AMERICAN-EURASIAN JOURNAL OF SUSTAINABLE AGRICULTURE
ISSN: 1995-0748, EISSN: 1998-1074
2017, volume(11),issue(2):pages(19-30)
Published Online 15 April 2017in http://www.aensiweb.com/AEJSA/

Biodiversity of marine gastropods along the Uran coast, Navi Mumbai, west coast of India

[1]Prabhakar R. Pawar and [2]Abdel Rahman Mohammad Said Al-Tawaha

[1]Veer Wajekar Arts, Science and Commerce College,Department of Zoology,Phunde (Uran),Raigad,Navi Mumbai - 400 702, India.
[2]Department of Biological Sciences, Al Hussein Bin Talal University, Ma'an, P.O. Box 20, Jordan.

Received 12 January 2016; Accepted 31 March 2017; Available online 15 April 2017

Address For Correspondence:
Veer Wajekar Arts, Science and Commerce College, Department of Zoology, Phunde (Uran), Raigad, Navi Mumbai - 400 702, India
E-mail: prpawar1962@gmail.com

ABSTRACT

In the present study, survey of marine gastropods for biodiversity was done along three substations; Sheva creek, Peerwadi coast and Dharamtar creek of Uran (Raigad), Navi Mumbai, west coast of India. Marine gastropods were collected during spring low tides from intertidal regions and shallow coastal waters monthly from June 2013 to May 2015. A total of 60 species of gastropods representing 38 genera, 25 families and 8 orders were identified. Of these, 10 species belongs to family Muricidae, 9 species to Neritidae, 6 species to Trochidae and 4 species to Bursidae. Families Cypraeidae and Lottiidae were represented by 3 species each. 2 species each were reportedfrom families Turbinidae, Cerithidae, Potamididae, Naticidae, Conidae and Volemidae whereas 1 species each belongs to remaining 13 families. Maximum species diversity of gastropods is recorded during post-monsoon and pre-monsoon from rocky substratum of Peerwadi coast and Dharamtar creek than open mud flats of Sheva creek. This could be attributed to the habitat preference by gastropods to the rocky substratum with abundance of sea grass beds than open mud flats. The variation in abundance of gastropods at Uran coast could result from anthropogenic activities of Jawaharlal Nehru Port (JNPT), port related establishments, sedimentation, disposal of domestic sewage, industrial wastes, overharvesting, habitat loss, overfishing and tourism. This study reveals that gastropods from Uran coast are facing threat due to industrial pollution and anthropogenic activities.

KEY WORDS
Gastropods, biodiversity, mollusca, Jawaharlal Nehru Port, Uran,

INTRODUCTION

Benthos represents a major component of the marine environment and plays a vital role in the overall food chain in the sea [17].The benthic organisms contribute to a greater extent of total macrofaunal population forming an important role in nutrient cycles. The demersalfishery production potential of an aquatic ecosystem is virtually determined by the benthic animals living in close association with the bottom of estuaries [5].Macrobenthos consume all kinds of organic matter and in turn act as a food for many fishes, birds and other marine invertebrates.They act as a connecting link between the biotopes of substratum and water column in the aquatic systems. Benthos takes part in breakdown of particulate organic material and export energy to higher trophic level and can potentially support off-shore and pelagic communities[1].

The molluscs are soft - bodied, heterogeneous group of animals with great antiquity and diversity.They represent one of the most diverse and species-rich phyla of the animal kingdom and are only second to the arthropods. Due to their ubiquitous distribution and enormous species number, molluscs play important ecological roles in aquatic and terrestrial ecosystems of the world.They provide key species for ecosystem functioning,e.g. food for echinoderms, fish, birds and mammals.Molluscs are also used for biomonitoring and bioindication purposes like biological effects of environmental stress in general and of contaminant exposure in particular are measurable at various levels of biological organization [32].

About 80,000 to 100,000 species of molluscs have been recorded from various parts of the world. In India, till today, 5070 species of mollusca have been recorded of which 3370 species are from marine habitats [49].Molluscs frommarine habitat of India, belonging to 220 families and 591 genera, of which 1900 are gastropods, 1100 are bivalves, 210 are cephalopods, 41 are polyplacophores and 20 are scaphopods [2, 51].

Of the seven molluscan classes, gastropods make up more than 80% of the species and majority of gastropod species exhibit an extremely limited mobility or are completely sessile as adults. These molluscs represent the contamination of their habitat ideally [32].The gastropods seem to be the abundant animals in the intertidal pool and have worldwide distribution considering their wide adaptations[16, 28].

Some sea grass associated herbivore gastropods form an important links between the primary detritus and consumers and the energy assimilated by them plays a significant role in nutrient recycling at the sea grass area [27].Marine gastropods become a natural resource of economic importance and are exploited on the large scale for purposes like human consumption, medicinal uses, ornamental and other uses [39].

Marine edible gastropods of the Indian coasts include limpets, trochids, whelks, the sacred chank, olives, the green snail etc.Some species of Trochus and Turbo are exploited on a subsistence basis, for edible purposes by many fishermen families at Ramanathapuram, Rameswaram and Kanyakumari in Tamil Nadu [39].Flores-Garza et al [15] reported 18 species of edible gastropods along Acapulco's Bahía de Santa Lucia bay, Mexico.Tabugo et al [44] noted that in the Island of Hadji Panglima Tahil, in the province of Sulu, Philippines, natives fed edible gastropods to their young ones to strengthen the teeth as they are a good source of iodine and calcium.Similar results on edible gastropods were also reported by Koutsoubas [23],Lakshmi [26] and Hamli et al [19].

Marine gastropods are also very good source of bioactive compounds used as pharmacological products with antitumor, antileukemic, antibacterial and antiviral properties[12].Bioactive compounds from marine gastropods are also used in the treatment of Alzhimer's disease, Parkinson's disease, depression and epilepsy [40],asthma, rickets and certain skin ailments [39] and victims of strokes and heart disease[26].

