

Original Research Article

Molluscan Diversity on Miramar Beach, Goa, India

I. K. Pai* and Snehal S. Kanekar

Department of Zoology, Goa University, Goa-403 206, India

*Corresponding author: ikpai@unigoa.ac.in

Received: September 26, 2016; revised: December 5, 2016; accepted: December 6, 2016

Abstract: The molluscs compose the large phylum of invertebrate, has around 85,000 extant species comprises about 23% of all the named marine organisms. They live in marine waters, freshwater and also terrestrial habitats. They are highly diverse with regards to their size, structure, behavior and in habitat. The phylum is typically divided into 10 taxonomic classes, of which two are entirely extinct. Like any other groups, several molluscs are being discovered every year and the list of molluscs increases on regular basis. In India malacologists have contributed in discovering 'new species' every now and then. Despite the above, as Goa was liberated much later than Indian independence, there is a lacunae on the knowledge about the molluscan diversity in this part of our country. So, to understand the molluscan diversity, an opportunistic survey was conducted from June to January, at Goa's famous, Miramar beach, a beach in the middle of the city. In the present survey, transect and quadrat method was followed. The results showed the presence of 47 species of mollusc under 23 different families on the beach, proving rich molluscan diversity in the study site. Appearance of the species varies during monsoon and winter seasons of the year. Highest number of species was recorded during the monsoon season which gradually declines with the onset of autumn and winter season. It has been speculated that appearance of molluscan species depend upon the temperature and food of the beach. Maximum number of the species during monsoon is due to the availability of food and optimum temperature for breeding.

Key words: Marine ecology, Miramar beach, Molluscan diversity

Introduction

Molluscs are the soft bodied organisms, found mostly in marine and sometime in freshwater having around 50,000 to 1,20,000 described species (Chapman, 2009). In 1969, David estimated the number of extant molluscs are around 1,07,000 of which were about 12,000 fresh-water gastropods and 35,000 terrestrial. Bivalves account for around 14% of the molluscs, making them largest group among the molluscs (David, 1969). Around 23% of molluscs are Marine in nature (Hancock, 2008). They are considered as one the most successful organisms on this globe with considerable diversity in size (1mm to 15m), density (up to 40,000/m²) (Mohamed, 2012), ecological niche, living style, neurological advancement,

reproductive capacity etc. existing since Cambrian period. They include diverse organism such as snails, slugs and other gastropods; clams and other bivalves; mussels, oysters, clams, pearl-oysters, window-pane oysters, ark-shells, whelks, chanks, cowries, squids and cuttlefish etc.

India's has a coastline of 7,517 km with 43% sandy beaches; 11% rocky shores, including cliffs; and 46% mudflats or marshy shores. Later, Khade and Mane (2012) studied diversity of Bivalve and Gastropod, Molluscs of some localities from Raigad district, Maharashtra, west coast of India and reported the presence of bivalve (14 species belonging to 6 families and 4 orders) and 49 species of Gastropodes

belonging to 15 families and 5 orders Venkatraman and Venkataraman (2012) reported the diversity of Molluscan fauna along the Chennai coast. Ashok kumar *et al.* (2013) studied the diversity and distribution of intertidal mollusca of Saurashtra coast of Arabian Sea, India. Bijukumar *et al.* (2015) have provided monumental information on molluscan diversity at Lakshdeep. Vanamali and Jadhav (2005) assessed the Molluscan diversity of Dativare coast of Vaitarna estuary, Dist. Palghar, Maharashtra (India) and reported 30 species of molluscs belonging to 20 general and seven orders. Recently, in 2015, Tripathy and Mukhopadyay have well narrated extensive, earliest works, since 1930's, on study on molluscan diversity of India.

Regarding Goa coastline, it was Mascarenhas (1999), who recorded the role of anthropogenic activities on molluscs in Goa. Chatterji *et al.* (2002) evaluated molluscan diversity as potential source of antiviral drugs. Ingole and Clemente (2006) recorded the status of windowpane oyster *Placuna placenta* in Goa. Later in 2013, Anuradha worked on Biodiversity and distribution of marine gastropods (Mollusca), during pre and post monsoon seasons, Sreekanth *et al.* (2016) studied the effect of monsoon on coastal fish diversity including molluscs of Goa. Despite of the above, as there is no substantial study on molluscan diversity on Miramar beach, which is considered as a faunal store house, the present investigations were carried out.

