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Macrobenthos from coastal zones of Uran, India: A comprehensive species list with local distribution and photographs.

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ABSTRACT

A species list is an authoritative list of taxa for a defined area and updated species lists are necessary to reflect the current state of biodiversity knowledge and are essential for conservation planning and management. In this study, species composition of marine macrobenthos from intertidal and shallow subtidal was explored at three stations along the Uran coast of India, from June 2013 to May 2015. A total of 170 species were identified belonging to 119 genera, 83 families, 44 orders and 17 classes. Across 3 stations, Mollusca (n = 90 species) and Arthropoda (n = 33 species) collectively contributes about 72% of the total number of species found (n = 170 species). The next most frequently occurring marine macrobenthos in order were the Seaweeds (19 species), Sponges (16 species), Polychaetes (5 species), Platyhelminthes (4 species), Soft corals (2 species) and Tunicates (1 species). Among Mollusca, Gastropoda (67%, 60 species) accounted for > 1/2 of the molluscan species (90 species), followed by the Pelecypoda (26 species), and Cephalopoda (4 species). It was found that Port activities, agricultural expansion, logging, and road construction activities continue to threaten the diversity of Uran coast.

Keywords: Species list, Macrobenthos, Jawaharlal Nehru Port, Uran, Coastal biodiversity.

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INTRODUCTION

The most widely used metric of biodiversity is species richness, and much has been written about how many species may exist on land and in the sea. The question of how many marine species exist is important because it provides a metric for how much we do and do not know about life in the oceans. There are about 222,000–230,000 accepted eukaryotic marine species have been described [3].

A checklist is an authoritative list of taxa for a defined area. The species list is an important first step in establishing a baseline for understanding a major but understudied component of the marine ecosystem and will provide a foundation for further species-specific research focused on changes in invertebrate distribution, abundance, and biology, to be integrated into largescale studies of ecosystems. Updated species lists are necessary to reflect the current state of biodiversity knowledge and are thus essential for conservation planning and management [27].

Checklists are comprehensive lists covering all species of a certain group known to occur in a specific area. They provide an overall view of an area's diversity, its species composition and biological history, and functions as a living document. The list is the foundation document of a particular region and includes all background information. The list functions as a living document; species being added or, removed as time passes and new species are discovered or established species become extinct or are merged with other species [15].

Hendrickx and Harvey [16] documented that comprehensive evaluations and inventories serve as the basis for local practices of conservation. A checklist of regional marine species provides base line information and important data for comparative studies on biodiversity. It plays an important role in the recognition and delimitation of areas with need protecting, in the process to infer damage and impacts of anthropogenic activity, in the assessment of the complexity of biological communities, and in the estimation of resource availability [21].

Lu [22] reported that the benthic communities of intertidal region are considered as the pioneer components of coastal and marine ecosystem process. Intertidal benthos plays a critical role in coastal biodiversity such as variation in the physical and chemical composition of sediment [24a], recycling of nutrients [5], metabolism of defferent pollutants [34], source of bioactive sompounds and suitable indicators of pollution or environmental stress [23b], and are also used in the ecotoxicological studies such as heavy metal, PCB, PHC [12].

Mosbahi et al., [26] recorded that shallow waters and coastal areas are generally highly productive and ecologically important. Coastal habitats are threatened by anthropogenic stressors, including coastal development, habitat degradation and many human activities (pollution, tourism, clam harvesting, bait digging, commercial fisheries, eutrophication, sediment discharge, sand extraction and marine transportation) have directly and indirectly affected the biodiversity of these ecosystems on a worldwide scale [2, 7, 14].

Review of literature suggests that with few exceptions [1, 5, 15, 21, 23, 24, 27, 33, 34, 36, 38, 40], meager information is available on the species list of intetidal and subtidal marine macrobenthos.

The main objective of the present study was to produce a foundation document of species list of marine macrobenthos with local distribution and photographs for taxonomic study inhabiting three localities of Uran coast. This list is an attempt to provide a more complete inventory of macrobenthos with photographs of this region and update the taxonomic names.

MATERIALS AND METHODS

Study Area:

Uran (18º50'5'' to 18º50'20'' N, 72º57'5'' to 72º57'15'' E) with the population of 28,620 is located along the eastern shore of Mumbai harbor opposite to Coloba. Uran is bounded by Mumbai harbor to the northwest, Thane creek to the north, Dharamtar creek and Karanja creek to the south, and the Arabian Sea to the west. Uran is included in the planned metropolis of Navi Mumbai and its port, the Jawaharlal Nehru Port (JNPT) (Fig. 1).

