International Journal of Ecology and Environmental Sciences 42(4): 287-293, 2016
ISSN: 2320-5199 (Online);   (Print)

Interaction between Two Prominent Benthic Communities in Intertidal Ecosystem of Kathiawar Peninsula

PARESH PORIYA [1] AND RAHUL KUNDU [2]*

[1] *Department of Marine Science, Maharaja Krishnakumarsinhji Bhavnagar University, Bhavnagar364002, Gujarat, India.* E-mail: pareshporiya@gmail.com
[2] *Department of Biosciences, UGC Centre of Advanced Study in Arid Zone Biology, Saurashtra University, Rajkot 360005, Gujarat, India* E-mail: rskundu@sauuni.ernet.in
* Corresponding author

ABSTRACT

Intertidal zone of Kathiawar peninsular coastline shows a great deal of biological diversity. However, many changes in the diversity and distribution patterns of the intertidal macrofauna were observed in the vertical zones during the past few years. Two rocky intertidal sessile communities were studied along the western coast of India by hypothesising if there is any measurable change in the existing community structure or not. The micro-spatial and temporal variations were evaluated seasonally for one year by measuring percent cover of two prominent coexisting communities of Barnacles and Zoantharians. The distribution pattern of Barnacles and Zoantharians significantly varied within the micro-spatial scale, but only moderately within larger scales as increasing distance. The variation in recruitment process of barnacles and asexual budding of Zoantharians were the most important determinant factors of spatial variability of community dynamics at study sites during the study period. We also observed the expansion and setting up of new significantly large colonies of Zoantharians which were found eradicating the existing algal and faunal communities like barnacles. The observed competition was for the requirement of space for settlement and growth of the species involved. Invasion and increasing diversity of this cnidarian species also indicates the effects of a probable climate change.

Key Words: Zoantharians; Barnacles; Competition; Invasion; Intertidal Communities; Gujarat

INTRODUCTION

Competition is the interaction among individuals utilizing a limited resources resulting in reduced fitness in the competing individuals. As a primary mechanism of interaction, competition can occur between species (interspecific competition) or among members of a species (intraspecific competition) utilizing a shared resource. Competition for space has been studied by many investigators to make long-range predictions about community structure (Dayton 1971, Lang 1973, Paine 1974, Porter 1974, Osman 1975, Jackson 1977). The rocky shores of temperate regions has been investigated as an excellent ecosystem to understand this type of community processes (e.g. Connell 1961, 1970, 1976, 1985, Paine 1966, 1974, Menge 1976, Lubchenco 1978). The nature of rocky intertidal shores considerably vary from area to area in their size, structure, geology, exposure and spatial heterogeneity at both between and within shores (Stephenson and Stephenson 1949, Lewis 1974, Raffaelli and Hawkins 1996, Coates 1998). This spatial variability can result in an array of different patches on shores and the subsequent variation in community structure, which has been of interest to ecologists, as diversity is often directly related to environmental heterogeneity (Menge and Lubchenco 1981). Competitive interactions between scleractinian corals in the tropical open reef habitats were studied well which shows various growth strategies such as overtopping or hindering the competitor (Porter 1972, Connell 1976, Richardson et al. 1979). Interspecific competition between Zoantharians and other sessile invertebrates (Suchanek and Green 1981) and that of barnacles were also well studied (Connell 1961, Taylor and Woiwod 1982, Southward 1991, Sanford et al. 1994, Menge 2000, Sanford and Menge 2001). Such ecological processes were very sparsely studied from Indian coastline. In present study, the interaction between two prominent benthic communities in intertidal ecosystems of Kathiawar peninsula was studied to understand the basic fundamental processes and nature of the intertidal ecosystem of Indian coastline. The coastline of Kathiawar peninsula of Gujarat state has been extensively studied by various researchers (Misra and Kundu 2005, Vaghela et al. 2010, Gohil and Kundu 2011, 2013a, 2013b, Gohil et al. 2011, Poriya and Kundu 2013, Bhadja and Kundu 2012, Vakani et al. 2014, Sneha Joseph et al. 2014a, Faladu et al. 2014) who have analysed species specific and anthropogenic pressures on intertidal fauna. The basic ecological insight regarding various fundamental community ecological processes were not studied yet on this coastline.

