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DIVERSITY AND IMPACT OF SEASONAL VARIATION IN THE DISTRIBUTION OF MOLLUSCS IN MANAPADU COASTAL AREA, THOOTHUKUDI DISTRICT, TAMIL NADU, INDIA

S. DEVI PRIYA [a] AND L. JEYA PRABA [a*]

[a] Zoology Department and Research Centre, Sarah Tucker College (Autonomous), Tirunelveli-627007, Affiliated to Manonmaniam Sundaranar University, India.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Molluscs are economically and ecologically important components of aquatic ecosystems. In addition to supporting valuable aquaculture and wild-harvest industries, their populations determine the structure of benthic communities, cycling nutrients and they serve as prey resources for higher trophic levels. This study aims at identifying the diversity of Molluscs in the coastal area of Manapadu, Thoothukudi District, Tamil Nadu. The result of the study shows that a total of 61 species of molluscs belonging to 35 families were identified. Maximum numbers of species were identified during the post-monsoon season. Minimum species were identified during the summer season. ANOVA was carried out to test the level of significance. Significant results were observed only during the monsoon season. Biodiversity indices were calculated in which maximum species diversity of Shannon(H) Weiner index was noted as 4.107ng during the monsoon season, and minimum species diversity was recorded as 4.037 ng during the post-monsoon season. Alpha index and Margalf's index were also used in the study which showed varied diversity throughout different seasons. The study shows that molluscan species fluctuated seasonally throughout the year. Suggestions to update the checklist and distribution of Molluscs from the Manapadu region located on the southeast coast of India were presented in this study.

Keywords: Molluscs; bivalvia; gastropod; manapadu; coastal area.

**Corresponding author: Email: jayaprabha2009@gmail.com;*

1. INTRODUCTION

Mollusca is the second-largest phylum of invertebrate animals after Arthropoda. The members are known as mollusks or molluscs. In the geological time scale, molluscs evolved about 600 million years ago during the Cambrian period. Structurally molluscs are a heterogenous group of animals with different structural forms such as slugs, mussels, octopuses, and snails. The majority of the molluscs are known by their shells, but in some forms the shells are absent. India has a coastline of 7.516 km, adjoining the continental regions and the offshore islands. A very wide range of coastal ecosystems such as estuaries, lagoons, mangroves, backwaters, salt marsh, rocky coasts, sand stretches, and coral reefs were present. The coastal ecosystem is the interface between land and water which covers approximately 8% of the earth. They are exceptionally diverse and productive, particularly shallow-water tropical regions. The total number of species identified under the Phylum Mollusca varies between 80,000 to 1,00,000. They are more abundant in the littoral zones of tropical seas. Gastropods and bivalves constitute 98% of the total population of molluscs.

"In India 3,271 molluscs belong to 220 families and 591 genera, of which 1,900 are gastropods, and1,100 are bivalves" [1]. "The studies on Indian molluscs were initiated by the Asiatic Society of Bengal and the Indian museum, Calcutta" [2,3]. "Out of 3,370 species of marine molluscs in India, 1,282 species were from Andaman and Nicobar Island" [4].

"Molluscs serves as bio-indicators since they play a very important role in maintaining the aquatic ecosystem by recycling nutrients and by serving as nutrition for certain aquatic organisms. Fresh water molluscs serve as an important source of food for other animals i.e., fishes, birds, and mammals even for humanbeings. In the age of global decline of biodiversity, it is necessary to study the present status of different biota. The taxonomic study of Indian freshwater molluscs has been done by The zoological Survey of India", [4]. "Freshwater molluscs were reported in many studies in Maharashtra" [5,6,7,8,2,4,9,10].

The importance of gastropods, clams, oysters, and mussels in maintaining both the economic base and the ambiance of our coastal communities is also frequently overlooked [11,12]. Details on specific aspects of bivalve and gastropod management, aquaculture, and their relations to economic, public, and ecosystem health are of paramount importance, but such studies are lacking at present. The fact that many gastropods have been placed on the endangered list is of major concern. The importance of maintaining healthy molluscan populations and the type of information needed to sustain these structural and functional resources can be emphasized through this study.

The study provides detailed information on biodiversity of molluscs (Gastropods and Bivalves) in the coastal area of Manapadu and the information would assist the researchers and conservation managers to study and manage the resource for sustainable utilization. The Indian coastline is rich in molluscan diversity and this study can also be used in conservation and sustainable management of biodiversity through proper knowledge.

