DIVERSITY OF BIVALVES AND GASTROPODS IN SONADIA ISLAND, BANGLADESH

Durjoy Raha Antu[1], Tasfia Tanjim Islam[1], Md. Rasel Ahmed[1], Sumaiya Ahmed[1], Sujan Kumar Datta[2] and Md. Sagir Ahmed[2]*

[1]Department of Zoology, Jagannath University, Dhaka 1100, Bangladesh
[2]Department of Zoology, University of Dhaka, Dhaka 1000, Bangladesh

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ABSTRACT

An attempt was made to explore the gastropods and bivalves diversity of Sonadia Island, an important habitat for molluscs. The study was carried out from January 2020 to December 2020. To determine the species abundance and richness, 8 transects were selected based on different habitat of bivalves and gastropods occupancy. A total of 89 species of bivalves (45) and gastropods (44) under 37 families and 15 orders have been confirmed. Veneridae (10 species) was the dominant family of bivalves where Muricidae and Turritellidae (5 species) of gastropods. About 1380 individuals of gastropods and bivalves were found in 8 transects. The highest number of species observed in transect 5 (35 species) which was about 45.45% of the total species. In case of abundance, transect 3 occupied the highest 730 individuals (54.97%). The highest species diversity was observed in transect 4 (H= 2.814 Ds= 0.9158) and the lowest was transect 2. *Pirenella cingulate*, *Turritella duplicate* and *Cerithium columna* were the most abundant species within the transect area. Among 8 transects, two large clusters and one small cluster were noticed that indicated species diversity varies at different habitats. During the study, two main threats were observed for the gastropods and bivalves diversity losses *viz.,* collection of a huge number of live shells by the local people to make ornaments for the tourists of Cox's Bazar, and destruction by local fishers during fishing through the coastal belt of the Island. Proper management is recommended for the conservation of bivalves and gastropod diversity.

KEYWORDS: Biodiversity, Gastropods, Bivalves, Sonadia Island

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***Corresponding Author: Dr. Md. Sagir Ahmed, Department of Zoology, University of Dhaka, Dhaka 1000, Bangladesh.**
Email: sagir@du.ac.bd

Introduction

Molluscs are the second largest invertebrate group next to Arthropods (Bouchet, 1992). They are unsegmented and soft-bodied invertebrates with head, muscular foot, fleshy mantle and visceral mass containing several organ systems (Pyron et al., 2015). About 10,000 species under the phylum Mollusca have been described so far, and it is assumed that equal number of species yet to be discovered (Strong et al., 2008). Among the seven classes of Mollusca, Bivalvia and Gastropoda are the largest and most abundant with diverse groups of marine species (Bouchet, 2006). Bivalvia is a bilaterally symmetrical, filter feeder aquatic molluscs which contains two calcified equally convex valves, wedge-shaped foot and leaf-like gills. On the other hand, Gastropoda is a monophyletic group because of larval operculum, torsion mechanism and concentrated organ within the visceral mass (Leal, 2002). They are asymmetrical with developed head, eyes, variable numbered tentacles and muscular foot. A total of 148 bivalves and 318 gastropods have been documented from Bangladesh yet (Siddiqui et al., 2007).

Sonadia Island is a small half-moon shaped island of about 9 square kilometers (3.5 square miles), offshore of the Cox's Bazar coast which is declared as an Ecologically Critical Area (ECA) nationally by the Government of Bangladesh. This Island sited on the lap of the sea also has an important ecological value as it is one of the habitats of some globally threatened species among the few remaining safe places in the world. The ecosystem of Sonadia Island is always dynamic as a result of the overflowing sea tides. The 4,916 ha Sonadia Island comprises a wide variety of wetland habitats including mudflats, sand dunes, mangroves, sand bars, lagoons, saltpans and beaches (CWBMP 2006). Hossain et al., (2014) reported a total of 317 molluscs from the offshore islands of Kutubdia, Maheshkhali and Sonadia, of which 121 species were identified as gastropods under 27 families, and 125 species were bivalves under 19 families. Sonadia Island is a very important habitat for gastropods and bivalves because of different habitat types including sandy beach, clay-sandy estuarine and mangrove habitat. No specific study was conducted on gastropods and bivalves diversity of this island. Thus, an initiative has been taken to assess the bivalves and gastropods diversity based on morphometric characteristics and the distribution pattern of bivalves and gastropod species of this unique habitat.

