridae: deep-water hermit crabs, and (v) Pylochelidae: non-gastropod shelter using hermit crabs⁴. They are represented by approximately 2002 species worldwide³.

A significant number of studies are been undertaken globally to understand their biodiversity and role in an ecosystem. However, in India, the available information on coastal hermit crabs is meager. The history of hermit crab studies undertaken along the Indian coast is presented in Figure 1 which suggests its temporal inconsistency. Studies related to the hermit crabs of India were initiated during 1865 when the report on the diversity of hermit crabs was published for the first time from the Nicobar Islands by Heller⁵. A reasonable number (10) of literature is available before 1950^(refs. 5-13). No or very few publications are recorded from 1951 to 1980^(refs. 14-16). Eight publications are available during 1981-1990^(refs. 17-24) and a single publication is available during the year 1991- 2010^(ref. 25). In India, the research related to the hermit crabs have

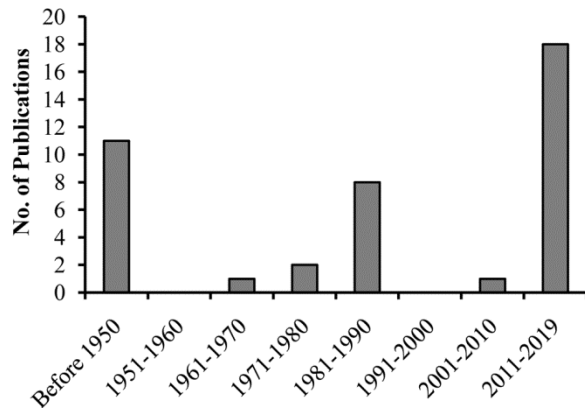


Fig. 1 — Year wise studies undertaken on the distribution of hermit crabs along Indian coast

accelerated after the year 2010 and a reasonable number (18) of the research articles have been published during the years 2011-2019^(refs. 1,3,26-41).

However, very few studies are available addressing the distribution of hermit crabs along the coastal states of India including Gujarat^{3,28,34-36,39,40}, Maharashtra^{1,38}, Karnataka²⁷, Kerala^{25,29-32}, Tamil Nadu^{17-21,33}, Andhra Pradesh^{16,24}, Odisha^{6,10}, West Bengal⁴¹, Andaman and Nicobar Islands¹⁵ and Lakshadweep⁸. According to a checklist of earlier study, hermit crabs of Indian coast include 112 species belonging to 26 genera and five families³⁷. The available distributional record of hermit crabs of Odisha is only confined to Chilika Lake^{6,10} and the scenario of other parts of the state is still unknown. The present article focuses on the biodiversity of hermit crabs along the Odisha coast and the same is compared with other coastal states with an aim to update the checklist of hermit crabs reported from Indian coast.

Materials and Methods

Field surveys were conducted in four representative sites along Odisha coast designated as site 1 at Gopalpur (19°15'43" N, 84°54'48" E), site 2 at Paradeep (20°16'48" N, 86°43'08" E), site 3 at Dhamara (20°57'06" N, 86°55'56" E) and site 4 at Chandipur (21°26'04" N, 87°02'05" E) during July-December, 2018. Field surveys were also conducted in the Chilika Lake however, no specimen of hermit crab was found during the study. Each site was surveyed by using 100 m line transects laid parallel to the coast. For each transect, live hermit crabs along with the gastropod shells were handpicked during the low tide from 3 to 4 quadrates (1 m X 1 m), preserved in 4 % formalin and were transported to the laboratory

for further analysis. The hermit crabs were pulled out from their shell after incubating in refrigerator for few minutes and were identified to the species level using standard identification manuals⁴². Various biodiversity indices such as species diversity (H'), species richness ($H'max$) and species evenness (J') were calculated for each site⁴³.

Information was extracted from the published literature and scientific names of hermit crabs were validated with World Register of Marine Species (WoRMS) database for preparing the checklist of hermit crabs of Indian coastal states. The inland species were eliminated to prepare an updated checklist.

Results

A total of seven species of hermit crabs (Fig. 2) belonging to two families (Diogenidae and Coenobitidae) were recorded from Odisha coast during the field surveys. Among the seven species, *Clibanarius longitarsus* (De Haan 1849) and *Clibanarius padavensis* de Man, 1888 are found as most commonly distributed species as they were observed in three out of the four sites surveyed. Species such as *Dardanus* sp. Paulson, 1875, *Diogenes alias* McLaughlin and Holthuis 2001 and *Diogenes miles* (Fabricius 1787) were reported only from Paradeep and *Coenobita cavipes* Stimpson, 1858 and *Clibanarius infraspinus* (Hilgendorf 1869) were recorded only from Gopalpur. The present study reports the occurrence of *Clibanarius infraspinus* for the first time from the Odisha coast.