Marine gastropods are most commercially attractive and important worldwide for ornamental purposes.Shells of gastropods are large, colourful, relatively cheap and available plentiful. Whole shells have been used for souvenir items, interior decorations, jewellery, currency, ornamental tools, horns, games, religious symbols and for shell crafts e. g. Tiger cowry, *Cypraea tigris*, *Lambis lambis*,*Strombus* spp. *Conus* spp. etc [26, 44, 50]. In India, ornamental molluscs were popular among common man as ornaments and currency. The ornaments and handicrafts made out of molluscan shells are becoming highly priced objects in Indian and foreign markets [52].

Molluscan shells have been found important for various commercial purposes like poultry feed, shell lime, cement, lime industries, calcium resources, industrial raw material, fisheries, handicrafts and interior decoration [15, 34, 38, 46].

Various species of gastropods have been recognized as a useful tool for monitoring of heavy metals pollution. These organisms accumulate comparatively higher concentrations of metals because of their sedentary nature, both from water and sediment. The extent of bioaccumulation thus can play key role in determining water and sediment quality criteria[9, 18].

The marine gastropod resources in India are exploited regularly for various purposes. This exploitation goes unnoticed in several places because it constitutes a very minor fishing when compared to other fishery resources[52]. Many studies have shown how unregulated harvesting and habitat degradation can threaten the molluscan population[13].The recent increase in human activities such as tourism and fishing along the shoreline of Maharashtra has intensified the exploitation of natural resources without any control [25].

Coastal environment of Uran has been under considerablestress since the onset of Jawaharlal Nehru Port (JNPT, an International Port), Oil and Natural Gas Commission (ONGC),LPGDistillation Plant, Grindwell NortonLtd., Gas Turbine Power Station (GTPS),Bharat Petroleum CorporationLimited (BPCL) Gas Bottling Plant, DP World,Container Freight Stations (CFS), sedimentation, tourism etc. These activities affect the ecology of gastropods from Uran coast,Navi Mumbai[36].

Although many studies have been undertaken to evaluate the species diversity of marine gastropods in India, no scientific studies have been carried out on the species composition of marine gastropods of Uran, Navi Mumbai; hence, the present study is undertaken. Objective of the study is to evaluate the impact of anthropogenic inputs on species composition of marine gastropods with respect to tidal and seasonal variability.

MATERIALS AND METHODS

Study Area:

Geographically, Uran (Lat.18º50'5" to 18º50'20" N and Long. 72º57'5" to 72º57'15" E)with the population of 23,254 is locatedalong the eastern shore of Mumbai harbor opposite to Coloba. Uranis bounded by Mumbai harbor to the northwest, Thane creek to thenorth, Dharamtar creek and Karanja creek to the south, and

theArabian Sea to the west. Uran is included in the planned metropolisof Navi Mumbai and its port, the Jawaharlal Nehru Port (JNPT) (Fig. 1).

The coast of Uran is a tide-dominated and thetides are semidiuranal. The average tide amplitude is 2.28 m. Theflood period lasts for about 6–7 h and the ebb period lasts for about5 h. The average annual precipitation is about 3884 mm of whichabout 80% is received during July to September. The temperaturerange is 12–36ºC, whereas the relative humidity remains between61% and 86% and is highest in the month of August.

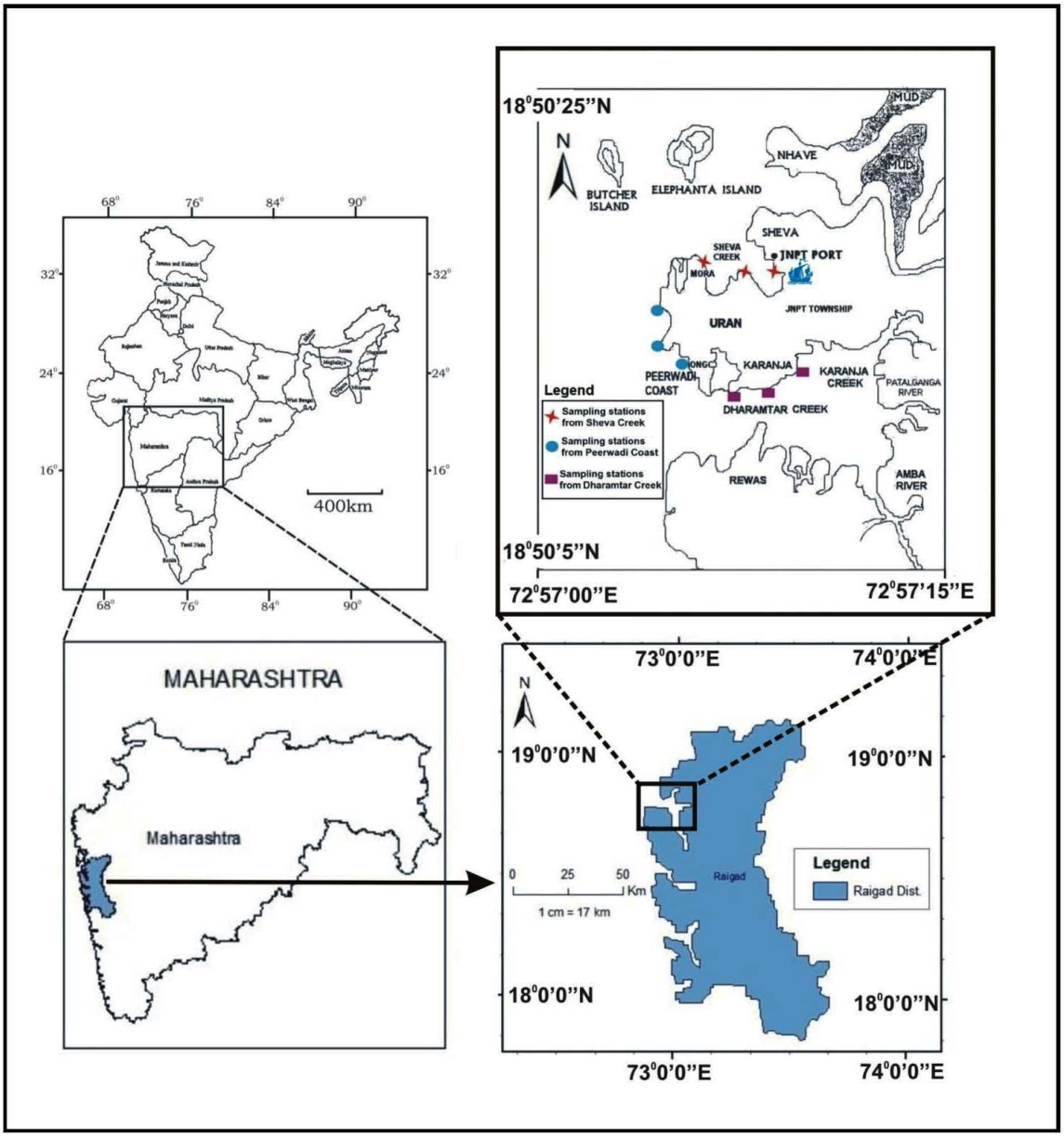


Fig.1: Map showing the study area along Uran coast

Sampling strategy:

The present study was carried out for a period of two years, i.e.,from June 2013 to May 2015. Three study sites namely Sheva creek, site I (Lat.18º50'20"N and Long. 72º57'5"E), Peerwadi coast, site II (Lat.18º50'10"N and Long. 72º57'1"E) and Dharamtar creek, site III (Lat.18º48'3"N and Long. 72º58'31"E) separated approximately by 10 km were selected along the coast.

The study siteswere surveyed monthly during springlow tides and gastropods were collected by hand picking method from intertidal regions and shallow coastal waters. Collected specimens were washed with seawater to remove the debris, and were transferred to the clean polythene bags; one sample per bagand were brought to the laboratory.

In the laboratory, morphological featuresof each specimen including shape, spiral length and shape, mouth opening, operculum shape, umbilicus shape and size and colourwere recorded [38]. The specimens were washed under tap water and then fixed in 10% formaldehyde-seawater solution and transferred into 90% ethanol.Empty shells were washed in water containing mild detergent and were rinsed in diluted hydrochloric acid to remove the hard outer coatand to reveal the natural colours.

Identification of gastropods:

All collected gastropods were photographed with Cannon EOS1100D digital camera and were identified up to species level using standardtaxonomic keys of Subrahmanyam et al. [41, 42, 43], Apte [3], Crothers [10], Paterson et al [33], Krieg [24], Bowling [8] and Marine Species Identification Portal website(http://species-identification.org).Scientific names and classification of gastropods was adopted from World Register of Marine Species (WRoMS) website (http://www.marinespecies.org).

RESULTS AND DISCUSSION

Total 60 species of gastropods belonging to 38 genera, 25 familiesand 8 orders were recorded from Uran coast (Table1,Fig.3).In present study, gastropods belonging toorder Archaeogastropoda, Caenogastropoda, Chitonida,Cycloneritimorpha, Littorinimorpha, Neogastropoda, Nudibranchia and Patellogastropodawere recorded.

Number of species of gastropods distributed in each family reveals that 10 species belongs to family Muricidae, 9 species to Neritidae, 6 species to Trochidae and 4 species to Bursidae. Families Cypraeidae and Lottiidae were represented by 3 species each. 2 species each were reported from families Turbinidae, Cerithidae, Potamididae, Naticidae, Conidae and Volemidae whereas 1 species each is contributed by remaining 13 families (Table 2, Fig. 2).

Table 1: Checklist of gastropods faunal diversity during study period from Sheva creek, Peerwadi coast & Dharamtar Creek of Uran

Order	Family	Scientific Name
Archaeogastropoda	Fissurellidae	*Diodora gibberula* (Lamarck, 1822)
Archaeogastropoda	Nacellidae	*Cellana radiata* (Born, 1778)
Archaeogastropoda	Trochidae	*Trochus radiates* (Gmelin, 1791)
Archaeogastropoda	Trochidae	*Trochus tentorium* (Gmelin,1791)
Archaeogastropoda	Trochidae	*Umbonium vestiarium* (Linnaeus, 1758)
Archaeogastropoda	Trochidae	*Trochus stellatus* (Gmelin, 1791)
Archaeogastropoda	Trochidae	*Trochus maculates* (Linnaeus, 1758)
Archaeogastropoda	Trochidae	*Clanculus guineensis* (Gmelin, 1791)
Archaeogastropoda	Turbinidae	*Astraea stellata* (Gmlin, 1791)
Archaeogastropoda	Turbinidae	*Astraea semicostata* (Kiener, 1850)
Caenogastropoda	Cerithiidae	*Clypeomorus bifasciatus* (Sowerby II, 1855)
Caenogastropoda	Cerithiidae	*Clypeomorus moniliferus* (Kiener, 1841)
Caenogastropoda	Potamididae	*Telescopium telescopium* (Linnaeus, 1758)
Caenogastropoda	Potamididae	*Potamides cingulatus* (Gmelin, 1791)
Chitonida	Ischnochitonidae	*Ischnochiton australis* (G.B. Sowerby II, 1833)
Cycloneritimorpha	Neritidae	*Nerita undata* (Linnaeus, 1758)
Cycloneritimorpha	Neritidae	*Nerita albicilla* (Linnaeus, 1758)
Cycloneritimorpha	Neritidae	*Nerita crepidularia* (Lamarck, 1816)
Cycloneritimorpha	Neritidae	*Nerita oryzarum* (Recluz, 1841)
Cycloneritimorpha	Neritidae	*Nerita costata* (Gmelin, 1791)
Cycloneritimorpha	Neritidae	*Nerita chamaeleon* (Linnaeus, 1758)
Cycloneritimorpha	Neritidae	*Nerita aterrima (*Gmelin, 1791)
Cycloneritimorpha	Neritidae	*Neritina pulligera* (Linnaeus, 1758)
Cycloneritimorpha	Neritidae	*Neritina punctulata* (Lamarck, 1816)
Littorinimorpha	Bursidae	*Bursa tuberculata* (Broderip,1833)
Littorinimorpha	Bursidae	*Bursa granularis* (Roding, 1798)
Littorinimorpha	Bursidae	*Bursa spinosa* (Schumacher, 1817)
Littorinimorpha	Bursidae	*Bursa lissostoma* (E. A. Smith, 1914)
Littorinimorpha	Cypraeidae	*Erosaria lamarckii* (J.E. Gray, 1825)
Littorinimorpha	Cypraeidae	*Luria lurida* (Linnaeus, 1758)
Littorinimorpha	Cypraeidae	*Cypraea tigris* (Linnaeus, 1758)
Littorinimorpha	Ficidae	*Ficus gracilis* (G. B. Sowerby I,1825)
Littorinimorpha	Naticidae	*Natica didyma* (Röding, 1798)