2. MATERIALS AND METHODS

2.1 Molluscan Survey

A reconnaissance survey was conducted to gather information about the areas being studied and to identify sampling sites. A random stratified sampling strategy was used to collect samples from benthic environment is which a first stage sampling area of 100 ^{m2} was chosen randomly, and within this first stage area, random positions were chosen for lacing the quadrats on each sampling occasion. Molluscs were also collected from local fisherman.samples were also collected from the bycatch obtained from trawl fishing nets. Faunal bivalves were collected by hand digging the substratum or by hand picking in different places of each sampling region. Specimens were brought to the laboratory, cleaned, and identified using appropriate monographs [1]. Data were collected fortnightly throughout the study period. Information was reported mainly in form of still photographs and a few empty molluscs were collected for identification purposes so that deep sea species caught on the fishing net can also be obtained.

2.2 Visual Evaluation and Seasonal Observation

The number of Mollusca belonging to each species were counted at monthly intervals for one year. Local people were questioned about the details of marine molluscs. Seasonal observations and recordings were also made during the study. The study period was divided into four seasons ie summer (April to June), pre-monsoon (July to September), monsoon (October to December), and winter (January to March).

2.3 Identification of Gastropods

"The shell characters such as shape, spire length,and shape, mouth opening, opercula shape, umbilicus

shape and size, color, and ornamentation of the shell were mainly for the identification of gastropods" [1].

2.4 Identification of Bivalves

"The bivalves were identified mainly based on its shell morphology. The shell comprises two valves. The outer surface may be striated or ribbed. The two valves are held together by an elastic ligament, which leaves a scar on the hinge" [1]

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2.5 Statistical Analysis

The data on molluscs were subjected to relevant statistical techniques like ANNOVA and correlationstudies were done using the software SPSS and PAST [13].

3. RESULTS AND DISCUSSION

A total of 61 species of Mollusc were collected and identified and were tabulated in Table 1. 35 families were collected. Maximum numbers of species were collected during post-monsoon, december. Minimum species were collected during summer season, Fig. 1 shows the satellite map of the study area- Manapadu village.

Strombidae(5), Olividae(4), Mactridae(4), Arcidae(3), Pinnidae(2), Veneridae(3), Mytiilidae(3), Naticidae(2), Volutidae(2), Cymatiidae(2) Cypraecidae(2), Cassidae(2), Buccidae(2), Trochidae(2), Newtoniellidae(1), Pteriidae(2), Pectinidae(1), Tellinidae(1), Tharaciidae(1), Babyloniidae(1), Cardiidae(1), Mangeliidae(1), F ascidariidae(1), Littorinidae(1), Muricidae(2), Turridae(1), Turritellidae(1), Turbinidae(1), Turbinellidae(1), Glycymordiode(1), Cultellidae(1), Pyramidellidae(1), Retusidae(1), Astaridae(1), Toonodae(1), A total of 21 species of Bivalvia and Gastropoda(40) species of were recorded (Fig. 2).

Dryness during summer season and unfavourable climatic condition with high temperature activating the process of decomposition oforganic sedimentsmay be the reason for low or minimum observation during March [14]. Tidal state, evaporation, rainfall, and concentration of groundwater input also influence the dry season towards diversity. Phytoplankton uptake alone with seasonal and diurnal variation also influence the cation concentration [15]. Monsoon and post-monsoon season favours more diversity of the molluscs fauna since dissolved organic carbon and dissolved inorganic nitrogen were found at the desired level for mollusc [16]. A similar report on Molluscan biodiversity and its seasonal fluctuations can be found in a study conducted by Teekar Taal,Haryana,India [8]. "The present study also reports mollusc density at its peak in September during the late monsoon period. The results clearly states that the post-monsoon is the most favourable time for the new inflow of mollusc species" [16]. "The distribution of molluscan species in the coastal region of India was reported in earlier studies" [14,17,8].

One-way analysis of variance (ANOVA) computed from the collected data during in the summer season,pre-monsoon, monsoon,and winter season (Table 2) for a significance level of 5% shows($P< 0.05$) i.e. the p-value of 0.89, 0.166 and 0.177 respectively but monsoon season shows a p valve of 0.001.Therefore, statistical significance was observed in the relation between molluscan density and monsoon season. This clearly indicates that the monsoon season favors more diversity of the molluscan fauna (Table 2).