The abundance of hermit crabs in different study stations is presented in Figure 3. The abundance was high in Gopalpur (131 individuals.transect⁻¹) followed by Chandipur (76 individuals.transect⁻¹), Dhamara (48 individuals.transect⁻¹) and Paradeep (37 individuals.transect⁻¹). Higher abundance of hermit crabs in Gopalpur is mainly attributed to the high numbers of *C. longitarsus* alone (121 individuals.transect⁻¹).

The Shannon-Wiener index shows that species diversity (H') is low in average for all the sites and was least in Gopalpur ($H' = 0.33$) and high in Paradeep ($H' = 0.85$; Table 1). Maximum species richness ($H'max = 1.38$) was observed in Gopalpur. Species evenness (J') was maximum in Chandipur ($J' = 0.98$) followed by Dhamara ($J' = 0.94$).

From the literatures and field surveys, it was found that 116 species of hermit crabs belonging to six families are residing in Indian coast. After referring

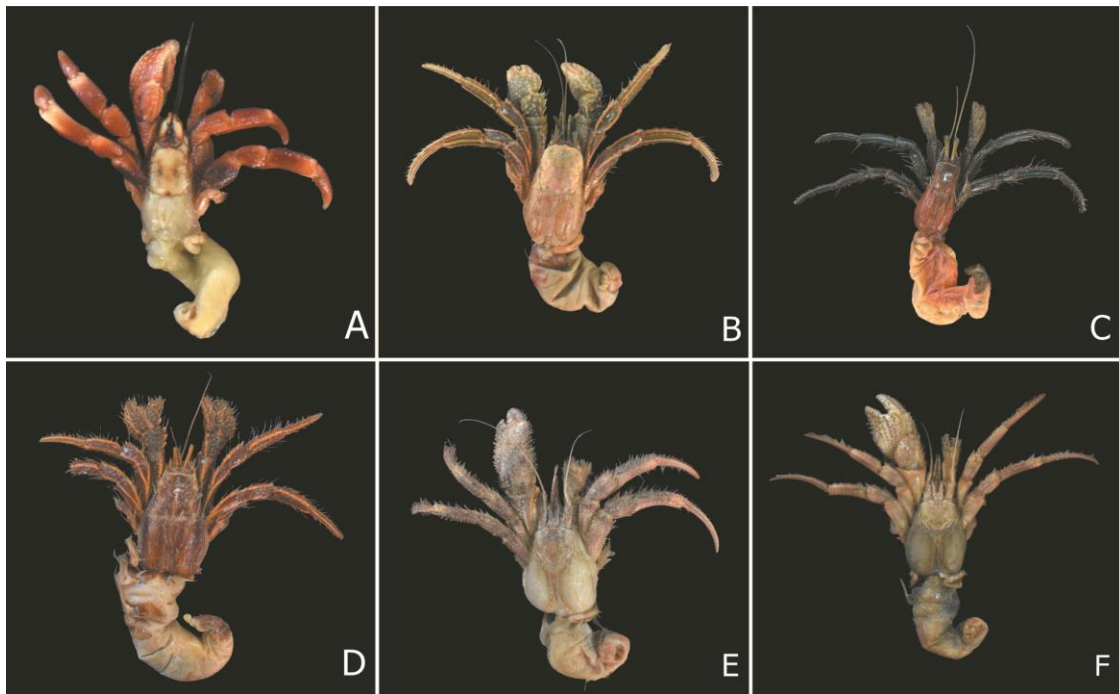


Fig. 2 — Images of the hermit crabs found along Odisha coast: (A) *Coenobita cavipes*, (B) *Clibanarius infraspinus*, (C) *Clibanarius longitarsus*, (D) *Clibanarius padavensis*, (E) *Diogenes alias*, and (F) *Diogenes miles*