Materials and Methods

Study area and period

This study was carried out in Sonadia Island (roughly between latitude 21.28″-21.33″ and longitude 91.50″-91.56″) from January 2020 to December 2020.

Sample collection and identification

The specimens were collected from the intertidal or sub tidal zone of Sonadia Island through direct hand picking, also from local fishers. The specimens were preserved in ice bucket with crushed ice and transfer to Advanced DNA Barcoding and Fisheries Laboratory, Department of Zoology, University of Dhaka for further analysis. Collected samples were tagged and photographed by a digital camera. Total 8 transects were selected based on different habitat of bivalves, gastropods occupy at Sonadia Island (Figure 1). Transect 2, 3, 5 was clay-sandy types habitat, transect 6, 7, 8 and 1 was mangrove habitat and Transect 4 was sandy habitat. Random shell collection within the island was conducted to obtain data on the number of species found. For transect survey, one 100 meters transect line was laid parallel to the intertidal zone. This was overlaid continuously with a 1 m × 1 m quadrat along the transect line.

The species were morphologically identified following Poutiers, (1998) and Siddiqui et al., (2007). The scientific names of gastropods and bivalves have been updated following the World Register of Marine Species (WoRMS) (WoRMS Editorial Board 2022)

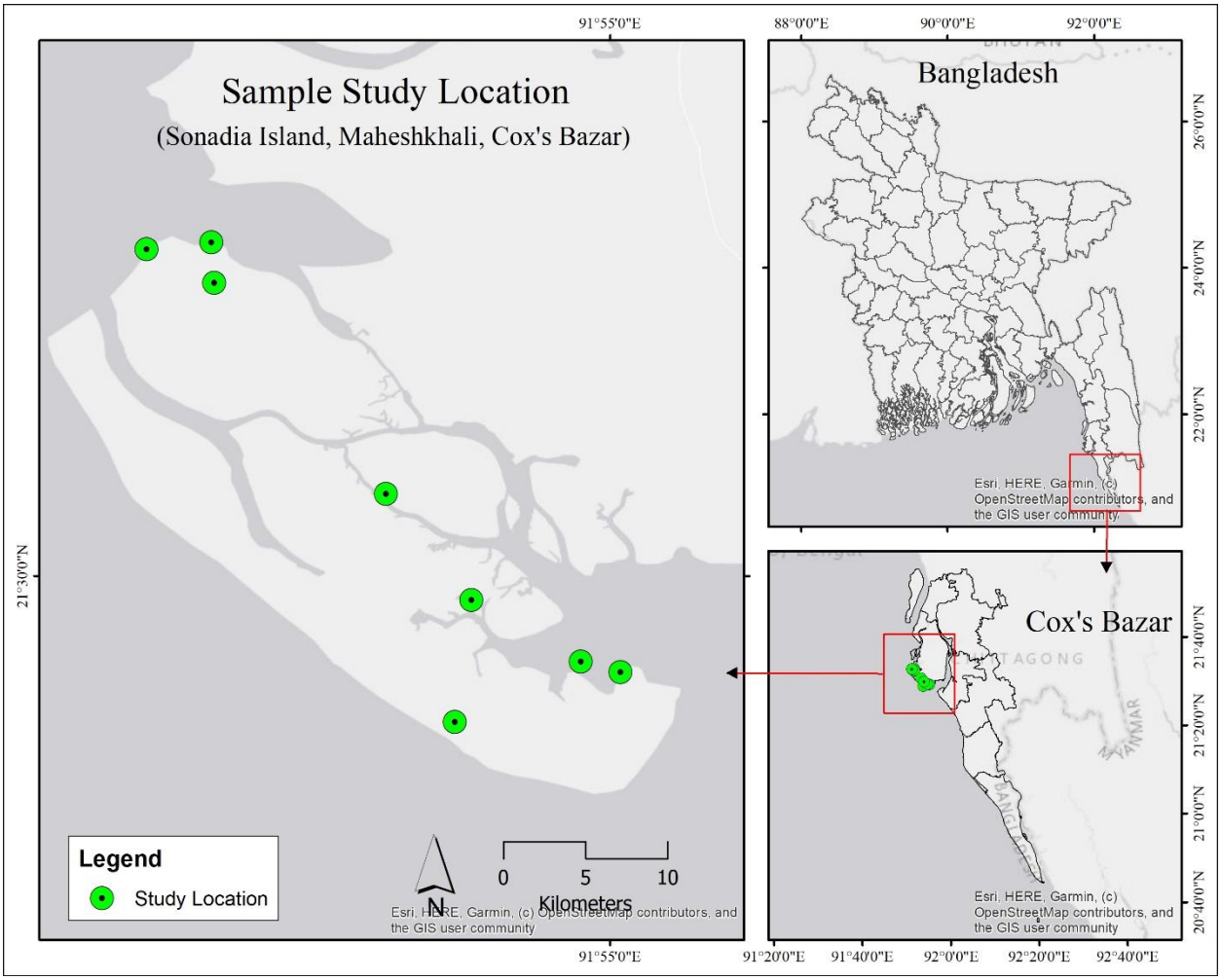

Figure 1. Study area and Transect location

Data Analysis

Species richness, abundance, relative abundance, diversity index (Simpson & Shanon), and habitat similarity index were analyzed following conventional procedures. Species richness expresses the number of species, while abundance marks the total number of individuals. The relative abundance of particular bivalves and gastropod species were calculated following the formula:

$$Relative\ abundance = \frac{Number\ of\ individual\ of\ a\ species}{Total\ number\ of\ individuals\ of\ all\ species} \times 100$$

Shannon-Weiner Index (*H′*) was calculated in order to know the species diversity based on species abundance using the Shannon and Weiner (1949) formula: $H = -[\Sigma Pi.ln(Pi)]$ Where H is the Diversity Index, Pi is the proportion of each species in the sample, and ln(Pi) is the natural logarithm of this proportion. Simpson Index (*D*) measures the probability of any two individuals drawn from noticeably large community belonging to different species (Simpson, 1949). It was measured by the following formula: $\mathbf{D = 1-(\frac{\Sigma n(n-1)}{N(N-1)})}$ Where n is the total number of bivalves or gastropods of a