Materials and methods

The state of Goa is known for several world famous beaches such as Calngute, Colva, Arambol, Vegator etc. Among them the Miramar beach has a special place as it is located within the city limits of Panjim the state capital. It is one of the most visited beaches of Goa. Many people mostly tourists come to this beach every day. Original name of the beach was Porta de Gaspar Dias, was then changed to Miramar, meaning 'vision of the Sea'. The beach is about 2.5 km long and sandy and spread along the estuary of Mandovi river entering Arabian Sea. During low tide water moves back to 500-600 m and during monsoon, the water will be rough and muddy.

A transect, about 100 m away and parallel to water line was marked. On this transect, quadrate of 1m L x 1m B x 30 cm D was marked alternatively on either side of the transect at a distance of 10 m each. The sand in these quadrates was moved and an all out search for moluscan shells was carried out. The shell obtained from each of the quadrate was recorded. Similar efforts were made at an interval of fortnight for 8 months starting from June, the monsoon to January, the winter. The shells obtained were cleaned in the laboratory and later the species was identified, recorded and tabulated. The identification of the shells was done by following standard literature (Hornell, 1951; Bartch, 1968; Abbott, 1973; Apte, 1998).

Results

Table 1 provides the data on molluscan diversity observed at Miramar beach. Table indicates the presence of 47 species of mollusks belonging to 23 families, both univalves and bivalves. It is also evident from same table that molluscs like *Arca granosa* *Arca bistrigata* belonging to Fl. Arcidae; *Paphia malabarica* from Fl: Veneridae; *Donax incarnates* (Fl: Donacidae) *Spisula voyi* (Fl. Mactridae) *Anomia simplex* (Fl: Anomiidae) *Perna viridis* (Fl: Mytillidae) were found to be present in all the eight month of study period. On the contrary, *Sunetta donacina* (Fl: Veneridae); *Donax cunaetus* (Fl: Donacidae); *Cardium setosum* (Fl: Cardidae); *Solen truncates* and *Siliqua radiate* both species belonging to Fl. Solenidae; *Cardiota antiquate* (Fl: Cardidae); *Chlamys singapurina* (Fl: Pectinidae); *Chama fragum* (Fl: Chamidae); *Nerita oryzarum* and *Nerita albicilla* (Fl: Neritidae); *Chrysame ambigua* (Fl. Mitridae); *Oliva nivosa* (Fl: Olividae); *Nassarius stalatus* (Fl: Nassaridae); *Thais tissoti* (Fl: Muridae) and *Babylonia spirata* (Fl: Buccinidae) were observed only during a particular month.

Further number of species observed during various months was 26 in June, 31 in July, 30 in August, 29 in September, 22 in October, 14 in November, 15 in December and 17 in the month of January. The trend indicates higher number of species during Monsoon probably matching with reproductive season and later there is a decline in the number species from October to January.