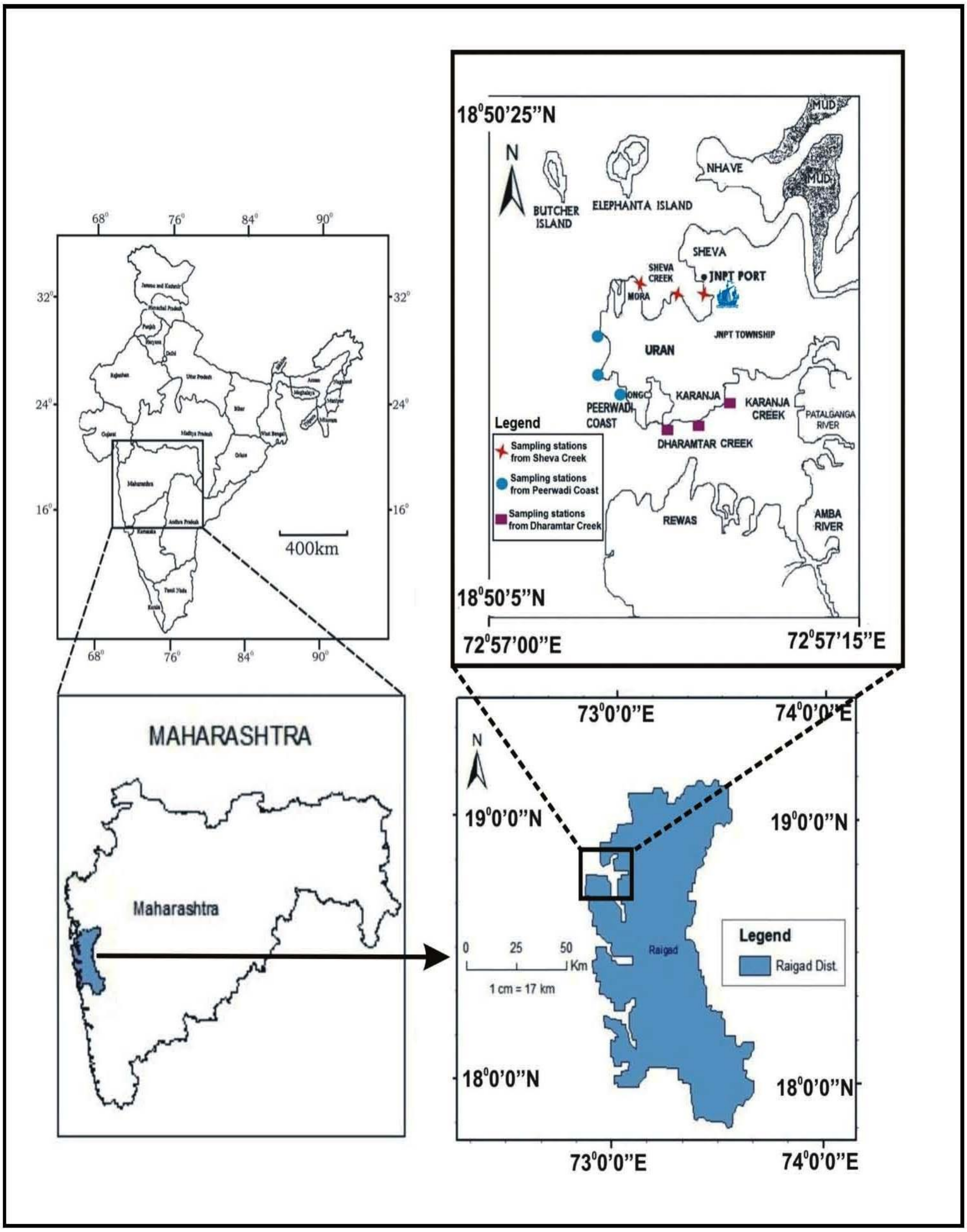


Figure 1. Map of study area showing location of sampling stations

The Uran coast is a tide-dominated and the tides are semidiuranal. The average tide amplitude is 2.28 m. The flood period lasts for about 6–7 h and the ebb period lasts for about 5 h. The average annual precipitation is about 3884 mm of which about 80% is received during July to September. The temperature range is 12–36ºC, whereas the relative humidity remains between 61% and 86% and is highest in the month of August.

Study Location:

For the present study, three sampling sites, namely Sheva creek, site I (18º50'20'' N, 72º57'5'' E), Peerwadi coast, site II (18º50'10'' N, 72º57'1'' E) and Dharamtar creek, site III (18º48'3'' N, 72º58'31'' E) separated approximately by 10 km were selected. These sites were selected on the basis of their strategic locations for Jawaharlal Nehru Port (JNP, an International Port), industries, port related infrastructural facilities and different anthropogenic activities along the entire coastal area.

Sheva creek is characterized by extensive mud flats with sparse mangrove vegetation and less rocky stretches. Jawaharlal Nehru Port (JNP) 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. Sheva creek and Dharamtar creek are considered as high anthropogenic pressure zones.

Field Sampling:

Studies on the diversity of macrobenthos from the intertidal regions of these sites were carried for a period of two years, i.e., from June 2013 to May 2015. The entire intertidal belt of each sampling site was subdivided into upper, middle and lower littoral zones. The diversity and distribution of macrobenthos in the intertidal belt at each station were studied during the spring low tide.

The macrobenthos were collected by hand picking method from intertidal regions and shallow coastal waters. Sponges, bivalves and seaweeds attached to the boulders, jetties, rocks on the shores, stones, pebbles, fishing nets and pneumatophores of mangrove were collected by scrapping. Collected specimens were washed with seawater to remove the debris, and were transferred to the clean polythene bags; one sample per bag and were brought to the laboratory.

In the laboratory, morphological features of each specimen were recorded. 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 coat and to reveal the natural colours.

Identification of macrobenthos:

All collected organisms were photographed with Cannon EOS1100D digital camera and were identified up to the lowest possible taxonomic level following Marine Species Identification Portal website (http://species-identification.org) and standard taxonomic keys of Bhavanath Jha et al. [6] for seaweeds, Van Soest et al., [42] for sponges, Apte [4] for gastropods, Coan & Valentich-Scott [9] for bivalves, Jeyabaskaran and Wafar [18] for crabs, Krieg [19], Hibberd and Moore [17] and Cantera [8] for other invertebrates. Scientific names and classification of gastropods was adopted from World Register of Marine Species (WoRMS) website (http://www.marinespecies.org).

RESULTS AND DISCUSSION

During the sampling period at Uran, 170 species of macrobenthos from 119 genera, 83 families, 44 orders and 17 classes were identified (Table 1). Across three stations, Mollusca (n = 90 species) and Arthropoda (n = 33 species) collectively contributes about 72% of the total number of species found (n = 170 species). The next most frequently occurring marine macrobenthos in order were the Seaweeds (19 species), Sponges (16 species), Polychaetes (5 species), Platyhelminthes (4 species), Soft corals (2 species) and Tunicates (1 species) (Fig. 2).

Table 1: % composition of macrobenthos recorded along Uran coast.

Sr. No.	Benthos	Division	Class	Order	Family	Genus	Species	Percentage Representation
1	Sea weeds	05	05	13	15	16	19	11.176 %
2	Sponges	---	03	08	10	12	16	9.412 %
3	Soft corals		01	01	01	01	02	1.176 %

4	Flat worms	---	01	01	04	04	04	2.353 %
5	Polychaetes	---	01	03	04	04	05	2.941 %
6	Crabs	---	01	01	12	21	33	19.411%
7	Gastropods	---	01	08	25	38	60	35.294 %
8	Pelecypods	---	01	04	08	18	26	15.294 %
9	Cephalopods	---	01	03	03	04	04	2.353 %
10	Tunicates	---	01	01	01	01	01	0.588 %
	TOTAL	**05**	**17**	**44**	**83**	**119**	**170**	**100%**

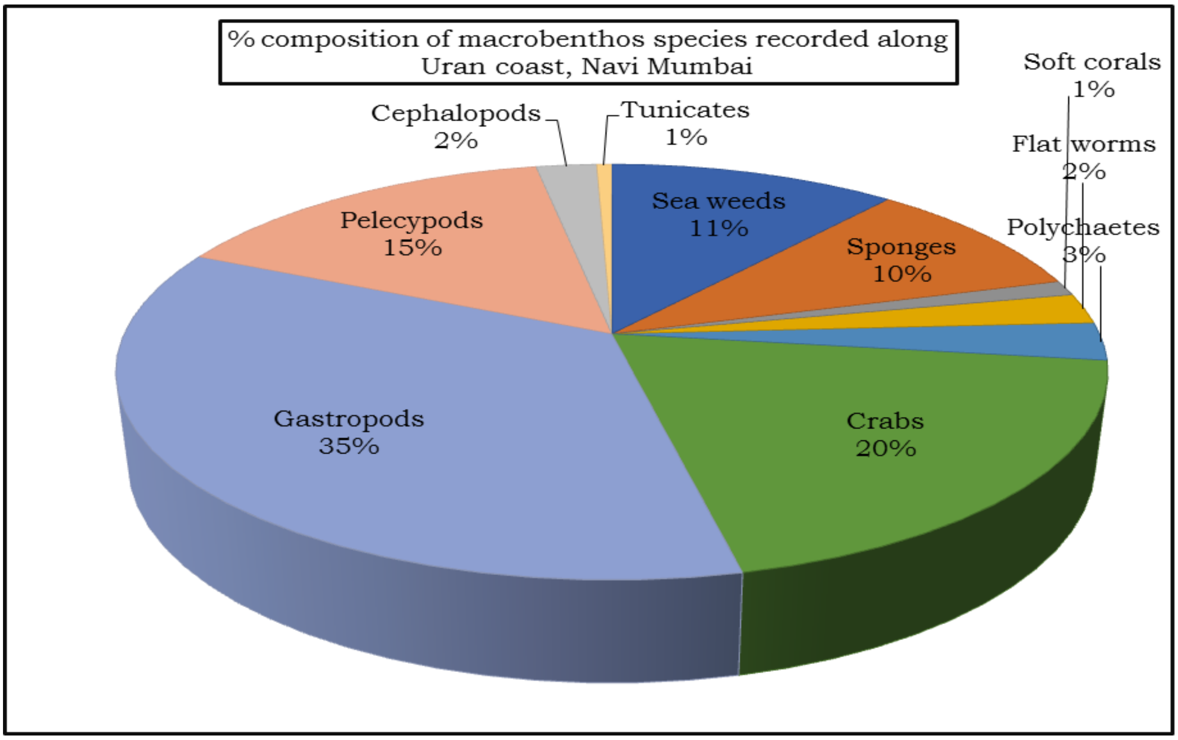


Figure 2 Average % composition of macrobenthos recorded along Uran coast.