Table 1: Continued

Order	Family	Scientific Name
Littorinimorpha	Naticidae	*Natica rufa* (Born, 1778)
Littorinimorpha	Rostellariidae	*Tibia curta* (G. B. Sowerby II, 1842)
Littorinimorpha	Tonnidae	*Tonna dolium* (Linnaeus, 1758)
Neogastropoda	Buccinidae	*Cantharus spiralis* (Gray, 1839)

Neogastropoda	Clavatulidae	*Makiyamaia arthopleura* (Kilburn, 1983)
Neogastropoda	Columbellidae	*Parvanachis obesa* (C. B. Adams, 1845)
Neogastropoda	Conidae	*Conus ambiguus* (Reeve, 1844)
Neogastropoda	Conidae	*Conus circumactus* (Iredale, 1929)
Neogastropoda	Mangeliidae	*Propebela harpularia* (Couthouy, 1838)
Neogastropoda	Muricidae	*Drupa konkanensis* (Melvill, 1893)
Neogastropoda	Muricidae	*Indothais blanfordi* (Melvill, 1893)
Neogastropoda	Muricidae	*Murex brunneus* (Link, 1807)
Neogastropoda	Muricidae	*Murex bundharmai* (Houart, 1992)
Neogastropoda	Muricidae	*Purpura bufo* (Lamarck, 1822)
Neogastropoda	Muricidae	*Stramonita floridana* (Conrad, 1837)
Neogastropoda	Muricidae	*Thais carinifera* (Lamarck, 1822)
Neogastropoda	Muricidae	*Thais sacellum* (Gmelin, 1791)
Neogastropoda	Muricidae	*Thais gradate* (Jonas, 1846)
Neogastropoda	Muricidae	*Vasula deltoidea* (Lamarck, 1822)
Neogastropoda	Nassariidae	*Nassarius vibex (Say, 1822)*
Neogastropoda	Onchidiidae	*Onchidium damelii* (Semper, 1882)
Neogastropoda	Volemidae	*Hemifusus pugilinus* (Born, 1778)
Neogastropoda	Volemidae	*Hemifusus cochlidium* (Linnaeus, 1758)
Nudibranchia	Chromodorididae	*Mexichromis mariei* (Crosse, 1872)
Patellogastropoda	Lottiidae	*Lottia septiformis* (Quoy & Gaimard, 1834)
Patellogastropoda	Lottiidae	*Lottia tenuisculpta* (Sasaki & Okutani,1994)
Patellogastropoda	Lottiidae	*Acmaea subrugosa* (d'Orbigny, 1846)

Table 2: Number of species of gastropods distributed in each family at Sheva creek, Peerwadi coast & Dharamtar Creek of Uran

Order	Family	Genera	Species	% composition of species
Archaeogastropoda	Fissurellidae	1	1	1.67
	Nacellidae	1	1	1.67
	Trochidae	3	6	10.00
	Turbinidae	1	2	3.33
Caenogastropoda	Cerithiidae	1	2	3.33
	Potamididae	2	2	3.33
Chitonida	Ischnochitonidae	1	1	1.67
Cycloneritimorpha	Neritidae	2	9	15.00
Littorinimorpha	Bursidae	1	4	6.67
	Cypraeidae	3	3	5.00
	Ficidae	1	1	1.67
	Naticidae	1	2	3.33
	Rostellariidae	1	1	1.67
	Tonnidae	1	1	1.67
Neogastropoda	Buccinidae	1	1	1.67
	Clavatulidae	1	1	1.67
	Columbellidae	1	1	1.67
	Conidae	1	2	3.33
	Mangeliidae	1	1	1.67
	Muricidae	7	10	16.67
	Nassariidae	1	1	1.67
	Onchidiidae	1	1	1.67
	Volemidae	1	2	3.33
Nudibranchia	Chromodorididae	1	1	1.67
Patellogastropoda	Lottiidae	2	3	5.00
8	25	38	60	100

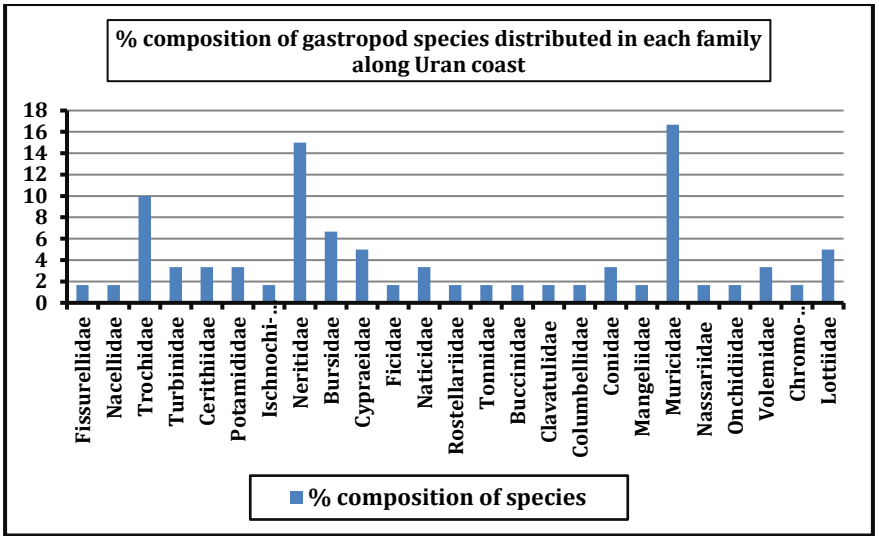


Fig. 2: Percentage composition of species of gastropods distributed in each family along Uran coast

Sheva creek is characterized by extensive mud flats with sparse mangrove vegetation and less rocky stretches. Jawaharlal Nehru Port (JNPT) and other port related establishments are located in the stretch of the creek. Gharapuri Island (Elephanta caves), a famous tourist spot is present on the north side of the creek. Intertidal region of Peerwadi coast has major portion of rocky substratum. Dharamtar creek is with rocky and coral substratum towards the Dronagiri Mountain whereas remaining part of the creek is dominated by the marshy areas and mud flats. Towards the Revas and Karanja side, the Dharamtar creek has mangrove associated habitats due to presence of dense and natural mangrove habitat.