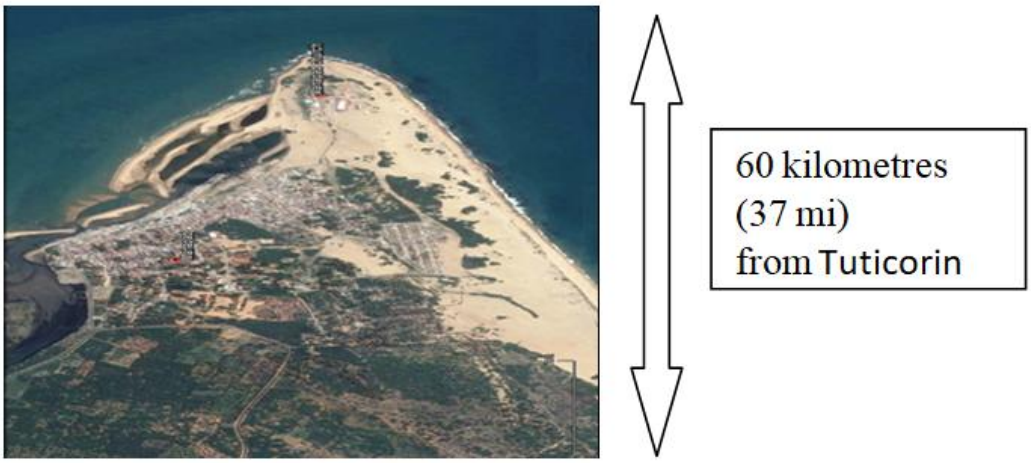

Fig. 1. Satellite map showing the location of Manapadu village

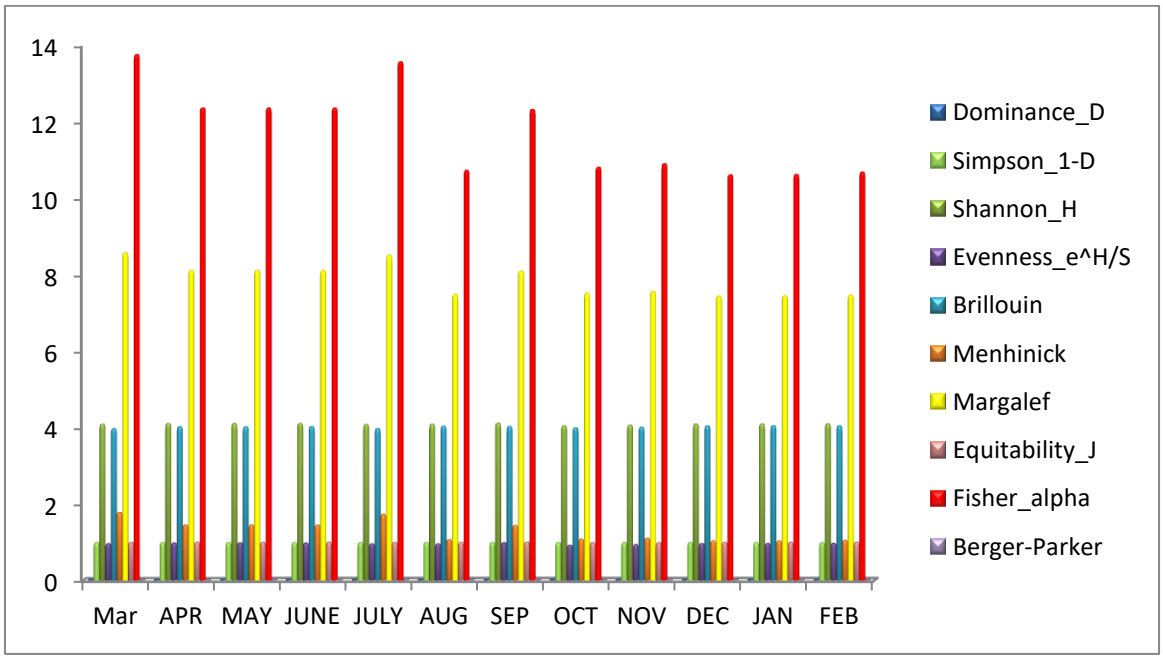

Fig. 2. Diversity index of Molluscs in Manapadu during March2017-February 2018

Table 1. Distribution of molluscan coastal area of Manapadu during March 2017-February 2018

