Journal of Ecology and Environmental Sciences
ISSN: 0976-9900 & E-ISSN: 0976-9919, Volume 6, Issue 1, 2015, pp.-143-146.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000261

POPULATION ECOLOGY OF INTERTIDAL HERMIT CRAB *Diogenes avarus* (DECAPODA: ANOMURA) FROM A MUDDY COAST OF WESTERN INDIA

RAVAL J.V.[1,2], KACHHIYA P.[1], PORIYA P.[1] AND KUNDU R.[1]*

[1]Department of Biosciences, UGC Centre of Advanced Study in Arid Zone Biology, Saurashtra University, Rajkot - 360 005, Gujarat, India.
[2]Department of Biology, Christ College, Rajkot - 360 005, Gujarat, India.
*Corresponding Author: Email- rskundu@sauuni.ernet.in

Received: May 09, 2015; Revised: June 09, 2015; Accepted: June 11, 2015

Abstract- The present communication is focused on the population dynamics of intertidal hermit crab *Diogenes avarus* (Heller, 1865) from a muddy coast off Arabian Sea (Western India). The intertidal coast was divided into two micro sampling sites based on anthropogenic pressure. Site-A was devoid of anthropogenic pressure while, Site-B was anthropogenically disturbed site as a place of worship attracts huge number of people every week. Population density and abundance of three size groups S1 (3-9 mm), S2 (10-15 mm) and S3 (16-30 mm) of *D. avarus* were assessed for one year at these two micro sampling sites. Results of the present investigation revealed a healthy population of selected hermit crab species in this typical muddy shore. Results indicated that the site without anthropogenic pressure showed high population of hermit crabs. It was therefore, concluded that the observed spatial variations might be due to the human interference.

Keywords- hermit crab, anthropogenic pressure, mudflat, size group, Saurashtra coast, India

Citation: Raval J.V., et al. (2015) Population Ecology of Intertidal Hermit Crab *Diogenes avarus* (Decapoda: Anomura) from a Muddy Coast of Western India. Journal of Ecology and Environmental Sciences, ISSN: 0976-9900 & E-ISSN: 0976-9919, Volume 6, Issue 1, pp.-143-146.

Introduction

Hermit crabs are anomuran decapod crustaceans that have developed some strategies to utilize gastropod shells and other types of cavities to shelter the soft parts of their uncalcified abdomen [1,2]. Hermit crabs are common inhabitants of coastal areas particularly the intertidal and subtidal zones where they represent a significant portion of the macrobenthic assemblage [3]. Hermit crabs are represented by approximately 2002 described species worldwide [4] and have undergone a considerable revision. Despite their importance, the population biology of these organisms is still poorly known [2]. Some significant studies on population ecology of hermit crabs have been conducted on European, temperate, and South American species [5-9]. Despite their ubiquitous presence on muddy mangrove areas, ecological studies pertaining to their population dynamics and reproduction are lacking probably due to their non-commercial value [3]. However, ecologically, hermit crabs are important scavengers and deposit feeders, thus playing a significant role in marine food webs and nutrient recycling. Their larvae contribute substantially to the plankton that are fed upon by juvenile fishes of commercially important species [10], whereas, adult hermit crabs are fed upon by predatory fishes such as sciaenids [11] and ariids [12]. That is why a detailed analysis of the population dynamics and a large-scale reproduction of hermit crabs will contribute to a greater understanding of their ecological significance in tropical estuaries.

Diversity of Hermit crabs in Indian water was investigated by many researchers like, Alcock [13], Chopra & Das [14], Kamalaveni [15], Nayak & Neelakantan [16,17], Desai & Mansuri [18], Thomas [19], Siddiqui et al [20], Rahayu [21], Ramesh et al. [22], Reshmi & Bijukumar [23,24] and Komai et al [25,26] but the population ecology aspect is less frequently studied. Gujarat provides a diverse range of habitats [27]. However, Vaghela & Kundu [28] studied population of *Clibanarious zebra* and *C. nathi* in rocky shore of West Coast of India. For the present study we have analyzed the population ecology of *D. avarus* from a muddy intertidal shore of West Coast of India. The study included the population of selected hermit crab in different size groups to know the variations in juvenile, subadult and adult population instead of the traditional aspects that considers the whole population for study at a given point of time. It was presumed that studies on different size groups of hermit crab will give a clear scenario about spatio-temporal variations in their population and how the juveniles and the adult are affected by anthropogenic pressure.