Table 1: Molluscan Diversity At Miramar Beach, Goa

Sl. No.	Name of the Organism	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	No. of months present
I. FL: ARCIDAE										
1	<i>Arca granosa</i> (Linnaeus, 1758)	10	10	10	9	10	10	8	10	8
2	<i>Arca bistrigata</i> (Dunker, 1866)	10	10	10	10	10	6	10	10	8
3	<i>Arca symmetrica</i> (Reeve, 1844)	8	8	6	4	2	0	3	2	7
4	<i>Arca inequivalis</i> (Bruguère, 1792)	8	5	6	6	4	0	0	2	6
FL: VENERIDAE										
5	<i>Paphia textile</i> (Gmelin, 1791)	5	4	2	2	0	2	0	0	5
6	<i>Paphia malabarica</i> (Dillwyn, 1817)	9	2	4	3	2	3	3	2	8
7	<i>Dosinia prostrate</i> (Linnaeus, 1758)	10	9	6	6	5	3	0	2	7
8	<i>Dosinia cretacea</i> (Reeve, 1850)	0	1	0	0	0	0	3	2	3
9	<i>Sunetta effosa</i> (Link, 1807)	6	5	5	3	2	0	8	7	7
10	<i>Sunetta donacina</i> (Gmelin, 1791)	0	0	0	0	2	0	0	0	1
11	<i>Sunetta scripta</i> (Linnaeus, 1758)	0	1	0	2	5	0	0	0	3
12	<i>Meretrix meretrix</i> (Linnaeus, 1758)	7	3	4	3	7	9	0	6	7
13	<i>Meretrix casta</i> (Gmelin, 1791)	9	8	7	4	2	4	4	0	7
14	<i>Circe scripta</i> (Linnaeus, 1758)	3	1	0	2	0	0	0	0	3
I. FL: DONACIDAE										
15	<i>Donax scortum</i> (Linnaeus, 1758)	8	7	8	3	7	0	8	7	7
16	<i>Donax incarnates</i> (Gmelin, 1791)	8	8	6	10	4	4	5	7	8
17	<i>Donax cunaetus</i> (Linnaeus, 1758)	0	0	1	0	0	0	0	0	1
II. FL. MACTRIDAE										
18	<i>Spisula voyi</i> (Gabb, 1866)	10	10	9	9	8	8	10	10	8
19	<i>Mectra cornea</i> (Reeve, 1854)	6	2	2	0	3	6	4	0	6
III. FL: CARDIDAE										
20	<i>Cardium setosum</i> (Redfield, 1846)	0	0	0	1	0	0	0	0	1
21	<i>Cardium asiaticum</i> (Bruguère, 1789)	3	1	2	0	0	0	0	1	4
IV. FL: SOLENIDAE										
22	<i>Venerupis macrophylla</i> (Dash, 1853)	0	2	2	0	0	0	0	0	2
23	<i>Solen truncates</i> (Philippi, 1843)	0	0	0	2	0	0	0	0	1
24	<i>Siliqua radiata</i> (Linnaeus, 1758)	0	0	0	2	0	0	0	0	1
I. FL: TELLINIDAE										
25	<i>Angulus sinuata</i> (Speng. 1782)	5	7	4	2	5	5	0	3	7
II. FL: ANOMIIDAE										
26	<i>Placenta placenta</i> (Linnaeus, 1758)	0	2	4	2	2	0	0	0	4
27	<i>Anomia simplex</i> (Orbigny, 1842)	10	10	6	9	7	7	9	8	8
III. FL: CARDIDAE										
28	<i>Cardiota antiquate</i> (Linnaeus, 1758)	0	0	1	0	0	0	0	0	1
29	<i>Beguina veriegeta</i> (Bruguère, 1792)	0	1	2	0	0	0	0	0	2
IV. FL: PECTINIDAE										
30	<i>Chlamys tranquebaricus</i> (Gmelin, 1791)	6	2	3	5	0	3	2	5	7
31	<i>Chlamys singapurina</i> (Smith, 1915)	0	0	0	1	0	0	0	0	1
V. FL: MYTILLIDAE										
32	<i>Perna viridis</i> (Linnaeus, 1758)	10	10	10	10	10	10	10	10	8
VI. FL: CHAMIDAE										
33	<i>Chama fragum</i> (Douvillei Lamy, 1921)	2	0	0	0	0	0	0	0	1
UNIVALVESXIII.										
FL: FISSURELLIDAE										
34	<i>Diodora ticaonica</i> (Reeve, 1850)	0	0	2	0	2	0	0	0	2
FL: NERITIDAE										
35	<i>Nerita oryzarum</i> (Récluz, 1841)	0	1	0	0	0	0	0	0	1
36	<i>Nerita albicilla</i> (Linnaeus, 1758)	0	0	1	0	0	0	0	0	1
FL: TROCHIDAE										

