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Diversity and habitat characteristics of Malacofauna (Gastropod and bivalves) in the Intertidal areas of Azheekal coast, Kerala, India

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Original Article

Abstract

This study aimed to investigate the distribution of the Malacofauna in the Azheekal Coast, Kollam district of Kerala. Field studies were done in the spring, summer, and autumn of 2023 at 3 stations. As a result, 3602 individuals were examined and 36 species of gastropods and 12 species of bivalves were recorded. An assessment of diversity indices such as Shannon-Wiener index (H) Simpson Dominance Index (D) and Evenness index (E) gave significant values indicating very high diversity of molluscans along the study sites. The present study provides information on the molluscan resources of the selected study area, which forms the baseline data for future ecological studies.

Keywords: *Biodiversity, Mollusca, Gastropoda, diversity indices*

Introduction

Gastropods and bivalves form macrobenthic groups that are often found in areas with sandy and muddy substrates in the aquatic environment. These creatures are widely distributed and many live in sessile or motile, brackish and brackish water habitats (Kudratov *et al.,* 2023). Macrozoobenthic animals are crucial in sediment control, facilitate the circulation of organic matter as an energy source in the food chain, and contribute significantly to the distribution and productivity of aquatic plant flora (Desai *et al.,* 2020). These aquatic animals are also important providers of high nutrient content to meet the nutritional needs of protein- and carbohydrate-rich communities. The high nutritional value of mussels makes them a popular food source for both domestic and international export (Biandolino *et al.,* 2019). High market demand for several macrobenthic species has led to the continuous exploitation of communities, especially crustaceans and, oysters, causing ecological pressure on these aquatic populations (Pereira *et al.,* 2023).

At the bottom of aquatic habitats, gastropods and bivalves lead generally sedentary lives with sluggish motility. According to Bahtiar *et al.* (2022) and Foster *et al.* (2022), these aquatic macrozoobenthic organisms are therefore suitable indicators of environmental conditions in aquatic settings. These creatures are contaminated when the environment in that region is contaminated, which causes them to accumulate pollutants in their bodies that match the amounts of pollutants in the surrounding environment (Alhejoj *et al.,* 2017). Within a given habitat, a greater macrozoobenthic diversity index signifies that the aquatic region is still in excellent condition, whereas a lower macrozoobenthic diversity index implies mild to severe contamination.

Unfortunately, there is still a dearth of information on the variety and habitat features of gastropods and bivalves in the Azheekal coastal region due to relatively little study in this area. However, there are few available data on the gastropod and bivalve populations on the Azheekal. Thus, it is imperative to investigate the diversity index and habitat features of gastropods and bivalves in this region to furnish local communities and governmental authorities with crucial data on the population circumstances of the aquatic biota. Data on gastropod and bivalve populations can also reveal environmental factors, such as whether they inhabit clean, moderately contaminated, or extremely polluted locations.

The present study was an attempt to evaluate the molluscan

diversity of selected regions of the Azheekal Coast to elucidate its variations and to link the same with existing environmental scenarios.

Material and methods

Study area

The study site was situated on the Azheekal Coast with coordinates of. 9°02′–9°16′ N and 76°′20′–76°32′ E. Azheekal Beach is an 800-metre-long beach on the coast of the Arabian Sea in Karunagappally Taluk of Kollam Metropolitan Area, Kerala, India. The coastal areas are made of intertidal zones, of which some have sandy, muddy, and rocky shores. Three areas, Site 1 (rocky shore), Site 2 (muddy), and Site 3 (sandy) were randomly selected as sampling sites (Fig. 1).

Data collection

Bivalves and gastropods were sampled between November 2022 and April 2023. There was sampling using transects. Through direct hand selection, monthly regular collections were made in 2022 and 2023. Digital cameras were used to take the pictures. Every gastropod and bivalve sample that was gathered at the study sites was stored in sample vials with a 4% formalin solution and then identified in the laboratory. After consulting online databases, revision papers, manuals, and publications (Röckel *et al.,* 1995; Rao, 2003; Robin, 2008; Edward *et al.,* 2022), the shells were identified down to the species level. The identified shells were carefully put into individual bottles and labelled with the species name, family, order, collecting site, date, and name of the collector. The numbers of shells of each species obtained from each site were also recorded for calculating the diversity indices.

Data analysis

Statistical analysis was PAST 3.0 software (Hammer *et al.*, 2001) used to analyze biological indices such as Margalef's index (d), Shannon Weiner index (H') and I Evenness (J') and Simpson's dominance index (also principal component analysis (PCA analysis).