MATERIALS AND METHODS

Study Area

Gujarat covers 1600 km long coastline of India. Kathiawar Peninsula is located in south western part of Gujarat (India) and occupies about 865 km long coastline. The present study was carried out at a rocky intertidal belt of Veraval coast (20º 53' N, 70º 26' E; Figure 1).

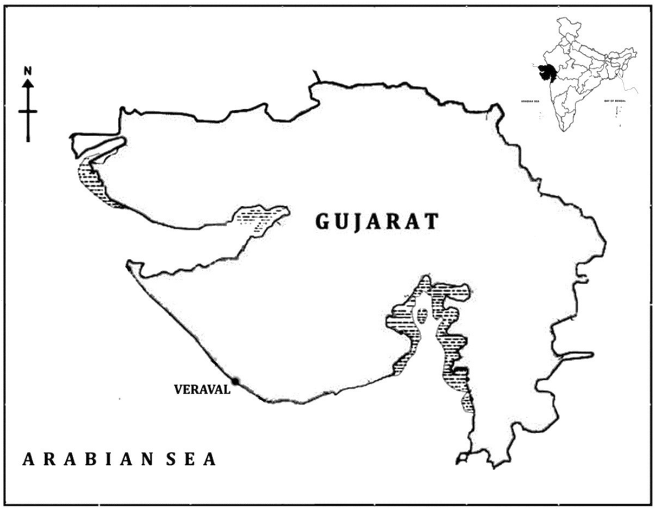

Figure 1. Location of the study area along the Kathiawar peninsular coastline off the Arabian Sea.

The tides in this area are mixed semi-diurnal, with two high tides and two low tides a day. This site was chosen on the basis of a reconnaissance survey and ecological studies carried out on the same site. The intertidal zone of Veraval coast is mainly rocky with few sandy patches interspersed with many tide pools, puddles, crevices and small channels. The natural pools differ in their shape and size. The upper zone of the intertidal belt is covered with sandy silt and studded with pieces of broken molluscan shells. This coast has a tidal exposure of about 600 to 850 m and the lower littoral zone ends up at steep vertical decline towards subtidal zone.

The sampling site was about five km long. The entire intertidal zone of this area was divided into four microsampling sites on the basis of their substratum type and their assemblages. The micro-sampling sites were coded as S-1, S-2, S-3 and S-4. Site S-1 is 700 m long and has tidal exposure of about 60 m, having bare rocky substratum with fewer sharp edges and has a gradient slope. Site S-2 is 800 m long with tidal exposure of about 55 m. This site has rocky substratum with large pools and puddles which remain mostly submerged. Site S-3 is 1200 m long with tidal exposure of about 85 m, with few small pools and puddles and many crevices. Site S-4 is 700 m long with a tidal exposure of about 55 m.

Sampling and Data Analysis

The intertidal zone was surveyed every month from June 2013 to May 2014. The monthly data were represented seasonally by taking mean value of all the months of a season which are winter (December to February), summer (March to May), monsoon (June to August) and post-monsoon (September to November). Baseline data on the diversity and distribution of barnacles and zoantharians in different intertidal zones were collected by using belt transect method. According to the length of each microsite, 5 m wide transects (15 m apart), running from high shore to low shore were sampled. The percent cover of barnacles and zoantharians was estimated in each transect by randomly placing 50 x 50 cm quadrats at almost regular interval. Quadrat frequency was determined on the basis of the total length of the sampling sites. The quadrat was divided into 25 sub-quadrats of 10 × 10 cm; the cover of each selected macrobenthos was then measured by giving a score from 0 to 4 to each sub-quadrat and adding up these values over the 25 sub-quadrats making a total of 100 % (Meese and Tomich 1992, Dethier et al. 1993). The data were subjected to different statistical analyses for their cumulative acceptability. Significance of spatial and temporal variations was compared by using one and two factor ANOVA. All statistical analyses were done as per Sokal and Rohlf (1987).

RESULTS AND DISCUSSION

The rocky substratum of Veraval coast has many pools, puddles and crevices which makes it biologically and ecologically important niche. These niches and algal cover on the littoral area offer a variety of habitats for sessile and mobile organisms like sponges, gastropods, hermit crabs, annelids, flat worms, sea anemones, zoantharians, barnacles, etc. Sampling site S-1 had numerous small to large coral colonies. Large *Porites sp.* colonies were thriving with some dominant algal population of chlorophyceae like *Ulva lactuca* at sampling site S-2. The sampling site S-3 had larger population of gastropods than other microsites. Sea anemone and other gastropods like *Cerithium sp.* were the most common macrofaunal forms of this site. The sampling site S-4 had moderate algal growth.