S.N	Class	Order	Family	Binomial name	Common name
1	Bivalvia	Carditoida	Astaridae	Goodalia triangularis	No common names recorded
2	Bivalvia	Arcoida	Arcidae	Andara transversa	transverse ark
3	Bivalvia	Arcoida	Arcidae	Trisidostortuosa	Tweekleppigensoort
4	Bivalvia	Arcoida	Arcidae	Anadararhombea	Ark clams
5	Bivalvia	Adapedonta	Cultellidae	Siliqua patula	Pacific razor clam
6	Bivalvia	Arcida	Glycymerididae	Glycymerisglymeris	bittersweet clams
7	Bivalvia	Mytilida	Mytiilidae	Arculatulasenhousia	Asian mussel
8	Bivalvia	Neogastropoda	Mytiilidae	Rapanavenosa	Veined rapana whelk
9	Bivalvia	Veneroida	Mactridae	Mactraabbreviata	Tweekleppigensoort
10	Bivalvia	Veneroida	Mactridae	Mactraachatina	Tweekleppigensoort
11	Bivalvia	Veneroida	Mactridae	Mactraturgida	Tweekleppigensoort
12	Bivalvia	Veneroida	Mactridae	Mactragrandis	Tweekleppigensoort
13	Gastropoda	Caenogastropoda	Naticidae	Nautica gulateriana	Moon snails
14	Gastropoda	Caenogastropoda	Naticidae	Amauropsisislandica	Iceland moonsnail
15	Gastropoda	Caenogastropoda	Newtoniellidae	Cerithiellametula	Sea snail,
16	Bivalvia	Pteriida	Pteriidae	Pinctada radiata	Mother of pearl
17	Bivalvia	Pteriida	Pinnidae	Atrinazelandica	Horse mussel
18	Bivalvia	Pectinida	Pectinidae	Chlamys hastata	Spiny scallop
19	Bivalvia	Pteriida	Pinnidae	Atrinapectinata	Pen shells
20	Bivalvia	Pteriida	Tellinidae	scissulinadisper	Mollusc
21	Bivalvia	Venerida	Veneridae	mertrixiyrata	Hard clam
22	Bivalvia	Venerida	Veneridae	Saxiidomus gigantea	Butter clam
23	Bivalvia	Venerida	Veneridae	Lioconchahieroglyphica	Saltwater clam
24	Bivalvia	Pholadomyoida	Thraciidae	Cochlodesmapraetenue	hin lantern-shell
25	Gastropoda	Buccinidae	Bucciidae	Buccinumundatum	Common whelk
26	Gastropoda	Caenogastropoda	Bucciidae	Colusislandicus	Tea snails
27	Gastropoda	Caenogastropoda	Babyloniidae	babyloniazeylanica	Sea snail
28	Gastropoda	Cardiida	Cardiidae	Cardium flavum	white strawberry cockle
29	Gastropoda	Littorinimorpha	Cymatiidae	cymatium aquatile	Sea snails
30	Gastropoda	Caenogastropoda	Cypraecidae	Cypraeatigris	Tiger cowrie
31	Gastropoda	Caenogastropoda	cypraecidae	Cypraeamauritiana	cowries,
32	Gastropoda	Caenogastropoda	Mangeliidae	Bela brachystoma	Marine gastropod mollusks
33	Gastropoda	Caenogastropoda	cassidae	Phaliumglaucum	Grey bonnet

S.N	Class	Order	Family	Binomial name	Common name
34	Gastropoda	Caenogastropoda	cassidae	Phaliumbisulcatam	Grey bonnet
35	Gastropoda	Caenogastropoda	fascidariidae	Fasciolariatulipa	The true tulip
36	Gastropoda	Caenogastropoda	Littorinidae	Plittorinaangulifera	mangrove periwinkle
37	Gastropoda	Mytilida	Mytilidae	pernaviridis	Asian green musse
38	Gastropoda	Caenogastropoda	Muricidae	Rapanavenosa	Veined rapa whelk
39	Gastropoda	Caenogastropoda	Olividae	oliva reticularis	Netted olive
40	Gastropoda	Caenogastropoda	Olividae	Oliva sayana	Olive snails
41	Gastropoda	Caenogastropoda	Olividae	Agaronianebulosa	Sea snail
42	Gastropoda	Caenogastropoda	Olividae	Ancilla cinnamomea	Sea snail
43	Gastropoda	Pteriida	Pteriidae	Pinctada fucata	Akoya pearl oyste
44	Gastropoda	Pteriida	Pyramidellidae	Pyramidelladolabrata	Giant Atlantic pyram
45	Gastropoda	Caenogastropoda	Cymatiidae	cymatium perryi	sea snails
46	Gastropoda	Heterobranchia	Retusidae	Retusaobtusa	Arctic barrel-bubble
47	Gastropoda	Caenogastropoda	strombidae	Lobatuscostatus	Milk conch
48	Gastropoda	Caenogastropoda	Strombidae	Lambistruncata	Giant spider conch
49	Gastropoda	Caenogastropoda	Strombidae	Lambislambis	spider conch
50	Gastropoda	Caenogastropoda	Strombidae	Stombuscostatus	Milk conch
51	Gastropoda	Caenogastropoda	Strombidae	Stombusraninus	Hawk-wing conch
52	Gastropoda	Caenogastropoda	Tonnidae,	Maleapomum	Pacific grinning tun
53	Gastropoda	Caenogastropoda	Muricidae	Chicoreusramosus	Branched murex
54	Gastropoda	Trochida	Trochidae	Trochus stellatus	Stellate trochus
55	Gastropoda	Trochida	Trochidae	Gibbulapennanti	Sea snail
56	Gastropoda	Neogastropoda	Turridae	Lophiotomaindica	Indian turrid
57	Gastropoda	Caenogastropoda	Turritellidae	Turritella attenulata reeve	Sea snail
58	Gastropoda	Vetigastropoda	Turbinidae	Pomaulaxgiberosus	Sea snail
59	Gastropoda	Caenogastropoda	Volutidae	Harpulinalapponica	Sea snail
60	Gastropoda	Caenogastropoda	Turbinellidae	Tturbinellapyrumlinnaeus	Chank shell
61	Gastropoda	Caenogastropoda	Volutidae	Harpulinalapponica	Sea snail