37	<i>Umbonium vestiarius</i> (Linnaeus, 1758)	0	0	0	2	4	0	0	0	2
	FL: TURRITELLIDAE									
38	<i>Turritella duplicata</i> (Linnaeus, 1758)	2	1	0	3	0	0	2	0	4
39	<i>Turritella terebra</i> (Linnaeus, 1758)	0	1	0	0	0	0	2	0	2
	FL: NATICIDAE									
40	<i>Natica picta</i> (Recluz, 1843)	3	4	0	3	0	0	0	0	3
41	<i>Natica maculosa</i> (Lamarck, 1822)	3	1	1	0	1	0	0	0	4
	FL: BURSIDAE									
42	<i>Bursa tuberosissima</i> (Reeve, 1844)	2	1	2	0	0	0	0	0	3
	FL: MITRIDAE									
43	<i>Chrysame ambigua</i> (Swainson, 1829)	0	0	2	0	0	0	0	0	1
	XIV. FL: OLIVIDAE									
44	<i>Oliva nivosa</i> (Marrat, 1871)	0	0	0	1	0	0	0	0	1
	XIV. FL: NASSARIDAE									
45	<i>Nassarius stalatus</i> (Gmelin, 1791)	1	0	0	0	0	0	0	0	1
	XIV. FL: MURICIDAE									
46	<i>Thais tissoti</i> (Petit, 1852)	0	0	0	1	0	0	0	0	1
	FL: BUCCINIDAE									
47	<i>Babylonia spirata</i> (Linnaeus, 1758)	0	0	1	0	0	0	0	0	1
	Total number of species	26	31	30	29	22	14	15	17	

Table 2. Monthwise distribution of molluscs at Miramar Beach, Goa

8 Months (7 species)	<i>Arca granosa</i> (Linnaeus, 1758) <i>Arca bistrigata</i> (Dunker, 1866) <i>Paphia malabarica</i> (Dillwyn, 1817) <i>Donax incarnates</i> (Gmelin, 1791) <i>Spisula voyi</i> (Gabb, 1866) <i>Anomia simplex</i> (Orbigny, 1842) <i>Perna viridis</i> (Linnaeus, 1758)
7 months(8 species)	<i>Arca symmetrica</i> (Reeve, 1844) <i>Dosinia prostrate</i> (Linnaeus, 1758) <i>Sunetta effosa</i> (Link, 1807) <i>Meretrix meretrix</i> (Linnaeus, 1758) <i>Meretrix casta</i> (Gmelin, 1791) <i>Donax scortum</i> (Linnaeus, 1758) <i>Angulus sinuata</i> (Speng, 1782) <i>Chlamys tranquebaricus</i> (Gmelin, 1791)
6 months (2 species)	<i>Arca inequalis</i> (Bruguère, 1792) <i>Mectra cornea</i> (Reeve, 1854)
5 months (1 species)	<i>Paphia textile</i> (Gmelin, 1791)
4 Months (4 species)	<i>Cardium asiaticum</i> (Bruguère, 1789) <i>Placenta placenta</i> (Linnaeus, 1758) <i>Turritella duplicata</i> (Linnaeus, 1758) <i>Natica maculosa</i> (Lamarck, 1822)
3 months (5 Species)	<i>Dosinia cretacea</i> (Reeve, 1850) <i>Sunetta scripta</i> (Linnaeus, 1758) <i>Circe scripta</i> (Linnaeus, 1758) <i>Natica picta</i> (Recluz, 1843) <i>Bursa tuberosissima</i> (Reeve, 1844)
2 Months (5 species)	<i>Venerupis macrophylla</i> (Dash, 1853) <i>Beguina veriegeta</i> (Bruguère, 1792) <i>Diodora ticaonica</i> (Reeve, 1850) <i>Umbonium vestiarius</i> (Linnaeus, 1758) <i>Turritella terebra</i> (Linnaeus, 1758)
1 Month (15 species)	<i>Sunetta donacina</i> (Gmelin, 1791) <i>Donax cunaetus</i> (Linnaeus, 1758) <i>Cardium setosum</i> (Redfield, 1846) <i>Solen truncates</i> (Philippi, 1843) <i>Silqua radiata</i> (Linnaeus, 1758) <i>Cardiota antiquate</i> (Linnaeus, 1758) <i>Chlamys singapurina</i> (Smith, 1915) <i>Chama fragum</i> (Douvillei Lamy, 1921) <i>Nerita oryzarum</i> (Récluz, 1841) <i>Nerita albicilla</i> (Linnaeus, 1758) <i>Chrysame ambigua</i> (Swainson, 1829) <i>Oliva nivosa</i> (Marrat, 1871) <i>Nassarius stalatus</i> (Gmelin, 1791) <i>Thais tissoti</i> (Petit, 1852) <i>Babylonia spirata</i> (Linnaeus, 1758)