Diversespecies composition of gastropods reported from Uran coast is attributed to the depth, availability ofsuitable substratum, appropriate habitat and sediment nature. Ganesh and Raman [17] reported that several factors e.g. locality, depth, distance from the shore, river proximity and local oceanographic features such as bottom currents, etc., appeared important for determining benthos distribution patterns.

Diodora gibberula *Cellana radiata* *Clanculus guineensis* *Trochus radiatus* *T.tentorium*

Fig. 3: Species of gastropods recorded from Uran, Navi Mumbai.

T. stellatus *T. maculatus* *Umbonium vestiarium* *Astraea stellata* *C. bifasciatus*

Clypeomorus moniliferus *T. telescopium* *Potamides cingulatus* *Ischnochiton australis* *Nerita undata*

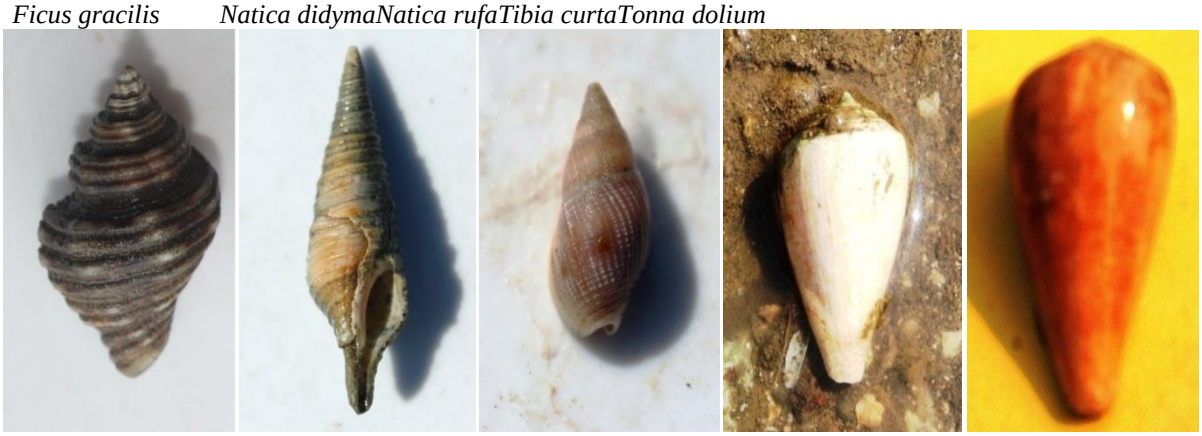
Nerita albicilla *Nerita crepidularia* *Nerita oryzarum* *Nerita costata* *Nerita chamaeleon*

Fig. 3: Continued.

Nerita aterrima *Neritina pulligera* *Neritina punctulata* *Bursa tuberculata* *Bursa granularis*

Bursa spinosa *Bursa lissostoma* *Erosaria lamarcki* *Luria lurida* *Cypraea tigris*

Ficus gracilis *Natica didyma* *Natica rufa* *Tibia curta* *Tonna dolium*



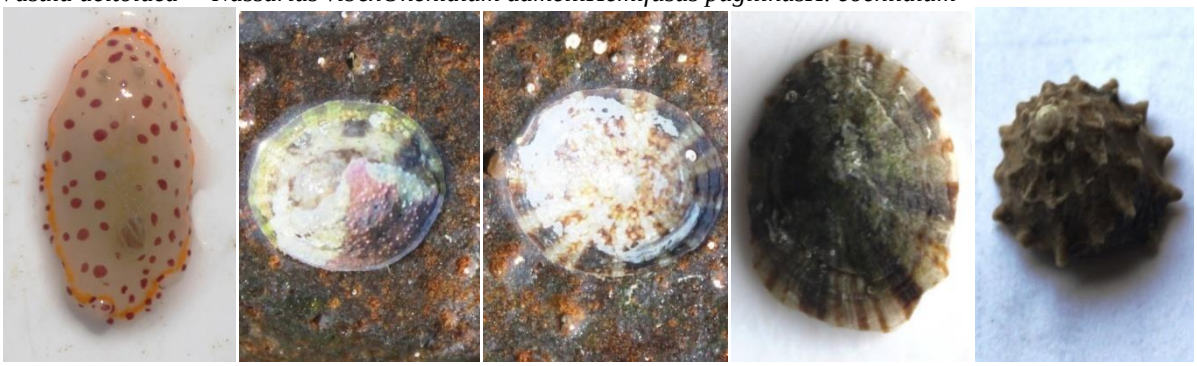
Cantharus spiralis *Makiyamaia orthopleura* *Parvanachis obesa* *Conus ambiguous* *C. circumactus*

Fig. 3: Continued.

Propebela harpularia *Drupa konkanensis* *Indothais blanfordi* *Murex brunneus* *Murex bundharmai*

Purpura bufo *Stramonita floridana* *Thais carinifera* *Thais sacellum* *Thais gradata*

Vasula deltoidea *Nassarius vibex* *Onchidium dameli* *iHemifusus pugilinus* *H. cochlidium*



Mexichromis mariei *Lottia septiformis* *Lottia tenuisculpta* *Acmaea subrugosa* *Astraea semicostata*

Maximum species of gastropods was recorded from rocky stretches of the Peerwadi coast and Dharamtar creek as compared to the open mudflats of Sheva creek. This is correlated to habitat preference of gastropods to the rocky substratum with abundance of sea grass beds than the open mudflats.Similar results were reported by Varadharajan et al [48] from Arukkattuthurai to Aiyyampattinam, south east coast of India and Long et al [27] in Sampadi Island, Lundu, Sarawak, South China Sea.Results of the study are in agreement with the work of Boehs et al [7] from Paranaguá Bay, Parana, Brazil, Picardal and Dolorosa [37] from bays in Puerto Princesa City, Palawan, Philippines and Mohanraj et al [31] from Gulf of Mannar Island coral reef associated gastropods.