Materials and Method

The study was conducted in the intertidal muddy coast of Koliyak (N 21˚ 35' 51.226'' E 72˚ 17' 33.259'') in the Gulf of Khambhat, West Coast of India [Fig-1]. The coast under investigation usually attracts a huge pilgrim rush because of its religious and cultural values. Initial Surveys were made to understand the coastal characteristics and to select the workable site. The whole intertidal coast is divided into two micro sites according to the presence of anthropogenic pressure. Site-A had not any anthropogenic pressure while Site-B was anthropogenically disturbed site. The anthropogenic pressure in the present paper is the pressure caused by human activities.

Every year around the month of September more than 2 lac people visit the place in just two days. The historical account has it that the Pandavas had established a temple named Nishkalank Mahadev. There is a regular disturbance by the pilgrims every day and it increases at weekends and public holidays. Visitors disturb the intertidal fauna and collect the shells which are crucial resources for the hermit crabs. The Site-B is a pedestrian's path to reach the temple. The substratum got hardened because of constant walk through on the mudflat at Site-B. The distance between Site-A and Site-B is one kilometer. Samples were taken monthly from January to December 2013 at lowest tide period. The collected data were represented seasonally by taking mean value of all the respected months of the particular season. The weather condition of this part of the peninsular India typically represents the periods of winter (December to February), summer (March to May), monsoon (June to August) and post-monsoon (September to November). Belt transect method was followed for the data collection using 50 x 50 cm quadrats. Fifty quadrates were laid at each site at every visit. Quadrats were thrown from high tide mark to low tide mark every time. The three size groups S1 (3-9 mm), S2 (10-15 mm) and S3 (16-30mm) of *D. avarus* were made based on the total body length of the hermit crab. Size group 1 is juveniles, Size group 2 is sub-adults and size group 3 is adults. The obtained data were subjected to different statistical analyses for their cumulative acceptability. Significance of temporal and spatial variations was compared by using single factor ANOVA. Statistical analysis was done as per Sokal & Rohlf [29].

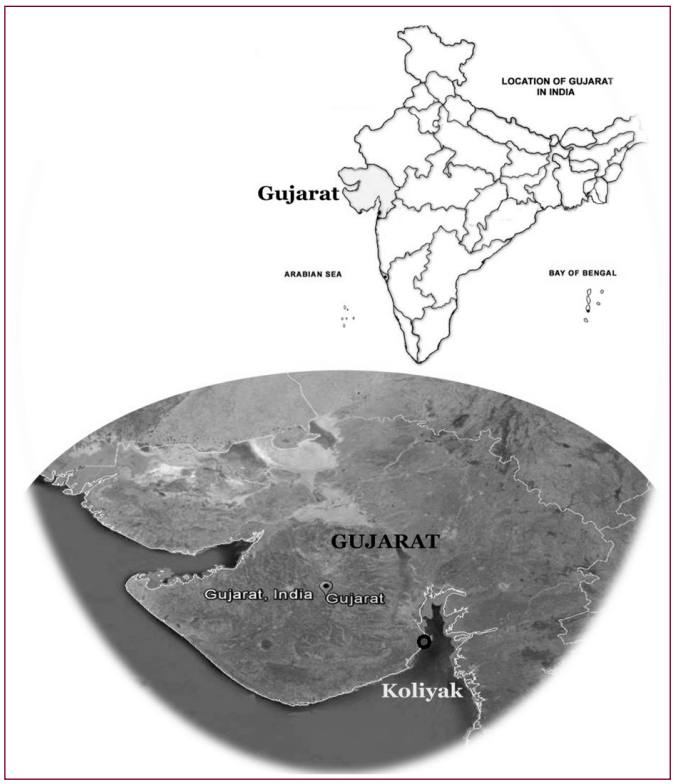

Fig. 1- Study site at Koliyak off Arabian Sea, west coast of India (N 21˚ 35´ 51.226´´ E 72˚ 17´33.259).