Results and discussion

Species richness of gastropods and bivalves

The Present investigation was undertaken to obtain baseline information on the status of biodiversity of marine macro molluscan gastropods and bivalves in the intertidal area of

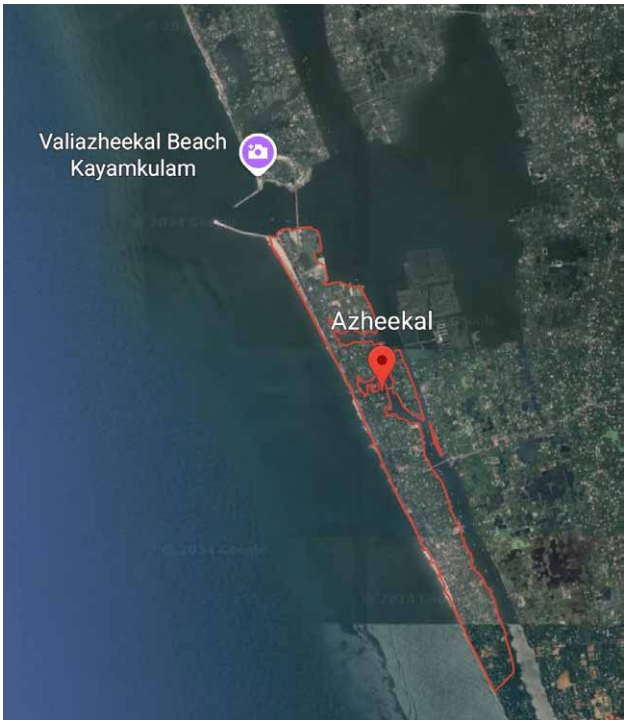

Fig. 1. Map of study area

Azheekal coast Kollam. In site 1, 29 species of gastropods are belonging to 22 families and 7 species of bivalves belonging to 8 families. In site 2, 23 species of gastropods are belonging to 13 families and 8 species of bivalves belonging to 6 families. In site 3, 20 species of gastropods belong to 15 families and 3 species of bivalves belong to 4 families. In summing up, there were 3602 individual molluscans sampled from the three randomly selected study sites and classified up to 36 species of gastropods belonging to 22 families and 12 species of bivalves belonging to 8 families (Table 1 and 2). Tables 1 and 2 showed the list of species of gastropods and bivalves encountered in the three study sites and specified whether the species was present or absent in the area. It showed that site 1 (rocky shore) had the highest number of species. Such results could be related to the topography of the intertidal zone of each study area1 contained a shoreline and deeper water, whereas site and 3 have wider sandy to muddy shorelines exposed during low tides and shallower water. As a whole, there were more species of gastropods than bivalves recorded in the present study. In family-wise landings among the gastropods the maximum number recorded were Muricidae (17%). In bivalves, the most abundant families were Mytilidae (25%) compared to other families.

Rocky shores provide a wide variety of food sources for marine organisms, including algae, plankton, and small invertebrates. This supports a diverse food web, with many species relying on other species for food. The study areas

Table 1. Species composition and occurrence of intertidal marine gastropods in Azheekal coast Kollam

No	Family	Species	Site A	Site B	Site C
1	Harpidae	*Harpa Major*	+	_	_
2	Conidae	*Conus inscriptus*	+	+	_
3		*Conus martensi*	+	-	+
4	Bursidae	*Bufonariae chinate*	+	_	_
5		*Bufonaria rana*	+	_	_
6	Cymatiidae	*Lotoria perryi*	+	+	+
7	Rostellariidae	*Tibia curta*	+	_	+
8	Babyloniidae	*Babylonia zeylanica*	+	_	+
9	Muricidae	*Vokesimurex malabaricus*	_	_	+
10		*Murex carbonnieri*	+	_	_
11		*Murex trapa*	+	_	_
12		*Murex virigineus*	+	_	_
13		*Chicoreus ramosus*	_	+	+
14		*Chicoreus brunneus*	_	_	+
15		*Bufonaria echinata*	+	_	_
16	Turritellidae	*Turritella attenuate*	_	+	_
17		*Turritella terebra*	+	+	_
18	Ranellidae	*Cymatimum perryi*	_	+	+
19	Littorinidae	*Littoraria articulata*	+	+	+
20	Cypraeidae	*Palmadusta asellus*	+	-	+
21	Epitonidae	*Acrilla acuminata*	+	-	-
22	Nacellida	*Cxellana radiata*	+	-	+
23	Fissurellidae	*Diodora singaporensis*	+	+	+
24		*Scutus unguis*	+	+	+
25		*Clypidina notata*	+	-	+
26	Chilodontidae	*Euchelus asper*	+	_	+
27	Trochidae	*Trochus radiatus*	+	_	+
28	Neritidae	*Neritta litterata*	+	+	-
29	Certiidae	*Planaxis sulcatus*	+	+	_
30	Littorinidae	*Echinolittorina malaccana*	+	+	_
31		*Echinolittorina vidua*	+	_	+
32	Cypraeidae	*Naria ocellata*	+	_	+
33		*Monteria moneta*	+	+	+
34	Bursidae	*Dulcerana granularis*	+	+	_
35	Columbellidae	*Pyrene flava*	-	+	_
36		*Lataxiena solenosteiroides*	_	+	+

Note: (+) indicates presence, (-) indicates absence

diversity of algae, sponges, crustaceans, echinoderms and Ascidians (Ravinesh and Biju Kumar, 2013; Anu *et al*., 2017) and the overall, combination of physical diversity, food availability, connectivity, adaptation, and environmental stability makes rocky shores a highly diverse in these regions.