Table 2 shows the month wise distribution of Molluscs at Miramar Beach, Goa. It can be seen that seven species of molluscs namely *Arca granosa*, *Arca bistrigata*, *Paphia malabarica*, *Donax incarnates*, *Spisula voyi*, *Anomia simplex* and *Perna viridis*

were seen in all the eight months of investigation. While eight species viz., *Arca symmetrica*, *Dosinia prostrate*, *Sunetta effosa*, *Meretrix meretrix*, *Meretrix casta*, *Donax scortum*, *Angulus sinuate*, *Chlamys tranquebaricus* were present in seven out of eight months

of observations. *Arca inequivalis* and *Mectra cornea* were present for six months. *Paphia textile* was seen to be present for five out of eight months of study period. The species of molluscs found during four months of study period were *Cardium asiaticum*, *Placenta placenta*, *Turritella duplicate* and *Natica maculosa*. If five species namely *Dosinia cretacea*, *Sunetta scripta*, *Circe scripta*, *Natica picta* and *Bursa tuberosissima* were recorded for three months during the study period, Similar number of species viz., *Venerupis macrophylla*, *Beguina veriegeta*, *Diodora ticaonica*, *Umbonium vestiarium*, and *Turritella terebra* were found during two months of the study period. 15 species namely *Sunetta donacina*, *Donax cunaetus*, *Cardium setosum*, *Solen truncates*, *Siliqua radiate*, *Cardiota antiquate*, *Chlamys singapurina*, *Chama fragum*, *Nerita oryzae*, *Nerita albicilla*, *Chrysame ambigua*, *Oliva nivosus* and *Nassarius stalatus* were found during a particular month only.

Discussion

To protect and care for our planet, we must comprehensively understand biodiversity. We can develop a culture of caring for the nature is possible when people can be inspired to conserve and protect the natural world and foster a culture of stewardship is possible by increasing public understanding of biodiversity. Molluscs are also known for their great range of anatomical diversity. Though quite considerable attempts have been made to enumerate terrestrial faunal diversity, cataloging marine diversity has taken a back seat due to various reasons. The molluscs, one of the ecologically, economically, biologically, evolutionarily important group, though has attracted attention of field biologists, such studies are scanty and scattered.

Further, to understand the impact of anthropogenic activities on biota of beaches, one has to have a base line data, which is missing in most of the beaches including Miramar beach in Goa. The present attempt is to have a base line data, which would be of great importance at a later date. The present studies deal with molluscan diversity at Miramar beach, Goa. During the study period, higher number of species of molluscs was recorded during July (31 spp.), August (30 spp.) and September (29 spp.) respectively, which coincides with rainy season which can be attributed to abundance of decomposers settled organic

matter in these water bodies during that time i.e., monsoon, as reported by Garg *et al.* (2009). In the later months, diversity of molluscs was limited to 22 (Oct), 14 (Nov), 15 (Dec) and 17 (Jan), post monsoon season, when the sea is comparatively calm, the condition, which may not support reproduction in molluscs. Apart from the above the High tide line also recedes considerably after monsoon season. This may be one of the reasons for lesser diversity during those months. The presence of *Arca granosa*, *Arca bistrigata*, *Paphia malabarica*, *Donax incarnates*, *Spisula voyi*, *Anomia simplex*, and *Perna viridis* in all the months under study, indicate that, they are well adapted to a wide ranges of physico-chemical changes taking place in the marine water from June to January. On the other hand presence of 15 species as mentioned above, were found during a particular month only reveals that these species have a narrow range of adaptability. If one sees the abundance, it was *Perna viridis*, *Arca granosa*, *Arca bistrigata*, *Spisula voyi*, *Anomia simplex* were found in a large number, all the months under study.