Low species diversity of gastropods recorded from open mudflats of Sheva creek could be attributed to the environmental variables like depth, sand, sediment organic matter and mean particle size. Similar results were reported by Kurhe et al [25] from Ratnagiri coast Maharashtra, India, Trivedi and Vachhrajani [46] along the coastal Saurashtra, Gujarat, India and Lumeran [28] from Asry Beach, Kingdom of Bahrain.

Maximum species diversity of gastropods was recorded during post-monsoon (October to January) and pre-monsoon (February to May). This could be correlated to the stable environment factors such as dissolved oxygen and salinity and decomposition of organic sediments [38]. Ganesh and Raman [17] noted that increased upwelling during March–May leads to annual phytoplankton production marked by impoverishment of dissolved oxygen, and an increase in nutrients and salinity at this time of the year. Results of the study are in agreement with the work of Elaiyaraja et al [14] from Southeast coast of India, Khade and Mane [22] from Raigad district, Maharashtra, west coast of India, Mohan et al [30] from Pulicat Lake, southeast coast of India, David [11] along the Goa coastline, India, Paul et al [34] in North-East Coast of India, Vanmali and Jadhav [47] from Dativare coast of Vaitarna estuary, Dist.-Palghar, Maharashtra and Banerjee et al [4] from maritime states of India.

Minimum diversity of gastropods recorded during monsoon (June to September) could be due to the heavy downpour, which caused drastic fluctuations in the temperature and salinity. Anbuchezhian et al [1] reported that temperature and salinity are important ecological factors which influence distribution of benthic organisms. Ganesh and Raman [17] noted that large scale discharges of silt by the rivers reduces the water transparency over large areas with a consequent fall in the rate and amount of photosynthesis affecting the diversity of benthos.

The biodiversity of marine organisms have been regularly monitored to study the climatic changes and pollution impacts [45].The marine gastropod are exploited for food, at the same time the beautiful shape and colour of the shells have attracted and aroused the imagination of man to use them for ornamental purpose also[52].Mehrnaz et al [29] reported that trawling is believed to affect the stock abundances directly by removing or killing individuals. Dolorosa and Dangan-Galon [13] documented that unregulated harvesting, habitat degradation, improper waste disposal, plastic materials and broken bottles (of liquor) and oil pollution

from boat discharge have threatened the marine gastropods from Iwahig River-Estuary, Palawan, the Philippines.

Sustainable use of marine and coastal living resources cannot be properly established without an adequate knowledge of biodiversity. Monitoring the biodiversity of a large ecosystem will allow a proper evaluation of the effects of natural and anthropogenic factors on species numbers, kinds and distribution [30].High market demand, coupled with a lack of awareness and inadequate enforcement were found to be the major driving forces behind the illegal marine curio trade [6, 20].Venkatraman and Venkataraman [51] stated that threats of problems to gastropods of Chennai coast include sedimentation, disposal of domestic sewage, industrial waste, over fishing and tourism. Similar results were reported by Kantor et al [21] in Nha Trang Bay, Vietnam.

The Sheva creek receives wastes and effluents from Asia's largest industrialized zone namely Thane Belapur industrialized area and Navi Mumbai Urban area [35].Waste water from petrochemical complex and other industries are disposed into Dharamtar creek [36].Peerwadi coast is in close proximity to human population and receives domestic waste and sewage from Nagaon, Kegaon and Uran.Maritime activities of Jawaharlal Nehru Port(JNP)affect the coastal ecosystem of Uran due to anthropogenic threat; still Uran coast harbours varied species diversity of gastropods.

Since no earlier reports are available on species diversity of gastropods from Uran coast, data presented here can be taken as a baseline data in knowing the status of gastropods and effect of industrial development on it and for a better management of gastropods.

Conclusion:

In the present study, the results showed that the Uran coast harbors a diverse group of gastropods. Gastropodspecies belonging to family Muricidae and Neritidae were dominant followed by families Trochidae and Bursidae over all the families recorded in the study.The study also reveals that gastropods in close proximity to human populations consist of fewer species whereas the community at a site distant from human development shows more diverse assemblage of species.The variation in abundance of species could result from anthropogenic activities of Jawaharlal Nehru Port (JNP). Activities like overharvesting, habitat loss, disposal of sewage, wastes and effluents, sedimentation and tourism will affect the coastal ecosystem.Present information on species diversity of gastropodswould be helpful as a baseline data for further monitoring of anthropogenic inputs on gastropods from Uran coast.

ACKNOWLEDGEMENTS

Financial support provided by University Grants Commission, New Delhi [File No: 42–546/2013 (SR) dated 22nd Mar 2013] is gratefully acknowledged.The corresponding author is thankfulto The Principal, Veer Wajekar Arts, Science and Commerce College Mahalan Vibhag, Phunde (Uran), Navi Mumbai 400702for providing necessary facilities for the present study. Special thanks to Dr. Rahul B. Patil for providing healthy cooperation during field visits for photography of the study sites and gastropods.Thanks are due to Mr. Sanket S. Shirgaonkar, who worked as a Project Fellow for the present study. Thanks to Dr. Atul G. Babar for the help rendered during preparation of location map of study area.

REFERENCES

[1] Anbuchezhian, R.M., G. Rameshkumar and S. Ravichandran, 2009. Macrobenthic Composition and Diversity in the Coastal Belt of Thondi, Southeast Coast of India. Global J. Environ. Res., 3(2): 68-75.

[2] Appukuttan, K.K.,2008. Molluscan resources and management strategies. Proc. Natl. Sem. Envtl. Mgt. Sust. Livelihood., pp: 6-12.

[3] Apte, D.A.,1988. The book of Indian Shells, Bombay Natural History Society; Oxford University Press, India, pp: 115.

[4] Banerjee, K., S. Chakraborty, R. Paul, G. Bal, S. Zaman, P. Pramanick, G. Amin, P. Fazli and A. Mitra,2015.Macrobenthic molluscan diversity in the major intertidal zones of the maritime states of India, J. Env. Sci. Pollut. Res., 1(1):8-11.