Distribution of Barnacles and Zoantharians

Barnacles and zoantharians were the most dominant groups amongst the sedentary benthos. Both the groups have thriving population in forms of small to large patches on hard rocks of all the assemblages. Five species of barnacles belonging to two families and four genera were reported during the study period from the sampling site. *Amphibalanus venustus* and *Megabalanus coccopoma* were sparsely distributed while *Tetraclita rufotincta, T. ehsani* and *Balanus amphitrite* were abundantly distributed throughout the coastline. Except few studies (Wagh 1969, Tsang et al. 2012), the diversity of barnacles is less documented from this coastline. Among the zoantharians, six species belonging to two families and three genera were recorded. Small to large patches of *Zoanthus sancibaricus* dominated throughout the coastline, while *Zoanthus kuroshio* and *Isaurus tuberculatus* were distributed sparsely. Small to medium size colonies of *Palythoa tuberculosa* were recorded at all microsampling sites. The phylogenetic relationships of these species from the same area have also been studied by molecular techniques (Sneha et al. 2014b).

Spatio-temporal Variation and Community Interactions

Data on the percent cover of barnacles and zoantharians analyzed for one year indicate that the pattern of spatial variations of both the groups was more or less similar except during the winter season. This may be due to some habitat similarity between sites. The pattern of the population growth of both communities was quite different except in the winter season. Settlement and growth of both populations in winter season may be feasible by low temperature (Vaghela et al. 2010, Bhadja and Kundu 2012). One-way ANOVA for the monthly percent cover of both communities showed significant variation at all the four microsampling sites which indicated the seasonal effect on population (Table1).

Table 1. One way ANOVA for the monthly cover of the two communities sampled at four different sites. (*f-critical:* 4.07) (* significant at $P < 5\%$)

	Monsoon	Post-monsoon	Winter	Summer
Barnacles	29.8*	22.5*	28.9*	8.21*
Zoantharians	24.5*	22.4*	51.5*	25.0*

Table 2. Two-factor ANOVA for spatial and temporal variations in the mean cover of the two communities sampled at four different sites. (*f-critical:* 3.86) (* significant at $P < 5\%$)

Variations	Barnacles	Zoantharians
Spatial	90.4*	28.3*
Temporal	50.5*	3.15

Two-factor ANOVA for the spatial and temporal variations in the mean cover of the two communities showed significant spatio-tmporal variation except in case of zoantharians (Table 2). Thus, results indicate significant effect of substratum structure and seasonal fluctuation. All the micro-sampling sites have different combination of substratum characteristics like pools, puddles, crevices and algal cover which affect the distribution of these communities in the intertidal zones (Faladu et al. 2014). Barnacle cover in intertidal zones decreased from monsoon to post-monsoon season at all the four sampling sites (Figure 2) while no marked variation in population cover of zoantharians was recorded in this season (Figure 3). It has been reported that distribution and population dynamics of barnacles depend on factors like supply of larvae, larval behavior, settlement, post-settlement mortality and subsequent recruitment into the adult population (Connell 1985, Jenkins et al. 2001) which in turn depend on substratum