While *Sunetta donacina*, *Donax cunaetus*, *Cardium setosum*, *Solen truncates*, *Siliqua radiate*, *Cardiota antiquate*, *Chlamys singapurina*, *Chama fragum*, *Nerita oryzae*, *Nerita albicilla*, *Chrysame ambigua*, *Oliva nivosus* and *Nassarius stalatus* were found rarely, indicating their narrow range of adaptability. Over all, by observing the results, one can conclude that Miramar beach, despite having high degree of anthropogenic activities due to one of the most frequently visited beaches in India, harbors appreciable molluscan diversity, which has to be maintained for eternity and generations to come.

Acknowledgements

It is pleasure to thank Head, Department of Zoology, Goa University for his support and encouragement and to Dr. Krishakumari, Scientist-E, National Institute of Oceanography, Goa, for extending her help in confirming the identification.

References

Abbott, R. T. 1973. Kingdom of sea shell. Homlyn Publing group Ltd. Italy.

- Apte, D. 1998.** The book of Indian shells. BNHS, Oxford University Press, Mumbai.
- Anuradha, D. 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
- Ashok Kumar, V., Poonam, B. and Kundu, R. 2013.** Diversity and distribution of intertidal mollusca at Saurashtra coast of Arabian sea, India. *GJBB.* 2(2): 154-158
- Bartch, P. 1968.** Molluscs. Dover Publications, New York.
- Bijukumar, A., Ravinesh, R., Arathi, A. R. and Idreesbabu, K.K. 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
- Chapman, A. D. 2009.** Numbers of Living Species in Australia and the World, 2nd edn. Australian Biological Resources Study, Canberra.
- Chatterji, A., Ansari, Z. A., Ingole, B. S., Bichurina, M. A., Sovetova, M. and Boikov, Y. A. 2002.** Indian marine bivalves: Potential source of antiviral drugs. *Current Science.* 82(10): 1279-1282.
- David, N. 1969.** "The Number of Living Species of Molluscs". *Systematic Zoology.* 18(2): 251-254.
- Garg, R. K., Rao, R. J. and Saksena, D. N. 2009.** Correlation of molluscan diversity with physico-chemical characteristics of water of Ramsagar reservoir, India. *Int J of Biodiversity and Conser.* 1(6): 202-207.
- Hancock, R. 2008.** "Recognizing research on molluscs". Australian Museum. Australia.
- Hornell, J. 1951.** Indian mollusks. BNHS, Diocesan Press, Madras.
- Ingole, B. S. and Clemente, S. 2006.** Status of windowpane oyster *Placuna placenta* (Linnaeus) population in Goa. In: Glimpses of marine archaeology in India. Proc. VII Conf. on Mar. Archaeology of Indian Ocean Countries, Ed: Gaur, AS and KH Vora. Pp: 130-133.
- Khade, S. N. and Mane, U. H. 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
- Mascarenhas, A. 1999.** Some observations on the state of coastal environment of Goa, west coast of India. Proceedings of the Workshop on Integrated Coastal and Marine Area Management Plan for Goa. Pp: 204-224.
- Mohamed, K. S. 2012.** Marine molluscan diversity in India-exploitation and conservation challenges in the 21st Century. In: Marine biodiversity status, opportunities and challenges. CUSAT, Kochi. Pp: 37-64.
- Sreekanth, G. B., Manjulekshmi, N., Chakraborty, S. K., Jaiswar, A. K., Zacharia, P. U., Vishnuradhan, R., Singh, N. P. and Pazhayamadom, D. G. 2016.** Effect of monsoon on coastal fish diversity of Goa: an example from the gillnet fishery. *Ind J Fisheries.* 63(2):8-18
- Tripathy and Mukhopadyay. 2015.** Marine Molluscan diversity In: Marine Faunal Diversity in India: Taxonomy, Ecology and Conservation. Ed: Krishnamoorthy Venkataraman & Chandrakasan Sivaperuman. Elsevier Publications, Amsterdam. Pp: 39-74
- Vanmali, H. S. and Jadhav, R. N. 2005.** Assessment of Molluscan Diversity of Dativare Coast of Vaitarna Estuary, Dist.-Palghar, Maharashtra (India). *Research Inventory: International Journal of Engineering and Science.* 5(9): 1-6.
- Venkatraman, C. and Venkataraman, K. 2012.** Diversity of Molluscan Fauna along the Chennai Coast. Intl day for Biol Div UP State Biodiversity Board. Pp: 29-35.