Results

Population density and abundance of various size groups of *D. avarus* was assessed in the present study. The results indicated that population density of size group 1 was very low at Site-B, the anthropogenically influenced site when compared with Site-A [Fig-2]. The highest density (0.33 no./0.25 m^2) was reported in the winter at Site-A. Hermit crabs of size group 1 were found absent in the summer at Site-B and their population density was also found very less (0.03 to 0.05 no./0.25 m^2) during rest of the seasons at this site [Fig-2]. Similar result was observed in case of abundance values of this size group [Fig-3]. Abundance was high (2.67 no./0.25 m^2) at Site-A and lowest (0.44 no./0.25 m^2) at Site-B in the winter [Fig-3]. However, significant spatial variation was observed in abundance value of this size group [Table-1].

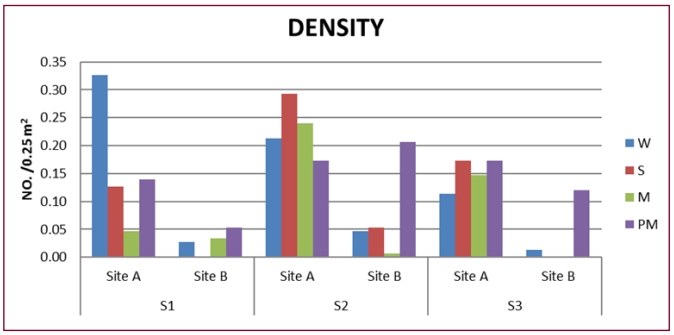

Fig. 2- Seasonal variation in population density of *D. avarus* at Site-A and Site-B. (S1: Size group 1, 3-9 mm, S2: Size group 2, 10-15 mm and S3: Size group 3, 16-30 mm).

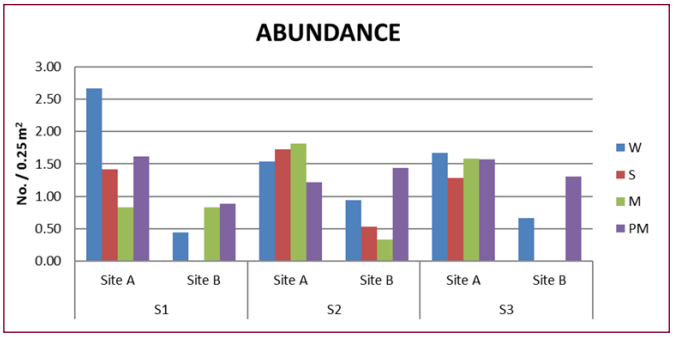

Fig. 3- Seasonal variation in population abundance of *D. avarus* at Site-A and Site-B. (S1: Size group 1, 3-9 mm, S2: Size group 2, 10-15 mm and S3: Size group 3, 16-30 mm).

Population density of size group 2 was found almost similar at Site-A with highest value (0.29 no./0.25 m^2) and lowest value (0.17 no./0.25 m^2). Density was found very low at Site-B as compared to Site-A [Fig-2]. At Site-B, the highest density was found 0.21 no/0.25 m^2. Population density of size group 2 was found almost high throughout the year for both the sites [Fig-2]. Similar results were observed in case of population abundance. The highest abundance value was reported during summer and monsoon at Site-A [Fig-3], in contrast with the abundance of size group 1 where the high abundance was found in winter season. The significant spatial variation was observed in density and abundance of size group 2 [Table-1].

The population density of size group 3 was found at its lowest in comparison with the size groups 1 and 2 at both the sites [Fig-2]. The density of size group 3 was found almost consistent throughout the year at Site-A with the highest value (0.17 no. /0.25 m^2) and lowest value was recorded (0.11 no./0.25 m^2). Abundance of this size group was found almost similar throughout the year for Site-A [Fig-3]. Population of this size group was absent during summer and monsoon at Site-B. Significant spatial difference was found in density and abundance of this size group [Table-1].