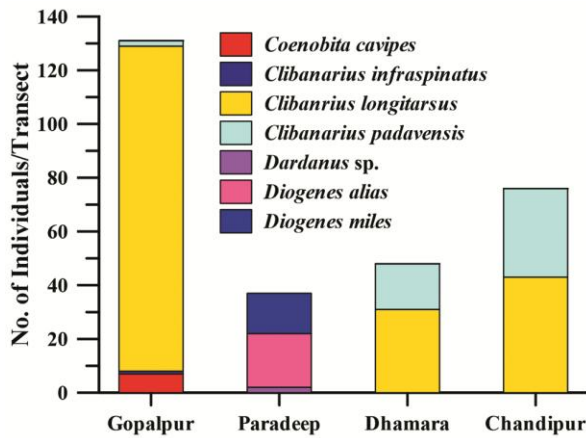


Fig. 3 — Abundance of hermit crabs in different stations

Table 1 — Species diversity (H'), species richness (H' max) and species evenness (J') of each study site

Study Sites	Species Diversity (H')	Species Richness (H' max)	Species evenness (J')
Gopalpur	0.33	1.38	0.24
Paradeep	0.85	1.09	0.48
Dhamara	0.64	0.69	0.94
Chandipur	0.68	0.69	0.98

with World Register of Marine Species (WoRMS), it was observed that two species (*Coenobita clypeatus* and *C. compressus*) are inland hermit crabs and hence

eliminated from the checklist resulting in reduction of the total number to 114 species belonging to 27 genera and six families (Table S1). However, after referring to the GBIF database (<https://www.gbif.org>) for the distributional records, it was noticed that only 61 species are available in India; whereas, the distribution data is not available for 11 species and distribution of 42 species is unlikely to the Indian waters.

In India, diversity of hermit crabs is high in west coast (73 species) as compared to the east coast (65 species) and Island ecosystems (49 species). Data collected from literature suggests that the diversity of hermit crabs is high in Tamil Nadu (53 species), Kerala (50 species) and Andaman & Nicobar Islands (46 species). Diversity of hermit crabs is recorded as 35, 23, 22, 21 and 20 species for Andhra Pradesh, Karnataka, Odisha, Gujarat and West Bengal, respectively. The present study reports the occurrence of *Clibanarius infraspinus* for the first time from Odisha thus changing the total number to 23 species. The diversity of hermit crabs is low for the Lakshadweep (13 species), Maharashtra (12 species), Goa (9 species) and Pondicherry (3 species). In terms of the number of species, Diogenidae (82) and Paguridae (19) were identified as dominant families. *Diogenes custos* (10 states), *Clibanarius infraspinus* (09 states), *Clibanarius padavensis* (09 states),

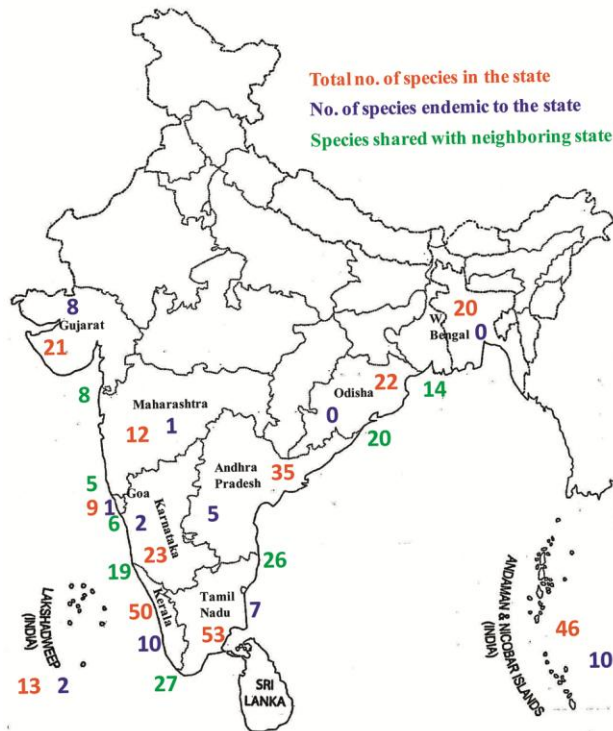


Fig. 4 — Species abundance of hermit crabs in different coastal states of India

Diogenes alias (09 states) and *Diogenes avarus* (09 states) were observed as most commonly distributed species.

A distributional map of hermit crabs along the Indian coast (Fig. 4) shows that among the total 114 species, 10 are exclusively found in Kerala and Andaman and Nicobar Islands each, followed by Gujarat (8 species), Tamil Nadu (7 species), Andhra Pradesh (5 species), Lakshadweep (2 species) and 1 species each in Maharashtra and Goa. Maximum sharing of species between neighboring states was observed between Kerala and Tamil Nadu (27 species) and minimum sharing was observed between Goa and Maharashtra (5 species).