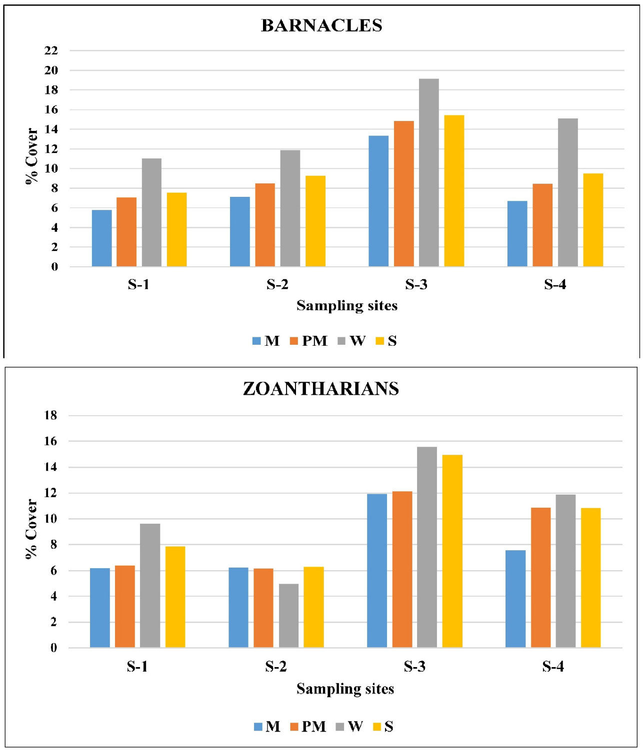

Figure 2. Seasonal variations in the percent cover of Barnacles and Zoantharians at different study sites.

structure and seasonal environment. In case of zoanth-arians, large number of gamete production during sexual reproduction, asexual budding, fission of polyps (Polak et al. 2011, Shiroma and Reimer 2010) and the sea surface temperature (Kaladharan et al. 2011) act as the main determinant factors of thriving population. The seasonal population growth pattern of zoantharians was somewhat uneven at Site-2 (Figure 2). Population growth of both the groups was high in winter season at all the sampling sites except that of zoantharians at Site-2, where population was low even in the winter season. Total percent cover of the barnacle population was high in the winter season while in case of zoantharians, population cover remains almost same with no marked variation between different seasons (Figures 3 and 4).

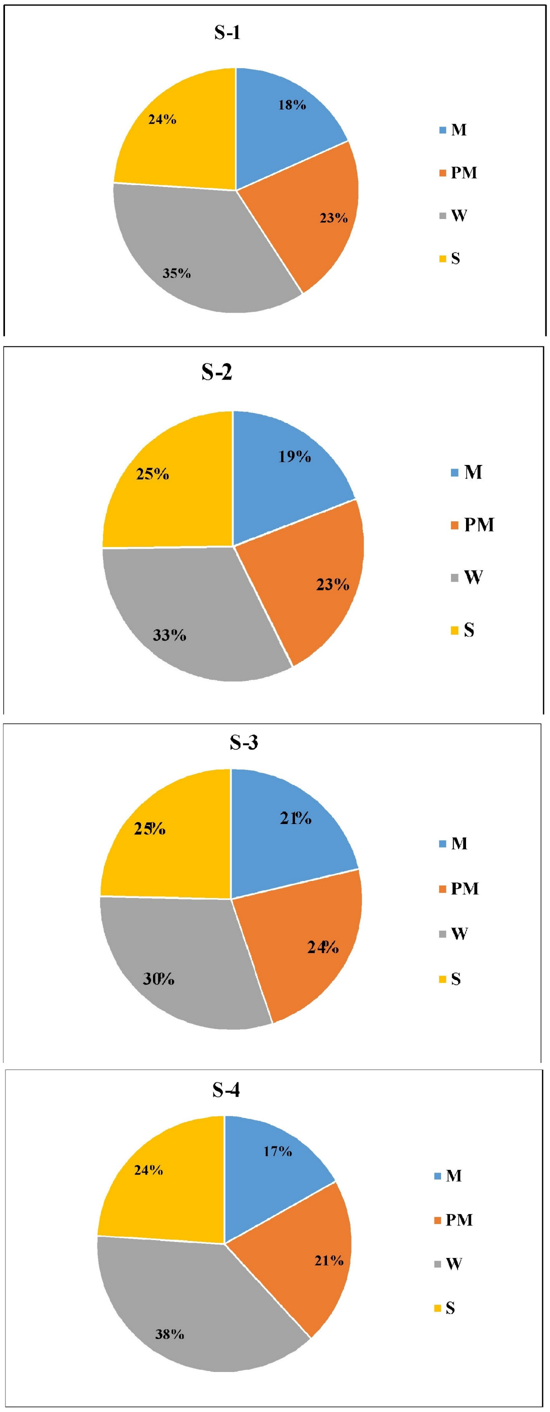

Figure 3. Total percent cover of barnacles in the intertidal zones of each microsites during different seasons