[5] Behera, Durga Prasad and Lakshman Nayak, 2013. A check list on macro faunal diversity of Bahuda estuary, Odisha, east coast of India. International Journal of Ecosystem, 3(6): 172-176. DOI: 10.5923/j.ije.20130306.02

[6] Bijukumar, A., R. Ravinesh, A.R. Arathi and K.K. Idreesbabu,2015.On the molluscan fauna of Lakshadweep included in various schedules of Wildlife (Protection) Act of India. Journal of Threatened Taxa, 7(6):7253-7268; http://dx.doi.org/10.11609/JoTT.o4140.7253-68.

[7] Boehs, Guisla., Theresinha Monteiro Absher and Andrea Da Cruz-Kaled, 2004. Composition and distribution of benthic molluscs on intertidal flats of Paranaguá Bay (Paraná, Brazil). SCI. MAR., 68(4): 537-543.

[8] Bowling, Brenda, 2014. Identification Guide to Marine Invertebrates of Texas. Texas Parks and Wildlife Department, 11/24/2014 2: 358.
[9] Chiarelli, R. and M.C. Roccheri, 2014. Marine Invertebrates as Bioindicators of Heavy MetalPollution. Open Journal of Metal, 4:93-106.http://dx.doi.org/10.4236/ojmetal.2014.44011.
[10] Crothers, J.H., 2003. Rocky Shore Snails as Material for Projects (With a key for their identification). Field Studies, 10: 601-634.
[11] David, Anuradha, 2013. Biodiversity and distribution of marine gastropods (Mollusca) during pre- and post-monsoon seasons along the Goa coastline, India. J. Mar. Biol. Ass. India, 55(1): 17-24. doi: 10.6024/jmbai.2013.55.1.01720-03.
[12] Dhinakaran, A., V. Sekar, G.V. Sethubathi and J. Suriya, 2011. Antipathogenic activity of marine Gastropoda (*Hemifusus pugilinus*) from Pazhayar, South East Coast of India. Int. J. Environmental Sci., 2(2): 536-542. doi:10.6088/ijes.00202020014
[13] Dolorosa, Roger G. and Floredel Dangan-Galon, 2014. Species richness of bivalves and gastropods in Iwahig River-Estuary, Palawan, the Philippines. International Journal of Fisheries and Aquatic Studies, 2(1): 207-215.
[14] Elaiyaraja, Chinnaiyan., Veeramuth Sekar, Ramadoss Rajasekaran and Olivia. J. Fernando, 2012. Diversity and Seasonal distribution of the turrids (Gastropoda: Turridae) among the four landing centers of Southeast coast of India. Annals of Biological Research, 3(12): 5718-5723.
[15] Flores-Garza Rafael, Sergio García-Ibáñez, Pedro Flores-Rodríguez, Carmina Torreblanca-Ramírez, Lizeth Galeana-Rebolledo, Arcadio Valdés-González, Arquímedes Suástegui-Zárate and Juan Violante-González,2012.Commercially Important Marine Mollusks for Human Consumption in Acapulco, Mexico. Natural Resources, 3: 11-17. http://dx.doi.org/10.4236/nr.2012.31003.
[16] Ganesh Temkar, Azeez Abdul P., S.Y. Metar, V.T. Brahmane, K.M. Sikotaria and K.L. Mathew, 2014.The studies on distribution and community structure of five selected species of marine gastropods along the rocky intertidal area of Veraval, Gujarat, India. J. Advan. Agric. Sci. Technol., 2(5): 84-91.
[17] Ganesh, T., and A.V. Raman, 2007. Macrobenthic community structure of the northeast Indian shelf, Bay of Bengal. Mar Ecol Prog Ser, 341: 59-73.
[18] Gupta, Sanjay Kumar and Jaswant Singh, 2011. Evaluation of mollusc as sensitive indicator of heavy metal pollution in aquatic system: A Review. The IIOAB Journal Special issue on Environmental Management for Sustainable Development, 2(1): 49-57.
[19] Hamli Hadi, Mohd Hanafi Idris, Abu Hena Mustafa Kamal and Wong Sing King, 2012. Diversity of edible mollusc (Gastropoda and Bivalvia) at selected Divison of Sarawak, Malaysia. Int. J. Adv. Sci. Eng. Information Tech., 2(4): 5-7.
[20] John, S., M.P.K. Batu, S. Kuppusamy and B.C. Choudhury,2012. An assessment of legally protected marine fauna in Curio trade - a market study from Tamil Nadu, India. International Journal of Conservation Science, 3: 217-230.
[21] Kantor, Yuri I., Alexander E. Fedosov and Ivan N. Marin, 2012. An Unusually High Abundance and Diversity of the Terebridae (Gastropoda: Conoidea) in Nha Trang Bay, Vietnam. Zoological Studies, 51(5): 663-670.
[22] Khade, S.N. and U.H. Mane, 2012. Diversity of Bivalve and Gastropod, Molluscs of some localities from Raigad district, Maharashtra, west coast of India. Recent Research in Science and Technology, 4(10): 43-48.
[23] Koutsoubas, D.,2005. Biogeography of the Gastropod molluscs in Hellenic Seas. Proceedings of the 7th Pan-Hellenic Symposium of the Hellenic Geographic Society, Mytilini, pp: 444-449.
[24] Krieg, Kate, 2005. Field Guide to Oregon's Rocky Intertidal. PISCO's Online Taxonomic Database, pp: 126.
[25] Kurhe, Anil R., Miguel A. Rodríguez and Ganesh D. Suryawanshi, 2014. Vertical distribution and diversity of gastropods molluscs from intertidal habitats of the Ratnagiri coast Maharashtra, India. International Research Journal of Natural and Applied Sciences, 1(6): 1-13.
[26] Lakshmi S. Asta,2011. Wonder molluscs and their utilities. International Journal of Pharmaceutical Sciences Review and Research, Article-0086, (2): 30-33.
[27] Long Shabdin Mohd, Abg Azizil Fansuri Abg Abdullah & Syahidatul Atiqah Ab Rahim, 2014. Marine Gastropod and Bivalves of Sampadi Island, Lundu, Sarawak. Monograph Aquatic Science Colloquium, pp: 75-87.
[28] Lumeran, Belen T., 2015. Gastropods in the Intertidal Zone of Asry Beach, Kingdom of Bahrain. Int. Advanced Research J. in Sci. Eng. and Tech., 2(7):93-97. doi: 10.17148/IARJSET.2015.2720 93.
[29] Mehrnaz, Shirmohammadi., Doustshenas, Babak., Dehghan, Mediseh Simin., Savari, Ahmad and Sakhaei, Nasrin, 2012. Impacts of Trawling on Distribution and Diversity of Gastropods in the Persian Gulf: the Bahrakan Fishing Area. Journal of the Persian Gulf (Marine Science), 3(10): 37-46.