particular species and N is the total number of bivalves and gastropods of all species. Bray-Curtis index (Bray and Curtis 1957) applied to determine similarities among transect. To determine over all abundance of each species against their rank, rank-abundance curves has been plotted by following Whittaker (1965). All statistical analyses were done in Microsoft Excel and PAST software (Hammer et al., 2001).

Result and Discussion

During the survey period, a total of 89 species of bivalves and gastropods have been confirmed. 45 species of bivalves under 16 families (Table 1) and 44 species of gastropods under 21 families (Table 2) have been identified based on morphological analysis. Among the bivalves, the dominant order was Venerida (15 species) and family was Veneridae (10 species) (Figure 3) in bivalves. In case of gastropods, the dominant order was Neogastrpoda and families were Muricidae and Turritellidae (5 species) (Figure 5). Within the eight transects, total 76 species of bivalves and gastropods under 14 orders have been observed.

Table 1. List of identified bivalves species

SL No	Order	Family	Genus	Species	English Name
1	Arcida	Arcidae	*Tegillarca*	*Tegillarca granosa*	Granular Ark
2				*Tegillarca nodifera*	Nodular Ark
3			*Anadara*	*Anadara antiquata*	Antique Ark
4				*Anadara pilula*	Ark clam
5				*Anadara indica*	Ark clam
6				*Anadara inaequivalvis*	Inequivalve Ark
7			*Barbatia*	*Barbatia amygdalumtostum*	Burnt-almond ark
8			*Glycymeris*	*Glycymeris reevei*	Bittersweet clams
9			*Barbatia*	*Barbatia candida*	White-beard ark
10	Pectinida	Pectinidae	*Volachlamys*	*Volachlamys tranquebaria*	Tranquebaria Scallop
11	Carditida	Carditidae	*Cardites*	*Cardites bicolor*	Twotoned cardita
12	Cardiida	Cardiidae	*Maoricardium*	*Maoricardium pseudolatum*	Broad Cockle
13			*Vepricardium*	*Vepricardium asiaticum*	Asiatic Cockle
14				*Vasticardium subrugosum*	Wrinkled Cockle
15				*Vepricardium coronatum*	Asiatic cockle
16			*Trachycardium*	*Trachycardium SP.*	Cockle
17		Donacidae	*Hecuba*	*Hecuba scortum*	Leather Donax
18			*Donax*	*Donax variabilis*	Donax
19		Psammobiidae	*Psammotella*	*Psammotella bertini*	Bertin’s Sanguin
20		Tellinidae	*Tellinimactra*	*Tellinimactra edentula*	Saddle Grooved Macoma
21			*Macomangulus*	*Macomangulus tenuis*	Thin tellin
22			*Serratina*	*Serratina capsoides*	Boxlike tellin
23		Semelidae	*Semele*	*Semele cordiformis*	Heart-shaped Semele
24	Myida	Pholadidae	*Barnea*	*Barnea candida*	White piddock
25				*Barnea manilensis*	Manila Piddock