The results of one way single factor ANOVA indicated significant spatial variations in all the size groups, however non-significant variation was also observed in case of temporal values of density and abundance [Table-1].

Table 1- Results of the one way ANOVA for the spatial and temporal variations in the density and abundance values of the different size group of studied hermit crab

	Spatial (f-critical 5.9874)		Temporal (f-critical 6.5914)	
	Density	Abundance	Density	Abundance
S1 (3-9 mm)	4.7726	6.3114*	0.5016	0.3231
S2 (10-15 mm)	8.9524*	7.3878*	0.1206	0.0525
S3 (16-30 mm)	13.3714*	10.0786*	0.3467	0.4017

∗ denotes significance at $p < 5\%$.

Discussion

In the present study, the micro sampling site without anthropogenic pressure shows high population of hermit crabs indicate as to the observed spatial variations between two micro sampling sites might be due to anthropogenic pressure. Coastal shallow seas face the greatest anthropogenic threats due to the impacts of accelerated human activities [30]. Similarly, Litulo [2] reported bi and polymodality of the size frequency distribution of *Clibanarius longitarsus* in southern Mozambique and he suggested that such distribution provides evidence of differences in recruitment patterns, mortality rates and behaviour among the hermit crabs. Variations in local abiotic factors may affect the structure and function of the benthic communities [31].

At the non-anthropogenic micro sampling site, less seasonal fluctuations were observed in the density and abundance values for size group - 3 which was having 16-30 mm total body length. As the animals of this size group grew to a larger size, it was comparatively less vulnerable and possibly would endure seasonal alterations to some extent. At the same time, shells of their choice were more frequently available compared to the other two smaller size groups. The natural occurrence of hermit crabs in specific gastropod shells can be explained by two factors - first is preference for these shells and secondly their relative abundance in the relevant size range with regard to crab abundance in different habitats [32].

Populations of Size group 2 hermit crabs remain constant which are sub adults and maintain population of the next size group 3. This may be a reason for fluctuations in the population of size group 1 and 2. Population of size group 1 found highly fluctuated when compared to the other two size groups. It may be because of vulnerability of these hermit crabs as they are juveniles. Limited availability of small sized gastropod shells may be a reason for this.

Population of size group 2 and 3 was found almost constant throughout the year. However, population of size group 2 was always high if compared to size group 3. Studied coast has good population of *Cerithium* sp. *Trochous* sp. and *Caliostroma* sp. [33-35]. Availability of these shells provides easy shell resource to size group 2. However, the size group 3 requires larger gastropod shells. Population of size group 3 at Site-B was found very low. Anthropogenic disturbance, large size shell collection by visitors and less population of big size gastropod [36,37] could be the reason for that. According to Mantellato et al [38], the unimodal pattern of size distribution is common in tropical and subtropical hermit crabs; they suggested that such pattern is usually attributed to a stable population with continuous recruitment and constant mortality rate.

Size group 1 was reported almost throughout the year in studied coastline that indicates year round reproduction of this hermit crab species. Year round reproductive season has also been reported for hermit crabs on the eastern Pacific and Atlantic coasts such as *Clibanarius zebra, Calcinus laevimanus* and *Calcinus latens* [39]. According to Turra & Leite [5], seasonal reproduction in temperate and tropical hermit crabs is an important life cycle strategy resulting from their evolutionary history as modulated by the dynamics of local processes. Throughout year reproduction in hermit crabs of the western Indo-Pacific region has been also reported for other tropical hermit crabs [3] while *Dardanus deformis* reported to reproduces throughout the year in Southern Mozambique, Indian Ocean [40].

At anthropogenically affected Site-B, the population of the size group 3 was less or similar to the size groups 1 and 2. The gastropods shells are the limiting factor for hermit crab population. Shell availability has been demonstrated to be an important limiting factor in hermit crab populations [41]. The abundance of shells seems to be the major factor influencing shell utilization [42]. As the effects of frequent pedestrians walking through, the hardening of the muddy substratum was observed at the pedestrian's path Site-B. The adult or size group 3 hermit crab may not prefer this habitat. The number of natural pools and puddles at anthropogenically disturbed site was very less when compared to the Site-A. Abundance of these micro habitats may also be a reason for less population density at the Site -B.