Table 2. ANNOVA - Relation between the seasonal variations and molluscan density

Months		Sum of Squares	df	Mean Square	F	Sig (P).
Summer	Between Groups	2755.246	56	49.201	2.445	.089
	Within Groups	161.000	8	20.125		
	Total	2916.246	64			
Pre-monsoon	Between Groups	2151.215	56	38.415	1.909	.166
	Within Groups	161.000	8	20.125		
	Total	2312.215	64			
Monsoon	Between Groups	18032.554	56	322.010	9.541	**.001**
	Within Groups	270.000	8	33.750		
	Total	18302.554	64			
Winter	Between Groups	2329.985	56	41.607	1.860	.177
	Within Groups	179.000	8	22.375		
	Total	2508.985	64			

In a similar biodiversity study of marine molluscs from Thanjavur district in Tamil Nādu, about 20 species were reported of class Gastropoda and 20 species of class Bivalvia. Forty-one species of gastropods and 5 species of bivalves were reported along the intertidal beaches of Mumbai coast. Thirty species of gastropods were reported from Cuddalore coast during the year1998 and among them,*Babylonia spirata* was reported in maximum numbers along the coastline.

"Similar reports were produced from a study conducted inDativare Coast of Vaitarna Estuary, Dist.-Palghar, Maharashtra (India)" [18]. "According to a study on reef environments, high molluscan richness is associated with the diversity coral cover" [16,19]. Additionally, the fact that the lower the number of species that use the same ecological niche, the lower the competition among them which also may have favored the increased abundance of dominant and more generalist species. The present study revealed that there is a good diversity of molluscs. most of these species were indigenous. some of the recorded species have greater commercial value and biodiversity importance [20-22].

"A diversity index is commonly used to characterise species abundance in a biological system. Maximum species diversity of Shannon(H) Weiner index 4.107 was found during the monsoon season-September.

Minimum species diversity Shannon Weiner index was recorded as 4.037 ng during the post-monsoon season- October. The results showed the mollusc species fluctuated seasonally. A Similar biodiversity study of marine molluscs was conducted on selected locations of Andhra Pradesh coast in south-eastern India" [14]. Maximum species abundance Alpha index was recorded 13.76 g during the summer season-march. Minimum species abundance Alpha index was recorded as 10.61 9ng during the post monsoon-December. Maximum species richness Margalf's index was recorded as 8.571 during the summer season- march. Minimum species richness Margalf's index was recorded as 7.52ng during the post-monsoon-October. Maximum species evenness was recorded as 0.9801 during the post-monsoon season-December. Minimum species evenness was recorded during the post-monsoon season as 0.9139- October. Maximum species abundance Alpha index was recorded as 0.01867 during the monsoon season-October. Minimum species abundance Alpha index was recorded as 0.01676 during the pre-monsoon season- September.The results of thepresent study were similar to the report on Molluscan biodiversity and its seasonal fluctuations byTeekar taal,Haryana, India [8].

4. CONCLUSION

This study provides important baseline information on the structure of molluscan communities in the Manapadu coastal area. Molluscan community assemblages and their relationships with environmental variables provide important baseline data against which any future anthropogenic impacts might be assessed and could be used as sensitive indicators of future environmental change. Higher diversity value observed in the present investigation clearly showed the healthy nature of the Molluscan ecosystems along Manapadu coastal waters. The data generated through the present research report can provide baseline information for commercial exploitation of seaweed resources along Manapadu coastal waters.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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