Among Mollusca, Gastropoda (67%, 60 species) accounted for > 1/2 of the molluscan species (90 species), followed by the Pelecypoda (26 species), and Cephalopoda (4 species).

Species composition of macrobenthos:

- Seaweeds: (Table 2, Plate 1)

Table 2: Checklist of benthic macrophytes recorded along Uran coast, Navi Mumbai collected during June 2013 to May 2015

Class	Order	Family		Scientific Name
Division: Charophyta				
Charophyceae	Charales	Characeae	1	*Chara baltica* (A. Bruzelius,1824)
Division: Chlorophyta				
Ulvophyceae	Cladophorales	Cladophoraceae	2	*Cladophora rupestris* (L.) Kutzing 1843)
		Valoniaceae	3	*Valonia aegagropila* (C. Agardh, 1823)
	Ulotrichales	Gomonticeae	4	*Monostroma nitidium* (Wittrock,1866)
	Ulvales	Ulvaceae	5	*Ulva fasciata* (Delile, 1813)
			6	*Ulva lactuca* (Linnaeus, 1753)
			7	*Enteromorpha intestinalis* (L.) Nees, 1820

			8	*Enteromorpha linza* (L.) J. Agardh, 1883
Division: Cyanobacteria				
Cyanophyceae	Oscillatoriales	Oscillatoriaceae	9	*Lyngbya confervoides* (C. Agardh ex Gomont, 1893)
			10	*Lyngbya majuscule* (Harvey ex Gomont, 1892)
Division: Ochrophyta				
Phaeophyceae	Ectocarapales	Scytosiphonaceae	11	*Colpomenia sinuosa* (Derbes & Solier, 1851)
	Sphacelariales	Sphacelariaceae	12	*Sphacelaria tribuloides* (Meneghini, 1840)
Division: Rhodophyta				
Florideophyceae	Corallinales	Corallinaceae	13	*Amphiroa tribuloides* (Meneghini, 1840)
	Nemaliales	Galaxauraceae	14	*Galaxaura oblongata* (J. V. Lamouroux, 1816)
	Gelidiales	Gelidiaceae	15	*Gelidium pusillum* (Stackhouse) Le Jolis, 1863
		Gelidiellaceae	16	*Gelidiella acerosa* (Fosskal) Feldmann & G. Hamel, 1934
	Gracilariales	Gracilariaceae	17	*Gracilaria verrucosa* (Hudson) Papenfuss, 1950
	Halymeniales	Halymeniaceae	18	*Grateloupia filicina* (C. Agardh, 1822)
	Ceramiales	Rhodomelaceae	19	*Acanthophora specifera* (M.Vahl) Borgesen,1910
05	13	15		19


Chara baltica

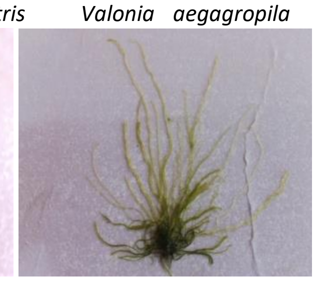

Cladophora rupestris


Valonia aegagropila


Monostroma nitidum


Ulva fasciata


Ulva lactuca


Enteromorpha intestinalis


Enteromorpha linza


Lyngbya confervoides


Lyngbya majuscule


Colpomenia sinuosa


Sphacelaria tribuloides



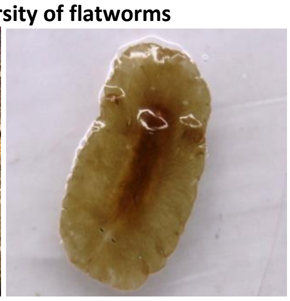

Amphiroa fragilissima *Galaxaura oblongata* *Gelidium pusillum* *Gelidiella acerosa*



Gracilaria verrucosa *Grateloupia filicina* *Acanthophora spicifera*

Species diversity of flatworms






Leptoplana tremellaris *Notoplana australis* *Pericelis hymanae* *Stylochoplana maculata*

Plate1: Species diversity of seaweeds

Varied diversity of seaweeds with 19 species representing 16 genera, 15 families and 13 orders were recorded. Of these, 7 species belongs each to Chlorophyta and Rhodophyta, 2 each to Cyanobacteria and Ochrophyta and 1 to Charophyta. Of the recorded species, 36.84% belongs each to Chlorophyta and Rhodophyta, 10.53% each to Cyanobacteria and Ochrophyta, and 5.26% to Charophyta. Seaweeds like *Ulva lactuca*, *Ulva fasciata*, *Enteromorpha intestinalis*, *E. linza* and *Gracilaria verrucosa* were recorded abundantly at all the stations.

- Sponges: (Table 3, Plate 2)

Table 3: Checklist of sponges, coelenterates, flat worms and polychaetes recorded along Uran coast, Navi Mumbai collected during June 2013 to May 2015

Class	Order	Family		Scientific Name
Sponges				
Calcarea	Leucosolenida	Leucosoleniidae	20	*Leucosolenia complicate* (Montagu,1818)
			21	*Leucosolenia variabilis (Haeckel, 1870)*
Demospongiae	Axinellida	Axinellidae	22	*Axinella damicornis* (Esper, 1794)
			23	*Axinella verrucosa* (Esper, 1794)
	Halichondrida	Halichondriidae	24	*Axinyssa ambrosia* (de Laubenfels, 1936)
			25	*Halichondria bowerbanki* (Burton, 1930)
			26	*Halichondria panacea* (Pallas, 1766)
			27	*Hymeniacidon heliophila* (Parker, 1910)

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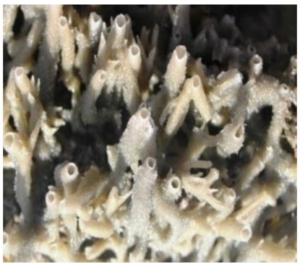
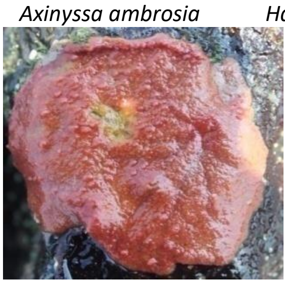
			28	*Hymeniacidon perleve* (Montagu, 1814)
	Haplosclerida	Haliclonidae	29	*Haliclona permollis* (Bowerbank,1866)
	Hadromerida	Hemiasterellidae	30	*Paratimea constellate* (Topsent, 1893)
		Suberitidae	31	*Protosuberitis epiphytum* (Lamarck, 1815)
	Poecilosclerida	Hymedesmiidae	32	*Kirkaptrickia borealis* (Koltun, 1970)
		Microcionidae	33	*Clathria parthena* (de Laubenfels,1930)
	Homosclerophorida	Plakinidae	34	*Plakina monolopha* (Schulze,1880)
Hexactinellida	Hexactinosida	Aphrocallistidae	35	*Aphrocallistes Beatrix* (Gray, 1858)
Coelenterates (Soft corals)				
Anthozoa	Alcyonacea	Nephtheidae	36	Dendronephthya klunzingeri (Studer,1888)
			37	*Dendronephthya hemprichi* (Klunzinger,1877)
Flat worms				
Rhabditophora	Polycladida	Leptoplanidae	38	*Leptoplana tremellaris* (Muller OF, 1773)
		Notoplanidae	39	*Notoplana australis* (Schmarda, 1859)
		Pericelidae	40	*Pericelis hymanae* (Poulter, 1974)
		Stylochoplanidae	41	*Stylochoplana maculata* (Quatrefage, 1845)
Polychaetes				
Polychaeta	Amphinomida	Amphinomidae	42	*Hermodice carunculata* (Pallas, 1766)
	Phyllodocida	Nereididae	43	*Perinereis cultrifera* (Grube, 1840)
			44	*Perinereis nuntiavallata* (Grube, 1857)
		Polynoidae	45	*Enipo gracilis* (Verrill, 1874)
	Terebellida	Terebellidae	46	*Neoamphitrite groenlandica* (Malmgren,1866)