Diversity indices

For analysing the alpha diversity of the three zones, diversity indices like the Shannon-Weiner diversity index, Margalef richness index, Simpson-dominance index and Pielou's

Table 2. Species composition and occurrence of intertidal marine bivalves in Azheekal coast Kollam

No.	Family	Species	Site 1	Site 2	Site 3
1		*Perna viridis*	+	+	_
2	Mytilidae	*Mytilus trossulus*	+	+	_
3		*Perna perna*	+	+	_
4	Lepetellidae	*Clypidina notate*	_	+	_
5	Veneridae	*Timoclea imbricata*	_	_	+
6		*Sunetta scripta*	+	+	_
7	Arcidae	*Anadara indica*	_	_	+
8		*Anadara granosa*	_	_	+
9	Cardiidae	*Donax speculum*	+	+	_
10	Pteridae	*Pinctada imbricata*	+	+	_
11	Donacidae	*Donax cuneatus*	+	_	_
12	Pteridae	*Pinctada margaritifera*	_	+	_

Table 3. Diversity indices of molluscan species

Stations	Margalef richness (d)	Pielous evenness (J')	Shannon diversity (H)	Simpson's dominance (I)
Station 1	2.058	0.9386	2.016	0.14
Station 2	1.717	0.6312	1.608	0.2747
Station 3	1.747	0.6716	1.619	0.2433

evenness index were calculated (Table 3). Shannon- Weiner index showed the highest value of 2.016 in the station1, followed by the station 3 (1.619) and the station 2 (1.608). According to Bath *et al.* (1999), the high diversity of molluscs is correlated with an increase in salinity. The Margalef species richness values were 2.058 for the rocky zone, 1.747 for the sandy shore and 1.717 for the muddy zone. Pielou's evenness index showed a high value of 0.9386 in the rocky zone, indicating more even distribution of species and comparatively less values of 0.6312 in the muddy zone and 0.6716 in the sandy zone, indicating less even distribution of species as the muddy zone.

The diversity indices for molluscan fauna are given in Table 3. Shannon diversity (H') and species richness (d) showed maximum values in station I (H'=2.016 and d=2.08 respectively). Despite this, the station was dominated by an invasive mussel, Mytella which will out-compete many other bio-fouling native species in future, causing changes in the community structure and trophic relationships of the wetland. *M. strigata* will eventually cause a considerable negative impact on the clam fishery and the lake ecosystem (Biju Kumar *et al.*, 2019). Two principal components (PC1 and PC2) represent the whole variable and other principal components are negligible. PC1 and PC2 expressed 96.839 and 2.1197 % of total variance respectively. The eigen value of PC1 and PC2 are 3.9894 and 0.0115 respectively. PC1 is highly influenced by the number of

Table 4. Loading values along with the Eigen value and % of variance.

	PC1	PC2
Shanon wienner	0.5007	-0.00278
Evenness	0.50058	0.20349
Margalef	0.4997	0.59786
Dominance	-0.49902	0.7784
Eigenvalue	3.9884	0.0115
%variance	99.721	0.2789

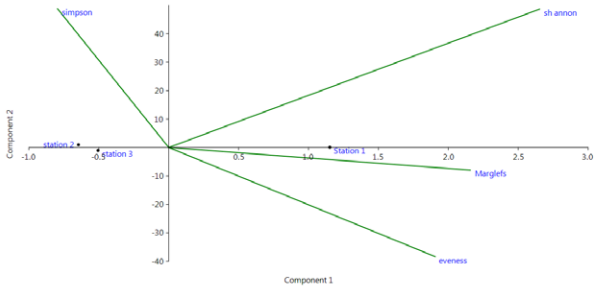

Fig. 2. PCA biplots of diversity indices

taxa and PC2 by the Margalef species richness index (0.59786) (Table 4). The evenness index and Shannon diversity index are very closely related to each other (Fig. 2).

Conclusion

The intertidal environments of the Azheekal Coast provide new habitats for molluscan species. General observations of seasonal variation in the abundance of intertidal molluscs indicate that their diversity is influenced by tides, waves, and electrical conductivity of the water, heterogeneous habitat and the presence of suitable ecological niches. Coastal Kollam beaches have a very alarming abundance of species and molluscs. These data on Azeekal coastal molluscan diversity provide fundamental ecological information about its dynamics along the coast.

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Authors contributions

Conceptualization: DRD, KP; Methodology: RK, AVS; Writing Original Draft: DRD; Supervision: KP.

Data availability

The data are available and can be requested from the corresponding author

Conflict of interests

The authors declare that they have no conflict of financial or non-financial interests that could have influenced the outcome or interpretation of the results.

Ethical statement

The study does not include activities that require ethical approval or involve protected organisms/ human subjects/ collection of sensitive samples/ protected environments.

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