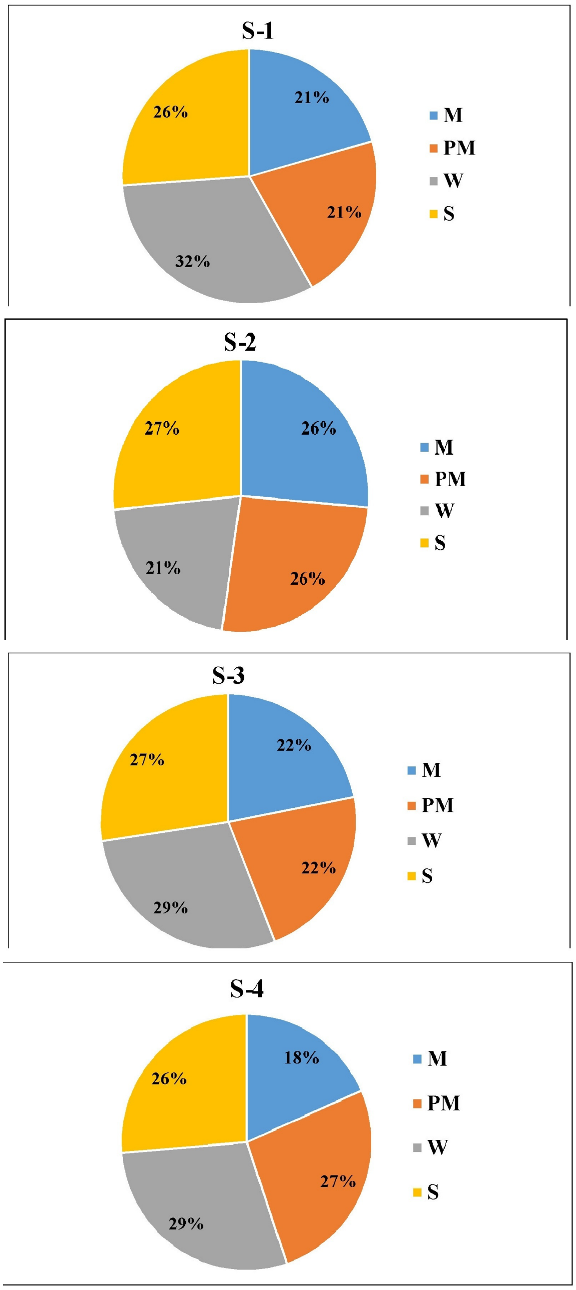

Figure 4. Total percent cover of zoantharians in intertidal zones of each microsites during different seasons.

Numerous small to large colonies of *Palythoa sp.* (about 1 to 5 m) and *Z. sansibaricus* (about 1 to 20 m) may be the possible reasons for similar stock population of zoantharians throughout the year. Their predation rate was also low due to sand encrusted body wall. Only few intertidal animals like *Hermodice sp.* were found to feed on zoantharians (Ott and Lewis 1972). But, the population of *Hermodice sp.* was reported low in this shore (Chaudhari 2014). Secondly, the presence of palytoxin (Ciereszko and Karns 1973, Mundy 2008) may act in the same fashion and may also be involved in the acquisition of space. However, space for recruitment and settlement was main factor in present study. Some direct observation also indicated rapid overgrowth of zoantharians, particularly *Z. sancibaricus,* on adult barnacles which affects the larval production and intern decreases the growth rate of population of barnacles (Harold et al. 2014). In Figure 5, the two images taken in August 2013 and October 2013 indicate tough competition of space between the two coexisting communities. Expansion and setting up of new significantly large colonies of zoantharians and few hard corals in the intertidal zone of the south Saurashtra coastline was also observed recently which found eradicating the existing algal or faunal species (Poriya and Kundu 2013).

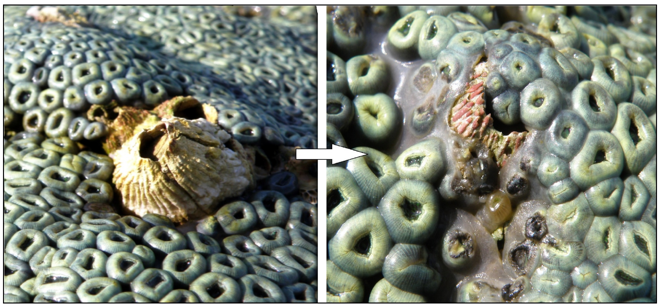

Figure 5. Successful overgrowth of *Z. sansibaricus* on an adult live barnacle.