Discussion

In an earlier report, 112 species of hermit crabs were described from Indian waters with maximum dominance of family Diogenidae (79 species)³⁷. The present study updated the total number of hermit crabs in India to 114 species. As reported earlier, family Diogenidae holds the credit of representing maximum species (82 species). States with low (Lakshadweep, Maharashtra, Goa and Pondicherry) species diversity can be due to the lack of proper scientific surveys. Earlier study also described that the

east coast (81 species) of India is much diverse than the west coast (73 species)³⁷. However, the finding of the present study shows that their diversity is slightly higher in the west coast (73 species) as compared to the east coast (65 species). The variation in the data is probably due to the reason that, in the earlier study³⁷, offshore islands *i.e.* Lakshadweep and A & N Islands might have considered under west coast and east coast, respectively which are in the present study excluded from the mainland coast and kept separately as offshore islands.

Among the reported 114 species, only 61 species are included in GBIF with Indian distribution where as for the rest, either occurrence data is not available or the species are not likely distributed along the Indian coast. The findings of the present study support the occurrence of 61 species (included in GBIF) in the Indian coast. The study suggests that necessary actions shall be taken to add the rest of the species in GBIF after proper verification.

Clibanarius longitarsus and *Clibanarius padavensis* were observed as most widely distributed species in Odisha and *Diogenes custos* as the most widely distributed species of India. The present study reports the occurrence of *Clibanarius infraspinus* for the first time from Odisha thus extending its distributional range. In Odisha, the distribution of hermit crabs was noticed as region specific as *Dardanus sp.*, *Diogenes alias* and *Diogenes miles* are reported only from Paradeep whereas, *Coenobita cavipes* and *Clibanarius infraspinus* were recorded only from Gopalpur. The diversity of hermit crabs from Odisha was studied from Chilika lagoon nearly 100 years back and 22 species were reported^{6,10}. No study had been undertaken in the later years to explore the hermit crab diversity of Odisha. No hermit crabs were found inside the Chilika lagoon during the field surveys hence it is assumed that the species reported in the earlier studies^{6,10} might have been collected from the mouth region of the lake. In Odisha, the maximum diversity of hermit crabs can be evidenced from Paradeep ($H' = 0.85$); however, Gopalpur accounts for higher number of species ($H'_{max} = 1.38$). Seven species of hermit crabs were recorded during the field survey of the study area. Referring with the literature, it is concluded that in total 23 species of hermit crabs inhabit the coastal waters of Odisha.

The increasing unavoidable stress on the coastal environment due to human interference has affected adversely the coastal biodiversity in many

dimensions. Despite their significant contribution to the intertidal ecosystem, hermit crabs are one of the under explored taxa of the animal kingdom. Detailed time series study is required to update the coastal biodiversity database by generating baseline data which in turn will provide inputs in the development of proper management plans.

Supplementary Data

Supplementary data associated with this article is available in the electronic form at [http://nopr.niscair.res.in/jinfo/ijms/IJMS_50\(05\)385-390_SupplData.pdf](http://nopr.niscair.res.in/jinfo/ijms/IJMS_50(05)385-390_SupplData.pdf)

Acknowledgements

The authors express their sincere thanks to the Vice Chancellor, Berhampur University for providing basic facilities required for the study. Authors are also thankful to Dr. Anil Mohapatra, Scientist- D, Zoological Survey of India, EBRC, Gopalpur for his support. Authors are thankful to Dr. Sanjib K Baliarsingh, INCOIS, Hyderabad for his help in preparing graph.

Conflict of Interest

The authors declare no conflict of interest directly or indirectly with respect the study reported in this communication.

Author Contributions

The authors AB, SKP and SR were involved in data collection, field visit, sample collection, identification and manuscript preparation. SP and SM were involved in identification, critical analysis and manuscript preparation.