Leucosolenia complicata *Leucosolenia variabilis* *Axinella damicornis* *Axinella verrucosa*




Axinyssa ambrosia *Halichondria bowerbanki* *Halichondria panacea* *Hymeniacidon heliophila*




Hymeniacidon perleve *Haliclona permollis* *Paratimea constellata* *Kirkpatrickia borealis*

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Clathria parthena *Plakina monolopha* *Prosuberites epiphytum* *Aphrocallistes Beatrix*

Species diversity of soft corals and polychaetes




Dendronephthya hemprichi *D. klunzingeri* *Hermodice carunculata* *Perinereis cultrifera*



Perinereis nuntiavallata *Enipo gracilis* *Neoamphitrite groenlandica*

Plate 2: Species diversity of sponges

Collectively, 16 species of sponges representing 12 genera, 10 families and 8 orders were recorded at Uran, of which 13 species belongs to class Demospongiae, 2 to Calcarea and 1 to Hexactinellida. Species such as *Leucosolenia complicate, L. variabilis, Haliclona permollis* and *Clathria parthena* were recorded from site II and III where as *Aphrocallistes Beatrix* was reported only from site I.

- Crabs: (Table 4, Plate 3)

Table 4: Checklist of crabs recorded along Uran coast, Navi Mumbai collected during June 2013 to May 2015

Class	Order	Family		Scientific Name
Brachyuran crabs				
Malacostraca	Decapoda	Grapsidae	47	*Goniopsis cruentata* (Latreille, 1803)
			48	*Grapsus albolineatus* (Lamarck, 1818)
			49	*Metopograpsus frontalis* (Miers, 1880)
			50	*Metopograpsus messor* (Forskål,1775)
			51	*Metopograpsus oceanicus* (H. & Jacquinot,1846)
		Leucosiidae	52	*Persephona mediterranea* (Herbst, 1794)
			53	*Tokoyo eburnea* (Alcock, 1896)
		Matutidae	54	*Matuta lunaris*(Forskal, 1775)
		Menippidae	55	*Myomenippe hardwickii* (Gray, 1831)
		Ocypodidae	56	*Uca annulipes* (H. Milne Edwards, 1837)
			57	*Uca dussumieri* (H. Milne Edwards, 1852)

		Oziidae	58	*Epixanthus frontalis* (H. Milne Edwards, 1834)
			59	*Ozius* rugulosus (Stimpson,1858)
		Polybiidae	60	*Liocarcinus pusillus* (Leach, 1815)
		Porcellanidae	61	*Petrolisthes galathinus* (Bosc,1802)
		Portunidae	62	*Charybdis acuta* (A. Milne-Edwards, 1869)
			63	*Charybdis feriatus* (Linnaeus, 1758)
			64	*Charybdis japonica* (A. Milne-Edwards, 1861)
			65	*Charybdis lucifera* (Fabricius, 1798)
			66	*Charybdis orientalis* (Dana, 1852)
			67	*Charybdis truncata* (Fabricius, 1798)
			68	*Portunus pelagicus* (Linnaeus, 1758)
			69	*Portunus sanguinolentus* (Herbst, 1783)
			70	*Scylla serrata* (Forskål, 1775)
		Sesarmidae	71	*Aratus pisonii* (H. Milne Edwards,1837)
			72	*Metasesarma obesum* (Dana, 1851)
		Xanthidae	73	*Leptodius exaratus* (H. Milne Edwards, 1834)
			74	*Leptodius sanguineus* (H. Milne Edwards, 1834)
			75	*Paractaea monody* (Guinot, 1969)
			76	*Xantho incisus* (H. Milne Edwards, 1834)
			77	*Xantho poressa* (Olivi, 1792)
Anomuran crabs				
Malacostraca	Decapoda	Diogenidae	78	*Clibanarius senegalensis* (Chevreux & Bouvier, 1892)
			79	*Clibanarius taeniatus* (H. Milnne Edwards, 1848)

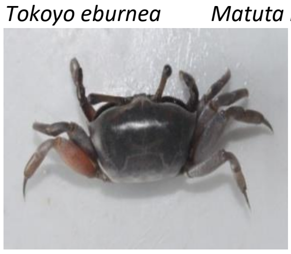



Goniopsis cruentata Grapsus albolineatus Metopograpsus frontalis Metopograpsus messor




M. oceanicus Persephona mediterranea Tokoyo eburnea Matuta lunaris



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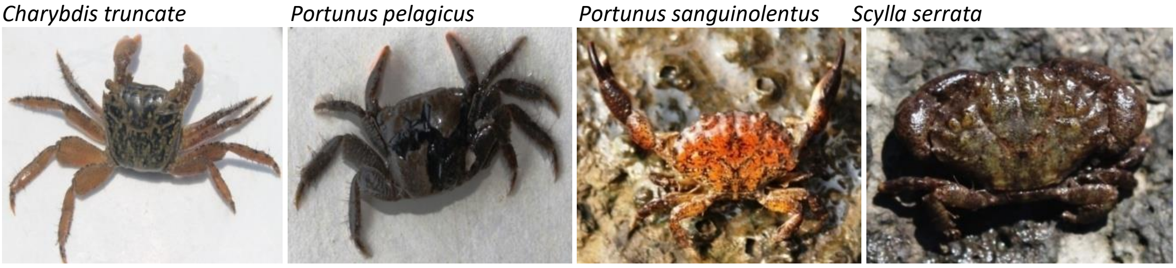
Myomenippe hardwickii Uca annulipes _♀ & ♂ Uca dussumieri Epixanthus frontalis

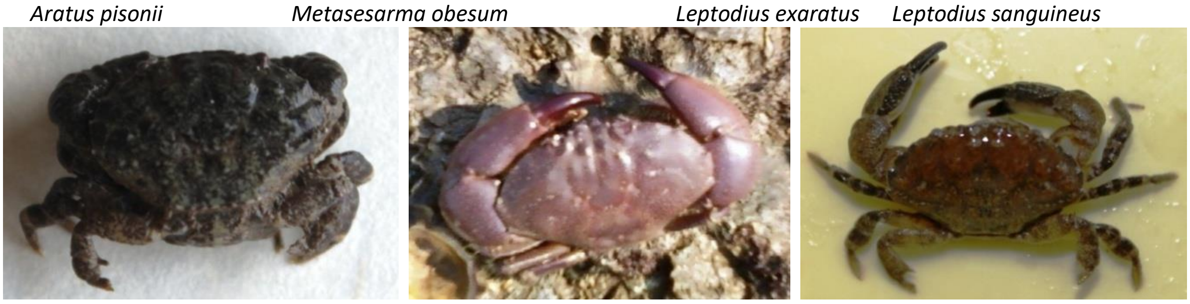
Ozius rugulosus Liocarcinus pusillus Petrolisthes galathinus Charybdis acuta