CONCLUSIONS

Intertidal zone of the studied coastline, which was mostly occupied by barnacles, is being covered by newly developing zoantharians colonies. The settlement of barnacles larvae requires free space which was highly affected by growth of new zoantharians colonies and expansion of old colonies. Zoantharians were observed to acquire and dominate space by killing or directly hindering the growth of its competitors which was also supported by the absence of large scale predation and tough spatial competitors. However, settlement and growth of new individuals on vertical crevices was limited in case of zoantharians compared to barnacles. This study suggests that though comparable diversities of coexisting population may occur in different states of a system, the regulating processes are mostly different.

ACKNOWLEDGEMENTS

This paper was presented at the International Conference on Tropical Ecosystems in a Changing World, organized by the International Society for Tropical Ecology, during 10 -12 December 2014 at the School of Environmental Sciences, Jawaharlal Nehru University, New Delhi. We are thankful to the University Grants Commission (UGC), Government of India, for support through its Centre for Advanced Study Programme. Paresh Poriya is thankful to the UGC also for Meritorious Research Fellowship. Various related Government Agencies and non-Government organizations are acknowledged for their support and active help during the study.

REFERENCES

Bhadja, P. and Kundu R. 2012. Status of the seawater quality at few industrially important coasts of Gujarat (India) off Arabian Sea. Indian Journal of Geo-Marine Sciences 41(1): 954–961.

Bhadja, P.; Poriya P. and Kundu R. 2014. Community structure and distribution pattern of intertidal invertebrate macrofauna at some anthropogenically influenced coasts of Kathiawar peninsula (India). Advances in Ecology 2014: 1-7. Article ID 547395. http://dx.doi.org/10.1155/2014/547395.

Chaudhari, B. 2014. Diversity and Distribution of Marine Worms of Kathiawar Peninsula. M.Phil. Thesis. Saurashtra University, Rajkot, India. 116 pages.

Ciereszko, L.S. and Karns T.K.B. 1973. Comparative biochemistry of coral reef coelenterates. Pages 183-203, In: Jones, O.A. and Endean, R. (Editors) Biology and Geology of Coral Reefs. Volume II. Biology. Academic Press, New York.

Coates, M. 1998. A comparison of intertidal assemblages on exposed and sheltered tropical and temperate rocky shores. Global Ecology and Biogeography Letters 7: 115-124.

Connell, J.H. 1976. Competitive interactions and the species diversity of corals. p. 51-58. In: Mackie, G.O. (Editor). Coelenterate Ecology and Behavior. Plenum Press, New York.

Connell, J.H. 1961. The effects of competition, predation by *Thais lapillus*, and other factors on natural populations of the barnacle, *Balanus balanoides*. Ecological Monograph 31: 61-104.

Connell, J.H. 1970. A predator-prey system in the marine intertidal region. I. *Balanus glandula* and several predatory species of *Thais*. Ecological Monograph 40: 49-78.

Connell, J.H. 1985. The consequences of variation in initial settlement vs. post settlement mortality in rocky intertidal communities. Journal of Experimental Marine Biology and Ecology 93:11-45.

Dayton, P.K. 1971. Competition, disturbance and com-munity organization: the provision and subsequent utilization of space in a rocky intertidal community. Ecological Monograph 41: 351-389.

Dethier, M.N.; Graham E.S.; Cohen S. and L. M. Tear. 1993. Visual versus random-point percent cover estimations: 'objective' is not always better. Marine Ecological Progress Series 96: 93–100.

Faladu, J.; Vakani, B.; Poriya, P. and Kundu R. 2014. Habitat preference and population ecology of limpets *Cellana karachiensis* (Winckworth) and *Siphonaria siphonaria* (Sowerby) at Veraval coast of Kathiawar Peninsula, India. Journal of Ecosystem Article ID 874013, 6 pages, DOI: 10.1155/2014/874013.

Gohil, B. and Kundu R. 2011. Ecological status of *Rhinoclavis sinensis* at Dwarka Coast, Gujarat (India). The Ecoscan 5(3 & 4): 131-134.