A total of 409 hermit crabs were encountered from both the sites. Among them 325 were from Site-A and 84 were form Site-B. Size group 2 makes the main population (185) of the total hermit crabs reported during the period of the study [Fig-4]. The population of size group 3 was least at the Site-A in relation to the other two groups. However, at the Site-B population of size group 1 was lowest. Thus anthropogenically affected site was not suitable for the size groups 1 and 3 which are juvenile and adult.

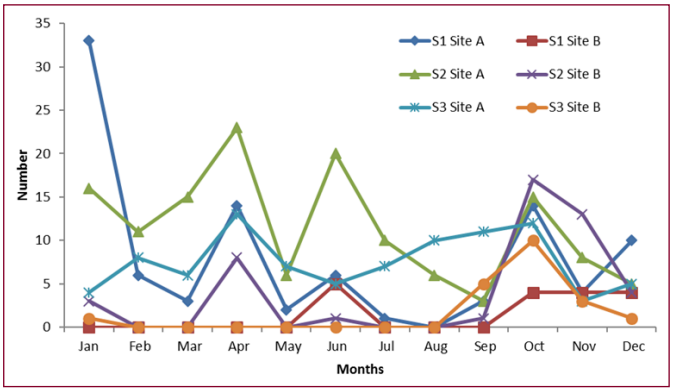

Fig. 4- Size group wise comparisons of numbers of hermit crabs for twelve months at Site-A and B.

Acknowledgements: The authors are thankful to the UGC, Government of India, for support through its CAS Programme. One of the authors (PP) is thankful to UGC, Government of India, for BSR Fellowship. Various related Government Agencies and non-Government organizations are also acknowledged for extending their support and active help during the study.

Conflicts of Interest: None declared.

References

[1] Litulo C. (2004) *Invertebrate Reproduction and Development,* 46, 41-46.

[2] Litulo C. (2005) *Journal of the Marine Biological Association of the United Kingdom*, 85, 121-125.

[3] Teoh V.C. & Chong H.W. (2014) *Hydrobiologia,* 724, 255-265.

[4] Appeltans W., Bouchet P., Boxshall G.A., Broyer C.De, Voogd N.J.de, Gordon D.P., Hoeksema B.W., Horton T., Kennedy M., Mees J., Poore G.C.B., Read G., Stohr S., Walter T.C. & Costello M.J. (2012) *World Register of Marine Species*.

[5] Turra A. & Leite F.P.P. (2000) *Journal of the Marine Biological Association of the United Kingdom*, 80, 1061-1069.

[6] Garcia R.B. & Mantelatto F.L.M. (2001) *Journal of the Marine Biological Association of the United Kingdom*, 81,955-960.

[7] Branco J.O., Turra A. & Southo F.X. (2002) *Journal of the Marine Biological Association of the United Kingdom*, 82,597-563.

[8] Martinelli J.M., Mantelatto F.L.M. & Fransozo A. (2002) *Crustaceana*, 75, 791-802.

[9] Macpherson E. & Raventos N. (2004) *Journal of the Marine Biological Association of the United Kingdom*, 84,371-376.

[10]Squires H.J., Ennis G.P. & Dawe G. (2001) *NAFO Scientific Council Studies*, 34, 7-17.

[11]Yap Y.N. (1995) *The biology of sciaenid fishes in the Matang mangrove waters*, M.Sc. Thesis, Department of Zoology, University of Malaya, Kuala Lumpur, Malaysia.

[12]Singh H.R. (2003) *The biology of the estuarine ariid catfishes (family: Ariidae) of the Matang Mangrove ecosystem (Perak, Malaysia)*, Ph.D. Thesis, University of Malaya.