Charybdis feriatus Charybdis japonica Charybdis lucifera Charybdis orientalis

Charybdis truncate Portunus pelagicus Portunus sanguinolentus Scylla serrata

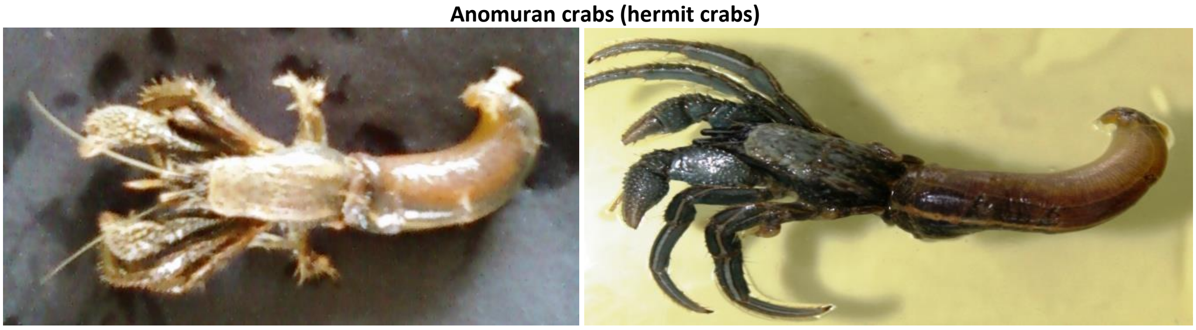


Aratus pisonii Metasesarma obesum Leptodius exaratus Leptodius sanguineus



Paractaea monodi Xantho incises Xantho poressa

Anomuran crabs (hermit crabs)



Clibanarius senegalensis Clibanarius taeniatus

Plate 3: Species diversity of brachyuran crabs

Thirtythree species of crabs belonging to 21 genera and 12 families under the order Decapoda in the class Malacostraca were recorded. Commeercially important brachyuran crabs like *Charybdis feriatus,* *Portunus pelagicus, P. sanguinolentus, Scylla serrata, Epixanthus frontalis, Leptodius sanguineus* and *Xantho incises* were reported from all stations. Anomuran crabs belonging to 2 species of family Diogenidae were also recorded.

- Mollusca: (Table 5 & 6, Plate 4 & 5)

Table 5: Checklist of gastropods recorded along Uran coast, Navi Mumbai collected during June 2013 to May 2015

Class	Order	Family		Scientific Name
Gastropods				
Gastropoda	Archaeo-gastropoda	Fissurellidae	80	*Diodora gibberula* (Lamarck, 1822)
		Nacellidae	81	*Cellana radiata* (Born, 1778)
		Trochidae	82	*Trochus radiates* (Gmelin, 1791)
			83	*Trochus tentorium* (Gmelin,1791)
			84	*Umbonium vestiarium* (Linnaeus, 1758)
			85	*Trochus stellatus* (Gmelin, 1791)
			86	*Trochus maculates* (Linnaeus, 1758)
			87	*Clanculus guineensis* (Gmelin, 1791)
		Turbinidae	88	*Astraea stellata* (Gmlin, 1791)
			89	*Astraea semicostata* (Kiener, 1850)
	Caeno-gastropoda	Cerithiidae	90	*Clypeomorus bifasciatus* (Sowerby II, 1855)
			91	*Clypeomorus moniliferus* (Kiener, 1841)
		Potamididae	92	*Telescopium telescopium* (Linnaeus, 1758)
			93	*Potamides cingulatus* (Gmelin, 1791)
	Chitonida	Ischnochitonidae	94	*Ischnochiton australis* (G.B. Sowerby II, 1833)
	Cyclo-neritimorpha	Neritidae	95	*Nerita undata* (Linnaeus, 1758)
			96	*Nerita albicilla* (Linnaeus, 1758)
			97	*Nerita crepidularia* (Lamarck, 1816)
			98	*Nerita oryzarum* (Recluz, 1841)
			99	*Nerita costata* (Gmelin, 1791)
			100	*Nerita chamaeleon* (Linnaeus, 1758)
			101	*Nerita aterrima* (Gmelin, 1791)
			102	*Neritina* pulligera (Linnaeus, 1758)
			103	*Neritina punctulata* (Lamarck, 1816)
	Littori-nimorpha	Bursidae	104	*Bursa tuberculata* (Broderip,1833)
			105	*Bursa granularis* (Roding, 1798)
			106	*Bursa spinosa* (Schumacher, 1817)
			107	*Bursa lissostoma* (E. A. Smith, 1914)
		Cypraeidae	108	*Erosaria lamarckii (*J.E. Gray, 1825)
			109	*Luria lurida* (Linnaeus, 1758)
			110	*Cypraea tigris* (Linnaeus, 1758)

		Ficidae	111	*Ficus gracilis* (G. B. Sowerby I,1825)
		Naticidae	112	*Natica didyma* (Röding, 1798)
			113	*Natica rufa* (Born, 1778)

Table 5: Continued

Class	Order	Family		Scientific Name
		Rostellariidae	114	*Tibia curta* (G. B. Sowerby II, 1842)
		Tonnidae	115	*Tonna dolium* (Linnaeus, 1758)
	Neo-gastropoda	Buccinidae	116	*Cantharus* spiralis (Gray, 1839)
		Clavatulidae	117	*Makiyamaia arthopleura* (Kilburn, 1983)
		Columbellidae	118	*Parvanachis obesa* (C. B. Adams, 1845)
		Conidae	119	*Conus ambiguus* (Reeve, 1844)
			120	*Conus circumactus* (Iredale, 1929)
		Mangeliidae	121	*Propebela harpularia* (Couthouy, 1838)
		Muricidae	122	*Drupa konkanensis* (Melvill, 1893)
			123	*Indothais blanfordi* (Melvill, 1893)
			124	*Murex brunneus* (Link, 1807)
			125	*Murex bundharmai* (Houart, 1992)
			126	*Purpura bufo* (Lamarck, 1822)
			127	*Stramonita floridana* (Conrad, 1837)
			128	*Thais carinifera* (Lamarck, 1822)
			129	*Thais sacellum* (Gmelin, 1791)
			130	*Thais gradata* (Jonas, 1846)
			131	*Vasula deltoidea* (Lamarck, 1822)
		Nassariidae	132	*Nassarius vibex* (Say, 1822)
		Onchidiidae	133	*Onchidium damelii* (Semper, 1882)
		Volemidae	134	*Hemifusus pugilinus* (Born, 1778)
			135	*Hemifusus cochlidium* (Linnaeus, 1758)
		Chromodorididae	136	*Mexichromis mariei* (Crosse, 1872)
		Lottiidae	137	*Lottia septiformis* (Quoy & Gaimard, 1834)
			138	*Lottia tenuisculpta* (Sasaki & Okutani,1994)
			139	*Acmaea subrugosa* (d'Orbigny, 1846)

Table 6: Checklist of pelecypods, cephalopods and tunicates recorded along Uran coast, Navi Mumbai collected during June 2013 to May 2015

Class	Order	Family		Scientific Name
Pelecypods				
Pelecypoda	Arcoida	Arcidae	140	*Arca granosa* (Linnaeus, 1758)
			141	*Barbatia barbata* (Linnaeus, 1758)
			142	*Barbatia foliata* (Forsskål in Niebuhr,1775)
			143	*Barbatia virescens* (Reeve, 1844)