References

- Nirmal T, *A taxonomic study of hermit crabs along selected districts of Maharashtra coast*, M.F.Sc. thesis, Central Institute of Fisheries Education, ICAR, Mumbai, India, 2015.
- Bundhitwongrut T, Thirakhupt K & Pradatsudarasar A, Population ecology of the land hermit crab *Coenobita rugosus* (Anomura, Coenobitidae) at Cape Panwa, Phuket island, Andaman coast of Thailand, *Nat Hist Bull Siam Soc*, 60 (2014) 31-51.
- Raval J V, Kachhiya P, Poriya P & Kundu R, Population ecology of intertidal hermit crab *Diogenes avarus* (Decapoda: Anomura) from a muddy coast of western India, *J Ecol Environ Sci*, 6 (1) (2015) 143-146.
- Martin J W & Davis G E, An updated classification of the recent Crustacea, Los Angeles: Natural History Museum of Los Angeles County, 2001, p. 129.
- Heller C, Crustacean, In: *Reise der österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Befehlen des Commodore B. von Wüllerstorff-Urbair*. Zoologischer Theil. Zweiter Band. III. Abteilung. Wien: Kaiserliche Akademie der Wissenschaften, 1865, p. 280 [in German].
- Henderson J R, Hermit-crabs from the Chilka Lake, *Rec Ind Mus*, 11 (1915) 25-29.
- Henderson J R, A contribution to Indian carcinology, *Trans Linn Soc, Lon*, 5 (1893) 325-458.
- Alcock A, Anomura. Fasc. I. Pagurides. Catalogue of the Indian Decapod Crustacea, In: *The Collection of the Indian Museum 2*, (Calcutta: Indian Museum), 1905, p. 197.
- Southwell T, Report on the Anomura collected by Mr. James Hornell at Okhamandal in Kattiawar in 1905-06, In: *Marine Zoology of West Coast*, edited by H James, (New Delhi: International Books & Periodicals Supply Service), 1909, pp. 105-123.
- Kemp S, Crustacea: Decapoda fauna of Chilka, Lake, *Mem Indian Museum*, 5 (1915) 199-325.
- Sundara Raj B, Order Decapoda. Suborder Anomura (Anomala), In: *The littoral fauna of Krusadai Island in the Gulf of Mannar with appendices on the vertebrates and plants*, (Bulletin of the Madras Government Museum, n.s. Natural History Section), 1 (1927) 129-134.
- Reddy A R, Notes on a collection of Paguridea from Porto Novo, *Curr Sci*, 3 (1935) 561-562.
- Kamalaveni S, On hermit-crabs (Family Paguridae), In: *The collection of the Indian Museum*, (Records of Indian Museum), 47 (1950) 77-85.
- Sankolli K N, On a new species of hermit crab *Paguruskulkarnii* sp. nov. (Anomura: Paguridae), *Zool Soc India*, 13 (1962) 136-142.
- Reddy K N & Ramakrishna G, On the Paguridae crabs (Crustacea-Decapoda) from Andaman and Nicobar islands, *Rec Zool Surv India*, 66 (1972) 19-30.
- Sarojini R & Nagabhushanam R, Pagurid crabs (Decapoda, Anomura) from Waltair Coast, *Rec Zool Surv India*, 66 (1972) 249-272.
- Khan S A & Natarajan R, Effect of salinity on the larval development of the estuarine hermit crab *Clibanarius longitarsus* (De Haan), *Indian J Geo-Mar Sci*, 10 (1981a) 132-135.
- Khan S A & Natarajan R, Coexistence in hermit crabs of Vellar estuary, *Indian J Geo-Mar Sci*, 10 (1981b) 201-204.
- Khan S A & Natarajan R, Distribution of hermit crabs in Vellar estuary, *Indian J Geo-Mar Sci*, 10 (1981c) 353-356.
- Khan S A & Natarajan R, Hermit crabs of Proto Novo Coast, *Rec Zool Surv India*, Occasional Paper, 67 (1984) 1-25.
- Varadarajan S & Subramoniam T, Reproduction of the continuously breeding tropical hermit crab *Clibanarius clibanarius*, *Mar Ecol Prog Ser*, 8 (1982) 197-201.
- Nayak V N & Neelakantan B, *Diogenes macLaughlinae* (Crustacea: Decapoda: Anomura) a new species of hermit crab from Karwar area with a description of first zoeal stage, *Indian Zool*, 9 (1985) 15-21.
- Nayak V N & Neelakantan B, A new species of hermit crab, *Diogenes karwarensis* (Decapoda: Anomura) from the west coast of India, *J of Bombay Nat Hist Soc*, 86 (1989) 71-77.
- Thomas M M, On a collection of hermit crabs from the Indian waters, *J Mar Biol Assoc India*, 31 (1989) 59-79.
- Reshmi R & Bijukumar A, First report of the hermit crabs *Coenobita brevimaus* and *Coenobita rugosus* (Crustacea:

- Decapoda: Anomura) from the Indian coast, *Mar Biodivers Rec*, 3 (2010) 1-4.
- 26 Reshmi R & Bijukumar A, New records of hermit crabs, *Calcinus morgani* Rahayu & Forest, 1999 and *Diogenes klaasi* Rahayu & Forest, 1995 (Crustacea: Anomura: Diogenidae) from India, *J Threat Taxa*, 3 (2011) 1771-1774.
- 27 Dineshababu A P, Durgekar R N & Zacharia P U, Estuarine and marine decapods of Karnataka inventory, *Fish Chimes*, 30 (2011) 20-24.
- 28 Vaghela A & Kundu R, Spatio-temporal variation of hermit crab (Crustacea: Decapoda) inhabiting rocky shore along Saurashtra coast, Western coast of India, *Indian J Geo-Mar Sci*, 41 (2012) 146-151.
- 29 Komai T, Reshmi R & Bijukumar A, A new species of the hermit crab genus *Ciliopagurus* Forest (Crustacea: Decapoda: Anomura: Diogenidae) from southern India, *Zootaxa*, 3266 (2012) 53-61.
- 30 Komai T, Reshmi R & Bijukumar A, A new species of the hermit crab genus *Diogenes* (Crustacea: Decapoda: Anomura: Diogenidae) from southern India, *Zootaxa*, 3613 (2013a) 380-390.
- 31 Komai T, Reshmi R & Bijukumar A, Rediscovery and range extension of *Ciliopagurus liui* Forest, 1995 & description of a new species of *Pagurus fabricius*, 1775 (Crustacea: Decapoda: Anomura: Paguroidea) from the Kerala State, south-western India, *Zootaxa*, 3710 (2013b) 467-484.
- 32 Ravinesh R & Bijukumar A, Comparison of intertidal biodiversity associated with natural rocky shore and sea wall: A case study from the Kerala coast, India, *Indian J Geo-Mar Sci*, 42 (2013) 223-225.
- 33 Vardharajan D & Soundarapandian P, Crab biodiversity from Arukkattuthurai to Pasipattinam, south east coast of India, *Indian J Geo-Mar Sci*, 43 (2014) 676-698.
- 34 Trivedi J N, Soni G M & Trivedi D J, On new records of hermit crabs (Anomura: Paguroidea: Diogenidae) from Gujarat state of India, *Electr J Env Sci*, 8 (2015) 33-42.
- 35 Trivedi J N, Osawa M & Vachhrajani K D, A new species of the genus *Diogenes dana*, 1851 (Crustacea: Decapoda: Anomura: Diogenidae) from Gujarat, north western India, *Zootaxa*, 4208 (2016) 189-197.
- 36 Trivedi J N & Vachhrajani K D, On new record of *Pagurus Kulkarni* Sankolli, 1962 (Crustacea: Anomura: Paguridae) from Gujarat, India, *Int J Fish Aqua Stud*, 4 (2016) 183-185.
- 37 Trivedi J N & Vachhrajani K D, An annotated checklist of hermit crabs (Crustacea, Decapoda, Anomura) of Indian waters with three new records, *J Asia Pac Biodivers*, 10 (2017) 175-182.
- 38 Nirmal T, Jaiswar A K, Chakraborty S K, Pavan Kumar A, Kantharajan G, *et al.*, New Records of Hermit Crab (Crustacea: Decapoda: Anomura) From Maharashtra Coast of India, *Int J Curr Microbio Appl Sci*, 6 (2017) 2871-2878.
- 39 Gosavi S, Trivedi J N, Trivedi D J & Vachhrajani K D, New records of anomurans (Crustacea: Decapoda) from Gujarat, India, *J Entomo Zool Stud*, 5 (2017) 658-662.
- 40 Kachhiya P, Raval J, Poriya P & Kundu R, 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, *J Threat Taxa*, 9 (2017) 10334-10339.
- 41 Sardar S, Ghosh D, Ghosh P K, Koustav B & Pal K, First report on the use of gastropod shells by hermit crabs from the eastern coast, India, *Pharma Innovation*, 8 (2019) 22-30.
- 42 McLaughlin P A, Illustrated keys to families and genera of the superfamily *Paguroidea* (Crustacea: Decapoda: Anomura), with diagnoses of genera of *Paguridae*, *Mem Mus Vic*, 60 (2003) 111-144.
- 43 Pielou E C, *The Interpretation of Ecological Data*, 1st edn, (John Wiley and Sons, New York), 2008, pp. 288.