[30] Mohan, D., V. Elumalai, G. Subbulakshmi, S. Jayalakshmi and M. Srinivasan, 2013. Biodiversity of cultivable molluscan resources from Pulicat Lake, southeast coast of India. Arthropods, 2(2): 53-65.
[31] Mohanraj, Jayaraj., Gurusamy Chelladurai, Srinivasan Balakrishnan and Iruthayam Vijaya Kuamr, 2015. Gulf of Mannar Island coral reef associated gastropods assemblages: Distribution and diversity pattern. Journal of Coastal Life Medicine, 3(9): 691-695. doi: 10.12980/jclm.3.2015jclm-2015-0023.
[32] Oehlmann, Jorg and Ulrike Schulte-Oehlmann, 2002. Chapter 17Molluscs as bioindicators. In B. A. Markert, A. M. Breure, H. G. Zechmeister (eds) Bioindicators and biomonitors. Eselvier Science B.V. pp: 577-635.
[33] Paterson, Gordon, L.J., Chittima Aryuthaka and Michael A Kendall,2004. A Field guide to the Common Marine Flora and Fauna of Ranong, pp: 352.
[34] Paul Poulami, A.K. Panigrahi and B. Tripathy, 2014. A Study of Marine Molluscs With Respect to Their Diversity, Relative Abundance and Species Richness in North-East Coast of India. Ind. J. Appl. Research, 4(12): 538-541.
[35] Pawar, Prabhakar R., 2013. Monitoring of impact of anthropogenic inputs on water quality of mangrove ecosystem of Uran, Navi Mumbai, west coast of India. Mar. Poll. Bull., 75:291-300. http://dx.doi.org/10.1016/j.marpolbul.2013.06.045.
[36] Pawar, Prabhakar R., 2015. Monitoring of Pollution Using Density, Biomass and Diversity Indices of Macrobenthos from Mangrove Ecosystem of Uran, Navi Mumbai, west coast of India. J. Bioremed. Biodeg., 6:299.doi:10.4172/2155-6199.1000299.
[37] Picardal, Rafael M. and Roger G. Dolorosa, 2014.The molluscan fauna (gastropods and bivalves) and notes on environmental conditions of two adjoining protected bays in Puerto Princesa City, Palawan, Philippines. India Journal of Entomology and Zoology Studies, 2(5): 72-90.
[38] Raju, C., S. Gowthami and G. Sridharan, 2015. Diversity of molluscs in Vellaiyar estuarine from Vellankanni coast, Nagappattinam District. Int. J. Res. Zoology, 5(2): 29-32.
[39] Santhiya, N., S. Baskara Sanjeevi, M. Gayathri and M. Dhanalakshmi, 2013. Economic importance of marine molluscs. Res. Environ. Life Sci., 6(4): 129-132.
[40] Sary, P.S., R.B.Pramod Kiran, N.K.Balasubramanian and A.Biju Kumar, 2014. Diversity of Cone Snails (Mollusca: Conidae) along Kerala coast. J. Aquatic Biology and Fisheries, 2: 607-610.
[41] Subrahmanyam, T.V., K.R.Karandikar andN.N.Murti, 1949. The marine Pelecypoda of Bombay. Journal of University of Bombay, 17: 50-81.
[42] Subrahmanyam, T.V., K.R.Karandikar andN.N.Murti, 1951. Marine Gastropods of Bombay, Part I. Journal of University of Bombay, 20(1): 21-34.
[43] Subrahmanyam, T.V., K.R.Karandikar and N.N.Murti, 1952. Marine Gastropods of Bombay, Part II. Journal of University of Bombay, 21(3): 26-73.
[44] Tabugo Sharon Rose M., Jocelyn O. Pattuinan, Nathanie Joy J. Sespene and Aldren J. Jamasali,2013. Some Economically Important Bivalves and Gastropods found in the Island of Hadji Panglima Tahil, in the province of Sulu, Philippines. Int. Res. J. Biological Sci., 2(7): 30-36.
[45] Tripathi, Amit Kumar., N. Nagarani and A.K. Kumaraguru, 2012. Diversity of gastropods at Pudhumadam coast region and unusual occurrence of *Tetraclita rubescens* on conus shell. Toxicological & Environmental Chemistry, 94(10):2046-2051.
[46] Trivedi, Jigneshkumar N. and Kauresh D. Vachhrajani, 2013. Study of intertidal distribution of *Cerithium scabridum*, Philippi, 1848 (Mollusca, Gastropoda) along the coastal Saurashtra, Gujarat, India. National Conference on Biodiversity: Status and Challenges in Conservation - 'FAVEO' pp: 130-134.
[47] Vanmali, H.S. and R.N.Jadhav, 2015. Assessment of Molluscan Diversity of Dativare Coast of Vaitarna Estuary, Dist.-Palghar, Maharashtra (India). Research Inventy: International Journal of Engineering and Science, 5(9):1-6.
[48] Varadharajan, D., P. Soundarapandian, B. Gunalan and R. Babu, 2010. Seasonal Abundance of Macro Benthic Composition and Diversity along the South East Coast of India. European Journal of Applied Sciences, 2(1): 1-5.
[49] Venkataraman, K. and M. Wafer,2005. Coastal and marine biodiversity of India. Indian J. Mar. Sci., 34(1):57-75.
[50] Venkatesan, V., 2010. Marine Ornamental Molluscs. Chapter 4. Procd. of National Training Programme on Marine Ornamental Fish Culture, Mandapam, CMFRI, pp: 27-32.
[51] Venkatraman, C. and K.Venkataraman, 2012. Diversity of Molluscan Fauna along the Chennai Coast. Marine Biodiversity: Uttar Pradesh State Biodiversity Board, pp: 29-35.
[52] WWF Report,2013. Commercially Important Gastropod Shell Resources and Trade in India: Distribution, Status & Conservation strategies, pp: 41.