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			144	*Barbatia obliquata* (Wood, 1828)
	Ostreoida	Ostreidae	145	*Crassostrea virginica* (Gmelin, 1791)
			146	*Saccostrea scyphophilla* (Peron & Lesueur, 1807)
			147	*Saccostrea glomerata* (Gould, 1850)
	Pectinoida	Pectinidae	148	*Volachlamys tranquebaria* (Gmelin, 1791)
			149	*Volachlamys singaporina* (Sowerby II, 1842)
		Placunidae	150	*Placuna placenta* (Linnaeus, 1758)
	Veneroida	Corbiculidae	151	*Villorita cyprinoides* (Gray, 1825)
		Psammobiidae	152	*Hiatula diphos* (Linnaeus, 1771)
		Trapezidae	153	*Trapezium sublaevigatum* (Lamarck, 1819)
		Veneridae	154	*Callista chione (Linnaeus,* 1758)
			155	*Chamelea gallina (Linnaeus,* 1758)
			156	*Dosinia caerulea (Reeve,* 1850)
			157	*Dosinia exoleta (Linnaeus,* 1758)
			158	*Gafrarium divaricatum* (Gmelin, 1791)
			159	*Katelysia japonica* (Gmelin, 1791)
			160	*Meretrix casta* (Gmelin, 1791)
			161	*Meretrix meretrix* (Linnaeus, 1758)
			162	*Meretrix lamarckii* (Deshayes, 1853)
			163	*Paphia rhomboides* (Pennant, 1777)
			164	*Pitar hebraeus* (Lamarck, 1818)
			165	*Protapes gallus* (Gmelin, 1791)
Cephalopods				
Cephalopoda	Myopsida	Loliginidae	166	*Loligo vulgaris* (Lamarck, 1798)
	Octopoda	Octopodidae	167	*Eledone cirrhosa* (Lamarck, 1798)
			168	*Octopus vulgaris* (Cuvier, 1797)
	Sepiida	Sepiidae	169	*Sepia officinalis* (Linnaeus, 1758)
Tunicates				
Ascidiacea	Aplouso-branchia	Euherdmaniidae	170	*Euherdmania claviformis* (Ritter, 1903)

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

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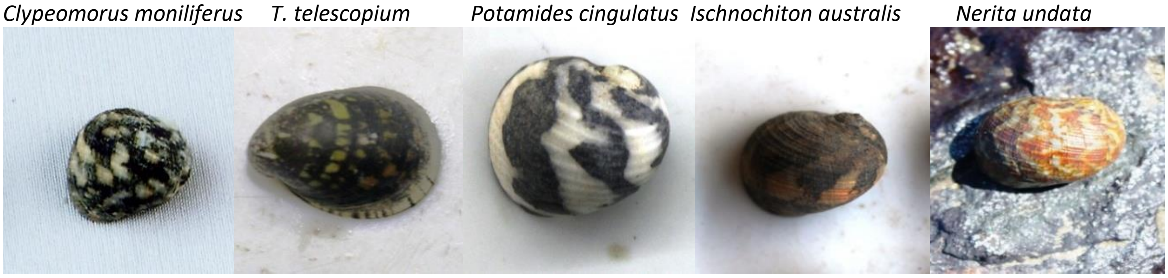
T. stellatus   T. maculatus   Umbonium vestiarium   Astraea stellata   C. bifasciatus

Clypeomorus moniliferus   T. telescopium   Potamides cingulatus   Ischnochiton australis   Nerita undata



Nerita albicilla   Nerita crepidularia   Nerita oryzarum   Nerita costata   Nerita chamaeleon

Species diversity of gastropods

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

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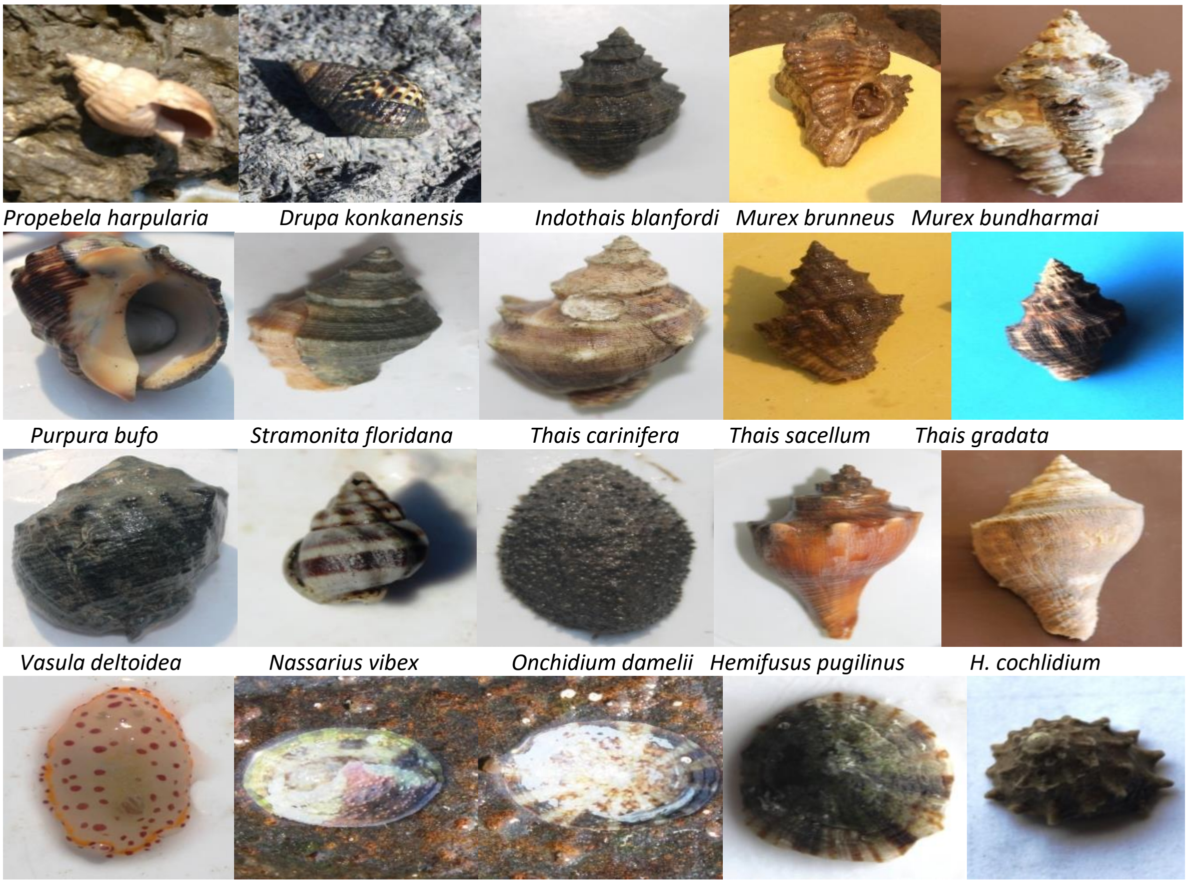