Gohil, B. and Kundu R. 2013a. Ecological status of *Cerethium caeruleum* at Dwarka coast, Gujarat (India). Indian Journal of Geo-Marine Science. 42: 481-486

Gohil, B. and Kundu R. 2013b. Ecological Status of *Cellana radiata* at Dwarka Coast, Gujarat, India. Research Journal of Recent Sciences. 2: 1-5.

Gohil, B.; Poriya P. and Kundu, R. 2011. Status of Intertidal macro faunal and floral diversity of Dwarka Sea Coast in prospects of some environmental factor. Bionano Frontier 4(2): 290-293.

Harold, S.; Henderson, C.; Baguette, M.; Bonsall, M.B.; Hughes, D. and Settele, J. 2014. BMC Ecology image competition 2014: the winning images. BMC Ecology 14:24.

Jackson, J.B.C. 1977. Competition on marine hard substrata: the adaptive significance of solitary and colonial strategies. American Naturalist 111: 743-768.

Jenkins, S.R.; Åberg, P.; Cervin, G.; Coleman, R.A.; Delany, J.; Hawkins, S.J.; Hyder, K.; Myers, A.A.; Paula, J.; Power, A.M. Range, P. and Hartnoll, R.G. 2001. Population dynamics of the intertidal barnacle *Semibalanus balanoides* at three European locations: spatial scales of variability. Marine Ecological Progress Series 217: 207–217

Kaladharan, P.; Asokan, P.K. and Said Koya, K.P. 2011. Revival of bleached *Zoanthus sociatus* (Ellis and Solander, 1786) in the intertidal waters of Thikkodi, Malabar Coast, Kerala. Journal of Marine Biological Association of India 53 (1): 157–159.

Lang, J.C. 1973. Interspecific aggression by scleractinian corals II. Why the race is not only to the swift. Bulletin of Marine Science 23: 260-279.

Lewis, J.R. 1964. The Ecology of Rocky Shores. The English Universities Press, London. Xx pages.

Lubchenco, J. 1978. Plant species diversity in a marine intertidal community: importance of herbivore food preference and algal competitive abilities. *The American Naturalist* 112: 23-39.

Meese, R.J. and Tomich, P. A. 1992. Dots on the rocks: a comparison of percent cover estimations methods. Journal of Experimental Marine Biology and Ecology 165: 59–73.

Menge, B.A. and Lubchenco, J. 1981. Community organization in temperate and tropical rocky intertidal habitats: prey refuges in relation to consumer pressure gradients. Ecological Monographs 51: 429-450.

Menge, B.A. 1976. Organization of the New England rocky intertidal community: Role of predation, competition and environmental heterogeneity. Ecological monograph 46: 355-393.

Menge, B.A. 2000. Recruitment vs. post recruitment processes as determinants of barnacle population abundance. Ecological Monographs 70: 265–288.

Misra, S. and Kundu, R. 2005. Seasonal variations on population dynamics of key intertidal mollusc at two contrasting locations. Aquatic Ecology 39: 315-324.

Moore, R.E. and Scheuer, P.J. 1971. Palytoxin: a new marine toxin from a coelenterate. Science 172: 495–498.

Mundy, R. 2008. Occurrence and toxicology of palytoxins. pages 693–713, In: Botana, L. M. (Editors) Seafood and Freshwater Toxins: Pharmacology, Physiology, and Detection. CRC Press, Boca Raton, FL.

Osman, R.W. 1975. The establishment and development of a marine epifaunal community. Ecological Monograph. 47: 37-63.

Ott, B. and Lewis, J.B. 1972. The importance of the gastropod *Coralliophila abbreviata* (Lamarck) and the polychaete *Hermodice carunculata.* Canadian Journal of Zoology 50: 1651-1656.

Paine, R.T. 1966. Food web complexity and species diversity. American Naturalist 100: 65-75.

Paine, R.T. 1974. Intertidal community structure: experimental studies on the relationship between a dominant competitor and its principle predator. Oecologia 15: 93-120.

Polak, O.; Yossi, L.; Brickner, I.; Kramarski-Winter, E. and Benayahu, Y. 2011. The widely-distributed Indo-Pacific zoanthid *Palythoa tuberculosa*: a sexually conservative strategist. Bulletin of Marine Science 87(3): 605–621.