[13]Alcock A. (1905) *Anomura. Fasc. I. Pagurides*, Catalogue of the Indian Decapod Crustacea in the Collection of the Indian Museum, Indian Museum, Calcutta, 2, 1-197.

[14]Chopra B. & Das K.N. (1940) *Records of the Indian Museum*, 42,145-153.

[15]Kamalaveni S. (1950) *Records of the Indian Museum*, 47, 77-85.

[16]Nayak V.N. & Neelakantan B. (1985) *The Indian Zoologist*, 9 (1&2), 15-21.

[17]Nayak V.N. & Neelakantan B. (1989) *Journal of the Bombay Natural History Society*, 86(1), 71-77.

[18]Desai A.Y. & Mansuri A.P. (1989) *Indian Journal of Current Biosciences*, 8, 129-132.

[19]Thomas M.M. (1989) *Journal of Marine Biological Association of India,* 31(1&2), 59-79.

[20]Siddiqui F.A., Kazmi Q.B. & McLaughlin P.A. (2004) *Tropical Zoology,* 17, 155-200.

[21]Rahayu D.L. (2007) *Zoosystema,* 29(3), 515-534.

[22]Ramesh S., Sankar S.S. & Elangomathavan R. (2009) *Recent Research in Science and Technology,* 1(4), 161-168.

[23]Reshmi R. & Bijukumar A. (2010) *Marine Biodiversity Records (Marine Biological Association of United Kingdom),* 3(1), 1-4.

[24]Reshmi R. & Bijukumar A. (2011) *Journal of Threatened Taxa,* 3, 1771-1774.

[25]Komai T., Reshmi R. & Bijukumar A. (2012) *Zootaxa,* 3266, 53-61.

[26]Komai T., Reshmi R. & Bijukumar A. (2013) *Zootaxa,* 3613(4), 380-390.

[27]Raval J.V. (2011) *International Journal of Zoology Research,* 2 (1), 30-35.

[28]Vaghela A. & Kundu R. (2012) *Indian Journal of Geo-Marine Sciences,* 41,146-151.

[29]Sokal R.R. & Rohlf F.J. (1987) *Introduction to Biostatistics*, Dover Publ., USA, 160-184.

[30]Jenkins M. (2003) *Science,* 302, 1175-1177.

[31]Fransozo A. & Mantelatto F.L.M. (1998) *Journal of Crustacean Biology*, 18(3), 202-211.

[32]Conover M.R. (1978) *Journal of Experimental Marine Biology and Ecology,* 32, 131-142.

[33]Gohil B. & Kundu R. (2013) *Indian J. Geo-Marine Science,* 42 (4), 481-486.

[34]Raval J.V. (2014) *Population structure of hermit crabs in an anthropogenically influenced rocky-muddy shore of the Bhavnagar coastline*, 7th National Level Science Symposium, Christ College, Rajkot.

[35]Raval J.V. & Kundu R. (2015) *Shell preference of a hermit crab Clibanarius zebra (Dana, 1852) (Diogenidae, Anomura) in a rocky-muddy shore on the Bhavnagar coastline*, 8th National Level Science Symposium, Christ College, Rajkot.

[36]Bhadja P. (2010) *Marine wealth of Saurashtra Coast, Spatial and Temporal variations in the seawater Quality and its role in intertidal assemblage and macrofaunal diversity round anthropogenically influenced shores*, Ph. D. thesis, Saurashtra University.

[37]Bhadja P. & Kundu R. (2012) *Indian Journal of Geo-Marine Sciences*, 41(1), 90-97.

[38]Mantellato F.L., Espo´sito D.L.A., Terossi M., Biagi R. & Meireles A.L. (2007) *Atlantica Rio Grande,* 29, 107-114.

[39]Reese E.S. (1969) *American Zoology*., 9, 343-355.

[40]Litulo C. (2005) *Journal of the Marine Biological Association of the United Kingdom*, 85, 883-887.

[41]Shih H.T. & Mok H.K. (2000) *Journal of Crustacean Biology*, 20 (4), 786-795.

[42]Barnes D.K.A. (1999) *Marine Ecology Progress Series*, 183, 241-251.