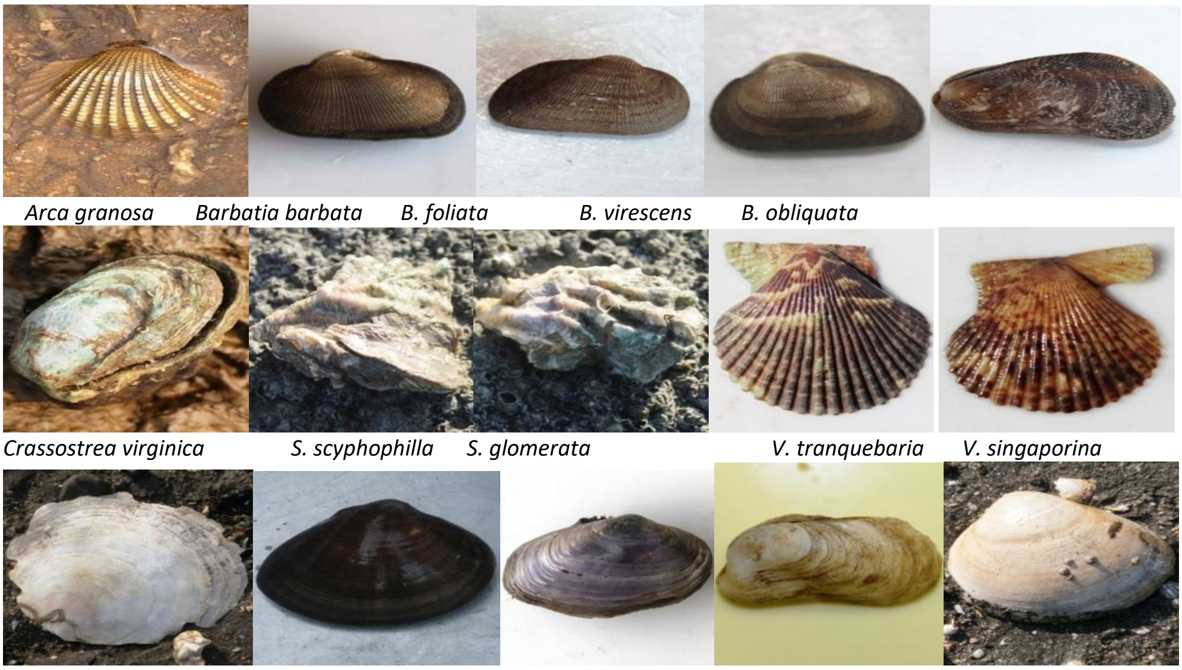
Propebela harpularia *Drupa konkanensis* *Indothais blanfordi* *Murex brunneus* *Murex bundharmai*

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

Vasula deltoidea *Nassarius vibex* *Onchidium damelii* *Hemifusus pugilinus* *H. cochlidium*

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

Plate 4: Species diversity of gastropods



Arca granosa *Barbatia barbata* *B. foliata* *B. virescens* *B. obliquata*

Crassostrea virginica *S. scyphophilla* *S. glomerata* *V. tranquebaria* *V. singaporina*

Placuna placenta *Villorita cyprinoides* *Hiatula diphos* *Trapezium sublaevigatum* *Callista chione*

Plate 5: Species diversity of pelecypods, cephalopods and tunicates

The present study noted 90 species of molluscs belonging to 60 genera, 36 families, 15 orders and 3 classes. The class gastropoda was dominant among the molluscs with 60 species and 25 families. 26 species of bivalves belonging to 18 genera, 8 families and 4 orders and, 4 species of cephalopods were also reported. Most of the gastropods were recorded on the gravel surfaces, among seaweeds, or between rocks. The bivalves observed in present study were found adhering to rocks in the littoral zone.

- Other macrobenthos:

Five species of polychaetes, 4 species of flat worms, 2 species of soft corals and 1 species of tunicates were also recorded.

The high diversity of gastropods at Uran is correlated to the existence of abundant rocks onto which gastropods can easily attach, as well as characteristics of the intertidal zones. It is also noted that the individual densities and abundances of the molluscan population were significantly higher than those of other groups [36]. Rios-Jara et al. [35] reported that the localities with more than one type of habitat have a larger number of species. In present study, highest species density of macrobenthos was recorded during post-monsoon and pre-monsoon season than the monsoon. Decrease in density of macrobenthos during the monsoon may be attributed to the low temperatures and salinities [20].

At Uran coast, the macrobenthos show clumped distribution followed by the uniform pattern of distribution [25]. Tantikamton et al [41] stated that water temperature, dissolved oxygen, salinity and nitrate in sediment were related to biodiversity. Also, a negative correlation between the density of the macrobenthos and mean grain size, and beach slope was reported by [13].

Srisunont et al [39] described that biodiversity can indicate ecosystem healthiness and richness of living organisms demonstrates good environment status due to suitable for life. Macrobenthos is one of the most popular indicators to indicate richness of nutrients which refer to water and sediment quality. Marine coastal ecosystems are among the most productive and diverse communities on Earth and are of global importance to climate, nutrient budgets, and primary productivity [37]. According to Costello et al. [10] classification of species provides hypotheses for the evolution, organisation, and ecological interactions of biodiversity from genes to ecosystems.

Results of the present study are in agreement with the work of Fernandes and Soares-Gomes [13] in Rio de Janeiro, Brazil, Datta et al. [11] in the intertidal region of south Mumbai, Rios-Jara et al. [35] on Gulf of Tehuantepec, Mexico, Ryu et al. [36] on Rocky Shores of Dokdo, Korea and, Mosbahi et al., [26] from the Kneiss Islands (Central Mediterranean Sea).

Zingde and Govindan [43] reported that Mumbai being a highly urbanised and industrialised city in India, discharges up to 230 million litres of industrial waste per day (MLD) and domestic wastes of around 2,200 MLD into the coastal ecosystem, of which, 1800 MLD are untreated. The Uran coast receives large daily volume of domestic and industrial wastes and effluents from Asia's largest industrialized zone namely Thane Belapur industrial area, Navi Mumbai Municipal Corporation and effluents from Jawaharlal Nehru Port [29]. Maritime activities of JNP and local dredging activities have promoted the changes in physico-chemical parameters, and inorganic nutrients in the seawater surrounding the Jawaharlal Nehru Port [28]. These activities have affected the water quality and diversity of macrobenthos from coastline of Uran [30, 31, 32].

Results of the study can be used as a baseline for understanding a major but understudied component of the Uran marine ecosystem and will provide a foundation for further research focused on changes in invertebrate distribution, abundance, and biology, to be integrated into largescale studies of ecosystems.

CONCLUSION

The present study contributes an inventory of 170 species of macrobenthos dominated by molluscs and crustaceans, which appears similar with other coastal marine ecosystems of India. This study indicates that intertidal region of Uran coast is fertile and provides a suitable habitat for diverse and wide range of organisms. The marine ecosystem of Uran is still under investigation and needs further research especially on marine macrobenthos. Immediate planning of conservation strategies is required for nearly the entire region. Port activities, agricultural expansion, logging, and road construction activities continue to threaten the diversity of Uran coast. Long-term monitoring studies are recommended to evaluate the impacts of human activities on the local marine communities.

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REFERENCES

[1] Adrianov Andrey V, Konstantin A Lutaenko, Kwang-Sik Choi and Liu Ruiyu. Final report for APN project: ARCP2008-05CMY-Adrianov. 2009; pp 134.
[2] Airoldi L. and Beck M. W. Oceanography and Marine Biology: An Annual Review, 2007; 45: 345-405.

[3] Appeltans Ward., Shane T Ahyong, Gary Anderson, Martin V Angel, Tom Artois, Nicolas Bailly, Roger Bamber, Anthony Barber, Ilse Bartsch et al. Current Biology, 2012; 22:2189–2202. http://dx.doi.org/10.1016/j.cub.2012.09.036.

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

[5] Behera, Durga Prasad and Lakshman Nayak. International Journal of Ecosystem, 2013; 3(6):172-176. DOI: 10.5923/j.ije.20130306.02.

[6] Bhavanath Jha., C. R. K. Reddy, Mukund C. Thakur and M. Umamaheswara Rao. Seaweeds of India -The Diversity and Distribution of Seaweeds of the Gujarat Coast. DOI 10.1007/978-90-481-2488-6 Springer Dordrecht Heidelberg London New York 2009; pp. 216.

[7] Borja A. and Dauer D. M. Ecological Indicators, 2008; 8:331-337. http://dx.doi.org/10.1016/j.ecolind.2007.05.004.