Poriya, P. and Kundu, R. 2014. Species invasion and succession as community and ecosystem responses towards climate change in the rocky intertidal ecosystems of Kathiawar Peninsula. Journal of Aquatic Biology and Fisheries 2: 426-430. http://keralamarinelife.in/Journals/Vol%203/065%20Paresh%20Poriya.pdf

Porter, J.W. 1972. Patterns of species diversity in Caribbean reef corals. Ecology 53: 745-748.

Raffaelli, D. and Hawkins, S. 1996. Intertidal Ecology. Chapman and Hall, London. 356 pages.

Richardson, C.A.; Dustan, P. and Lang, J.C. 1979. Maintenance of living space by sweeper tentacles of *Montastrea cavernosa*, a Caribbean reef coral. Marine Biology 55: 181-186.

Sanford, E. and Menge, B.A. 2001. Spatial and temporal variation in barnacle growth in a coastal upwelling system. Marine Ecology Progress Series 209: 143–157.

Sanford, E,; Bermudez, D.; Bertness, M.D.; and Gaines, S.D. 1994. Flow, food supply and acorn barnacle population dynamics. Marine Ecology Progress Series 104: 49–62.

Shiroma, E. and Reimer, J.D. 2010. Investigations into the Reproductive Patterns, Ecology, and Morphology in the Zoanthid Genus *Palythoa* (Cnidaria: Anthozoa: Hexacorallia) in Okinawa, Japan. Zoological Studies 49(2): 182-194.

Sneha, J.; Poriya, P.; Vakani, B.; Singh, S.P. and Kundu, R. 2014a. Identification of a group of cryptic marine limpet species, *Cellana karachiensis* (Mollusca: Patellogastropoda) off Veraval coast, India, using mtDNA COI sequencing. *Mitochondrial DNA* DOI:10.3109/19401736.2014.945577.

Sneha J.; Poriya, P. and Kundu, R. 2014b. Probing the phylogenetic relationships of a few newly recorded intertidal Zoantharians of Gujarat coast (India) with mtDNA COI sequences. *Mitochondrial DNA* DOI:10.3109/19401736.2014.971239.

Sokal, R.R. and Rohlf, F.J. 1987. Introduction to Biostatistics. Dover Publication. USA. pp. 160-184.

Southward, A.J. 1991. Forty years of changes in species composition and population density of barnacles on a rocky shore near Plymouth. Journal of the Marine Biological Association of the United Kingdom 71: 495–513.

Stephenson, T.A. and Stephenson, A. 1949. The universal features of zonation between tide-marks on rocky coasts. Journal of Ecology 37: 289-305.

Suchanek, T.H. and Green, D.J. 1981. Interspecific competition between *Palythoa caribaeorum* and other sessile invertebrates on ST. Croix Reefs, U.S. Virgin Islands. Proceedings of the Fourth International Coral Reef Symposium, Manila. 2: 679-684.

Taylor, L.R. and Woiwod, I.P. 1982. Comparative synoptic dynamics. I. Relationships between inter and intra-specific spatial and temporal variance/mean population parameters. Journal of Animal Ecology 51:879–906.

Tsang, L.M,Y.; Achituv, K. H.; Chu, B. and Chan, K.K. 2012. Zoogeography of intertidal communities in the West Indian ocean as determined by ocean circulation systems: Patterns from the *Tetraclita barnacles*. PLoS ONE 7(9): e45120.

Vaghela, A.; Bhadja, P.; Ramoliya, J.; Patel, N. and Kundu, R. 2010. Seasonal variations in the water quality, diversity and population ecology of intertidal macrofauna at an industrially influenced coast. Water Science and Technology 61 (6): 1505-1514.

Vaghela, A. and Kundu, R. 2012. Spatiotemporal variation of hermit crab (Crustacea: Decapoda) inhabiting rocky shore along Saurashtra coast, western part of India. Indian Journal of Geo-Marine Science. 41: 146-151.

Vakani, B.; Poriya, P. and Kundu, R. 2014. Spatio-temporal variations in the population ecology of two limpets in a rocky intertidal shore of south Saurashtra coast (Gujarat: India). The Ecoscan 8 (1 and 2): 71-75

Wagh, A.B. 1969. New records of intertidal barnacles from India. Current Science 14: 344–345.

Received 1 May 2016;
Accepted 16 November 2016