26	Venerida	Mactridae	*Mactra*	*Mactra luzonica*	Trough shell
27				*Mactra maculata*	Maculated Troughshell
28				*Mactra violacea*	Violet Troughshell
29			*Mactra*	*Mactra turgida*	Duck clams
30		Veneridae	*Dosinia*	*Dosinia variegata*	Variegated Dosinia
31			*Protapes*	*Protapes gallus*	Rooster Venus
32			*Paratapes*	*paratapes undulatus*	Undulate Venus
33				*Paratapes textilis*	Textile Venus
34			*Globivenus*	*Globivenus toreuma*	Embossed venus
35			*Sunetta*	*Sunetta scripta*	Purple Sunetta Clam
36				*Sunetta menstrualis*	Mauve Sunetta
37				*Sunetta sp.*	Sunetta
38				*Sunetta donacina*	Donacin Sunetta
39			*Timoclea*	*Timoclea arakana*	-
40		*Chamidae*	*Chama*	*Chama sp.*	Cemented saltwater clam
41	Ostreoidea	Spondylidae	*Spondylus*	*Spondylus squamosus*	Brown-striped Thorny Oyster
42	Adapedonta	Pharidae	*Neosiliqua*	*Neosiliqua winteriana*	Winter's razor clam
43			*Siliqua*	*Siliqua radiata*	Sunset razor clam
44		Solenidae	*Solen*	*Solen vagina*	European razor clam
45	Ostreida	Ostreidae	*Saccostrea*	*Saccostrea cucullata*	Hooded oyster

Table 2. List of identified gastropods species

SL No	**Order**	**Family**	***Genus***	**Species**	**English Name**
1	Trochida	Trochidae	*Trochus*	*Trochus maculatus*	Mottled Top Shell
2			*Clanculus*	*Clanculus albanyensis*	Yellow-mouth Top Shell
3			*Umbonium*	*Umbonium vestiarium*	Button Top Shell
4	Littorinimorpha	Tonnidae	*Tonna*	*Tonna dolium*	Spotted Tun
5				*Tonna tessellata*	Tesselate Tun
6		Naticidae	*Neverita*	*Neverita duplicata*	Moon Snail
7			*Mammilla*	*Mammilla melanostoma*	Moon Snail
8			*Paratectonatica*	*Paratectonatica tigrina*	Tiger moon snail
9		Littorinidae	*Littoraria*	*Littoraria melanostoma*	Periwinkles

10		Cypraeidae	*Cypraea*	*Cypraea sp.*	cowrie
11			*Lyncina*	*Lyncina carneola*	Carnelian cowrie
12		Ficidae	*Ficus*	*Ficus subintermedia*	Underlined Fig Shell
13		Cassidae	*Phalium*	*Phalium areola*	Checkerboard bonnet
14	Neogastropoda	Muricidae	*Rapana*	*Rapana rapiformis*	Turinish-shaped Rapa
15			*Indothais*	*Indothais lacera*	Carinate Rock Shell
16			*Drupella*	*Drupella rugosa*	Muricid Drill
17			*Indothais*	*Indothais blanfordi*	Blanford's Rock-shell
18			*Semiricinula*	*Semiricinula tissoti*	Murex snail
19		Clavatulidae	*Turricula*	*Turricula javana*	Java turrid
20		Olividae	*Agaronia*	*Agaronia gibbosa*	Fat Olive
21		Conidae	*Conus*	*Conus hyaena*	Hyena Cone
22				*Conus boeticus*	Boeticus cone
23		Nassariidae	*Nassarius*	*Nassarius stolatus*	-
24			*Bullia*	*Bullia vittata*	Ribbon bullia
25			*Nassarius*	*Nassarius foveolatus*	Knobbled horn shell
26			*Nassarius*	*Nassarius nodiferus*	Nassa mud snails
27		Babyloniidae	*babylonia*	*Babylonia spirata*	Spiral Babylon
28			*Babylonia*	*Babylonia japonica*	Japanese Babylon
29		Melongenidae	*Volegalea*	*Volegalea cochlidium*	Spiral melongena
30		Turridae	*Gemmula*	*Gemmula speciosa*	Splendid turrid
31		Ancillariidae	*Ancillista*	*Ancillista albicans*	-
32	Caenogastropoda	Turritellidae	*Turritella*	*Turritella duplicata*	Screw Shell
33				*Turritella columnaris*	Screw Shell
34				*Turritella terebra*	Screw Turret
35				*Turritella attenuata*	Screw Turret
36				*Turritella sp.*	Screw Turret
37		Xenophoridae	*Stellaria*	*Stellaria solaris*	Sunburst Carrier Shell
38		Cerithiidae	*Cerithium*	*Cerithium columna*	-
39			*Rhinoclavis*	*Rhinoclavis sinensis*	Knobbled horn shell
40		Potamididae	*Pirenella*	*Pirenella cingulata*	Girdled horn shell
41				*Pirenella alata*	Sea snail
42			*Cerithidea*	*Cerithidea obtusa*	Obtuse Horn Shell