[8] Cantera J. R. Estadios de vida vulnerable de organismos marinos de Bahía Málaga. Guía para su identificación. Programa Editorial. Cali: Universidad del Valle. 2011; 144 p.

[9] Coan Eugene V. and Paul Valentich Scott. Bivalve Seashells of Tropical West America. Marine Bivalve Mollusks from Baja California to Northern Peru Part I. Santa Barbara Museum of Natural History Monographs No. 6, Studies in Biodiversity No. 4. Santa Barbara Museum of Natural History, 2559 California 93105-2936 USA, http://www.sbnature.org ISBN (13) 978-0-936494-43-2, 2012; pp. 426.

[10] Costello Mark John, Simon Claus, Stefanie Dekeyzer, Leen Vandepitte, Eamonn ´O Tuama, Dan Lear and Harvey Tyler-Walters. PeerJ 2015; 3:e1201; DOI 10.7717/peerj.1201.

[11] Datta S. N., S. K. Chakraborty, A. K. Jaiswar and K. Venkateshvaran. J. Mar. Biol. Ass. India, 2008; 50 (1): 29-37.

[12] Dean H. K. Int J Trop Biol., 2008; 56: 11-38.

[13] Fernandes Renata Soares Ramalho and Abilio Soares-Gomes. Marine Ecology, 2006; 27: 160–169.

[14] Hadjibiros, K. Ecology and Applied Environmental Science. CRC Press, Taylor and Francis Group, Boca Raton, 2013; pp. 234.

[15] HELCOM. Baltic Sea Environment Proceedings, 2012; No. 130.

[16] Hendrickx M. and A. W. Harvey. Belgian Journal of Zoology, 1999; 129(2): 363-389.

[17] Hibberd Ty & Kirrily Moore. Field Identification Guide to Heard Island and McDonald Islands Benthic Invertebrates. The Department of Environment, Water, Heritage and the Arts, Australian Antarctic Division and the Fisheries Research and Development Corporation 2009; pp. 159.

[18] Jeyabaskaran R. S. and Wafar M. CD on Brachyuran Crabs of West Coast, India, National Institute of Oceanography, Dona Paula, Goa, India, 2002.

[19] Krieg Kate. Field Guide to Oregon's Rocky Intertidal. PISCO's Online Taxonomic Database. 2005, pp. 126.

[20] Kumar Palanisamy Satheesh and Anisa Basheer Khan. Aquatic Biosystems, 2013; 9:15 doi: 10.1186/2046-9063-9-15.

[21] Lozano-Cortes Diego, Edgardo Londono-Cruz, Vanessa Izquierdo, Fatnori Arias, Madeleine Barona and Valentina Zambrano. Check List, 2012; 8(4): 703–708.

[22] Lu L. Mar. Pollut. Bull., 2005; 51:1034-1040. http://dx.doi.org/10.1016/j.marpolbul.2005.02.013.

[23] Mahapatro D., Panigrahy R. C., Panda S. and Mishra R. K. J Coast Zone Manag 2015b; 18: 406. doi: 10.4172/2473-3350.1000406.

[24] Mahapatro Debasish, Panigrahy R. C., Panda S. and Mishra R. K. International Journal of Marine Science, 2015a; (33): 1-13. doi: 10.5376/ijms.2015.05.0033.

[25] Medrano Mary Grace T. International Journal of Technical Research and Applications, 2015, 9: 5-9.

[26] Mosbahi N., Pezy J.-P., Dauvin J.-C. and Neifar L. Open Journal of Marine Science, 2016; 6:223-237. http://dx.doi.org/10.4236/ojms.2016.62018.

[27] Nozeres C., Vandepitte L., Appeltans W., and Kennedy M. Best Practice Guidelines in the Development and Maintenance of Regional Marine Species Checklists. Copenhagen: Global Biodiversity Information Facility, 2012; 32pp, ISBN: 87-92020-46-1, http://www.gbif.org/orc/?doc_id=4712.

[28] Pawar Prabhakar R. Mar. Poll. Bull. 2013; 75:291–300. http://dx.doi.org/10.1016/j.marpolbul.2013.06.045

[29] Pawar Prabhakar R. J. Bioremed. Biodeg. 2015; 6:299. doi:10.4172/2155-6199.1000299.

[30] Pawar Prabhakar R. Adv. Environ. Biol., 2017; 1(2): 103-112.

[31] Pawar Prabhakar R. and Abdel Rahman Mohammad Said Al-Tawaha. Am.-Eursion j. Sustain. Agric., 2017a; 11(2): 19-30.

[32] Pawar Prabhakar R. and Abdel Rahman Mohammad Said Al-Tawaha. Adv. Environ. Biol., 2017b; 11(4): 1-11.

[33] Ramakrishna and Dey A. Part-I. *Rec. zool. Surv. India, Occ. Paper No.*, 2010; 320:1-357 (Published by the Director, *Zool. Surv. India,* Kolkata).

[34] Reiss H. and Kroncke I. Mar. Pollut. Bull., 2005; 50:1490-1499. http://dx.doi.org/10.1016/j.marpolbul.2005.06.017.

[35] Rios-Jara Eduardo, Ceciel-M. Navarro-Caravantes, Cristian-M. Galvan-Villa, and Ernesto Lopez-Uriarte. Journal of Marine Biology, 2009; Article ID 176801, 12 pages doi:10.1155/2009/176801.

[36] Ryu Shi-Hyun, Kuem-Hee Jang, Eun-Hwa Choi, Sang-Ki Kim, Sung-Joon Song et al. Zoological Studies, 2012; 51(5): 710-726.

[37] Solan Martin, Bradley J. Cardinale, Amy L. Downing, Katharina A. M. Engelhardt, Jennifer L. Ruesink and Diane S. Srivastava. SCIENCE, 2004; 306: 1177-1180.

[38] Spiridonov V. A., M. V. Gavrilo, E. D. Krasnova and N.G. Nikolaeva. Atlas of marine and coastal biological diversity of the Russian Arctic.—Moscow: WWF Russia, 2011; - 64 pp. A92, ISBN 978.5.9902786.2.2.

[39] Srisunont Chayarat, Nisachon Thongsanit, Jugkarin Suttiwichai and Adtapol Boonjan. Proceedings of the 3rd National Meeting on Biodiversity Management in Thailand. 2016; : 239–245.

[40] Susan V. Dalia, N. G. K. Pillai and P. Satheeshkumar. World Journal of Fish and Marine Sciences, 2012; (5): 449-453. DOI: 10.5829/idosi.wjfms.2012.04.05.63165.

[41] Tantikamton Khwanta, Nathawut Thanee, Suwit Jitpukdee, and Murray Potter. Int'l Journal of Advances in Agricultural & Environmental Engg., 2015; 2(1): 23-27. http://dx.doi.org/10.15242/IJAAEE.C0415023.

[42] Van Soest R. W. M., Boury-Esnault N., Hooper J. N. A., Rutzler K. de Voogd N. J., Alvarez de Glasby B., Hajdu E., Pisera A. B., Manconi R., Schoenberg C., Janussen D., Tabachnick K. R., Klautau M., Picton B., Kelly M., Vacelet J., Dohrmann M., Cristina Díaz M. & Cardenas P. World Porifera Database, 2014; http://www.marinespecies.org/porifera.

[43] Zingde M. D. and K. Govindan. Health status of coastal waters of Mumbai and regions around. In: Sharma V. K. (Ed.) Environmental problems of coastal areas in India. Bookwell Publ. New Delhi, India, 2000, pp.119-132.