43	Cycloneritida	Neritidae	*Nerita*	*Nerita balteata*	Lined Nerite
44				*Nerita albicilla*	Blotched nerite

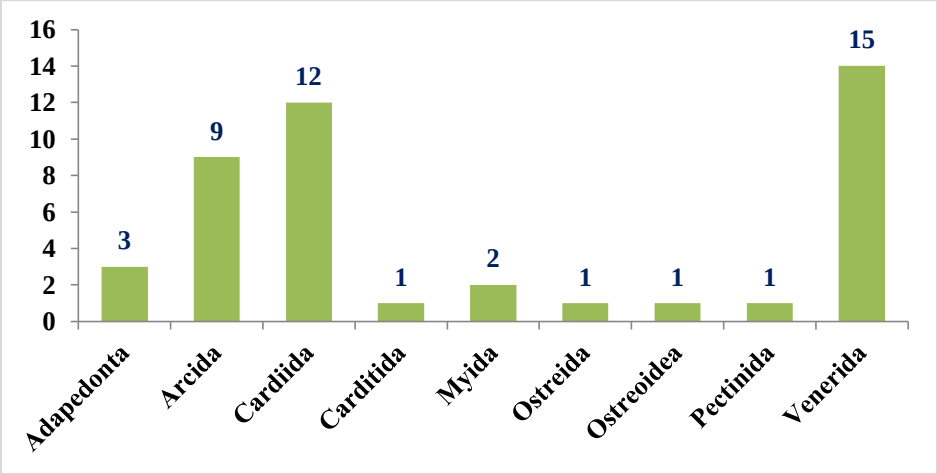

Figure 2. Bivalves species of different order

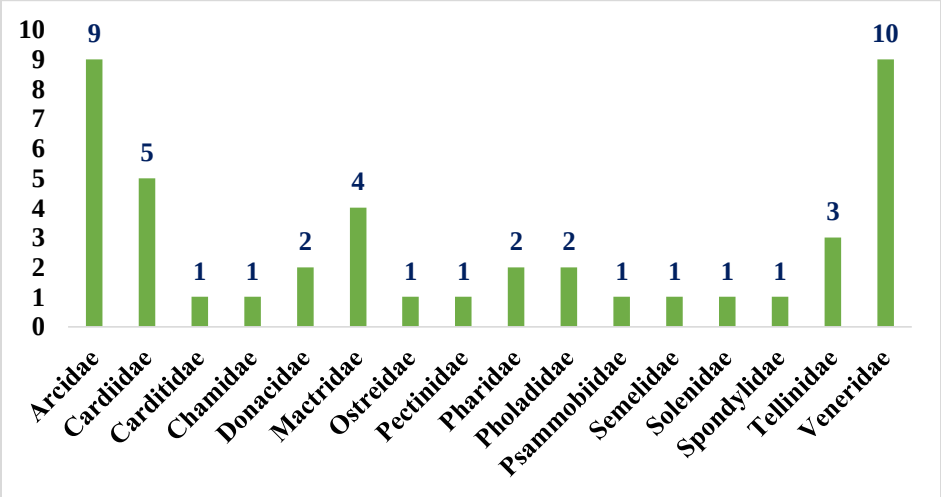

Figure 3. Bivalves Species of different families

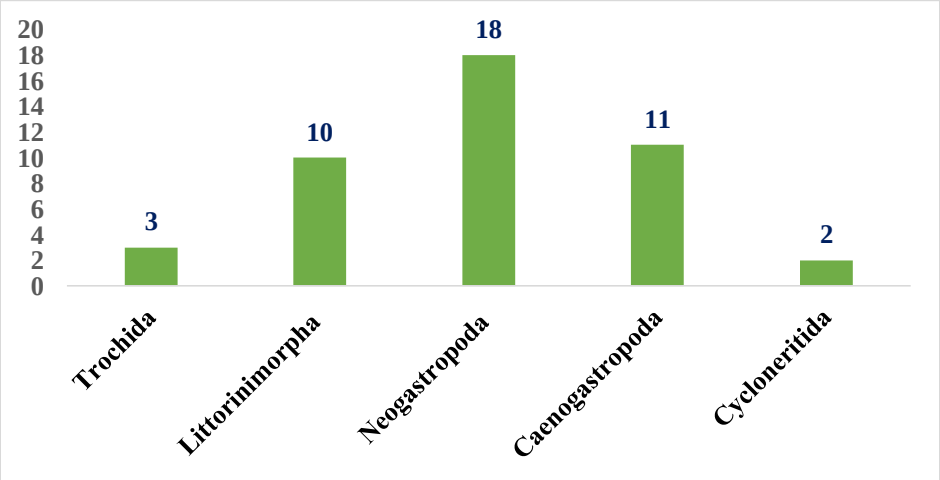

Figure 4. Gastropod species of different order

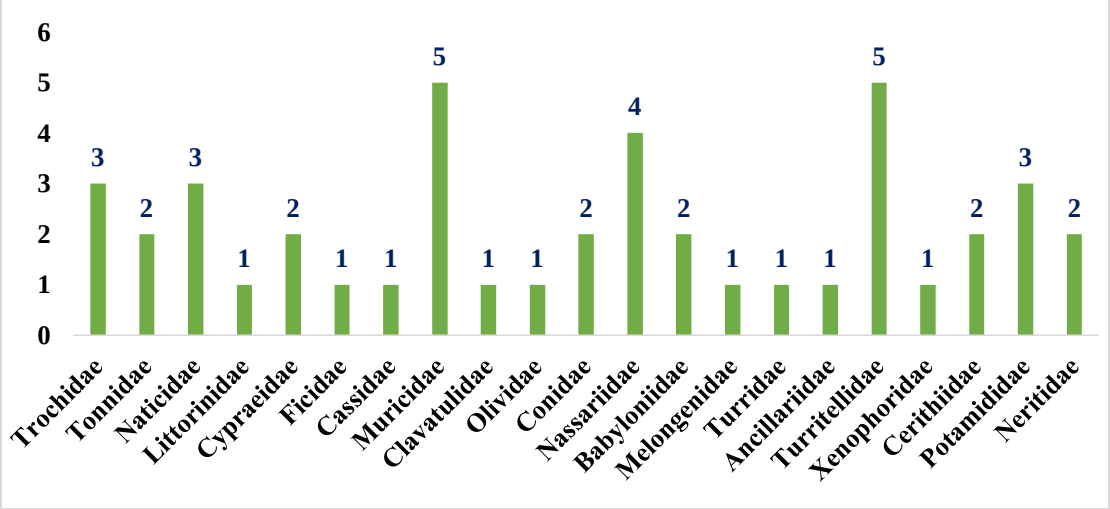

Figure 5. Gastropods Species of different families

Richness, abundance and diversity in transects

A total of 1328 individuals of bivalves and gastropods were collected belongs to 76 species (Table 3). The highest number of species was observed in transect-5 (35 species) which was 45.45% of the total species. Transect-3 occupied 29 species (37.66%) and rest of the transect species richness are Transect 1: 17 species (22.07%); Transect 2: 4 species (5.19%); Transect 4: 23 species (29.87%); Transect 6: 7 species (15.58%); Transect 7: 12 species (15.58%); Transect 8: 10 species (12.99%) **(Table 4; Figure 6)**. In case of abundance, Transect 3 occupied the highest 730 individuals (54.97%). The species abundance in other transect were: Transect 1: 70 individuals (**5.27%)**; Transect 2: 75 individuals (5.65%); Transect-4: 51 individuals (3.38%) Transect 5: 319 individuals (24.2%); Transect 6: 30 individuals (2.26); Transect 7: 24 individuals (1.81) Transect 8: 29 individuals (2.18) **(Table 4; Figure 7)**.

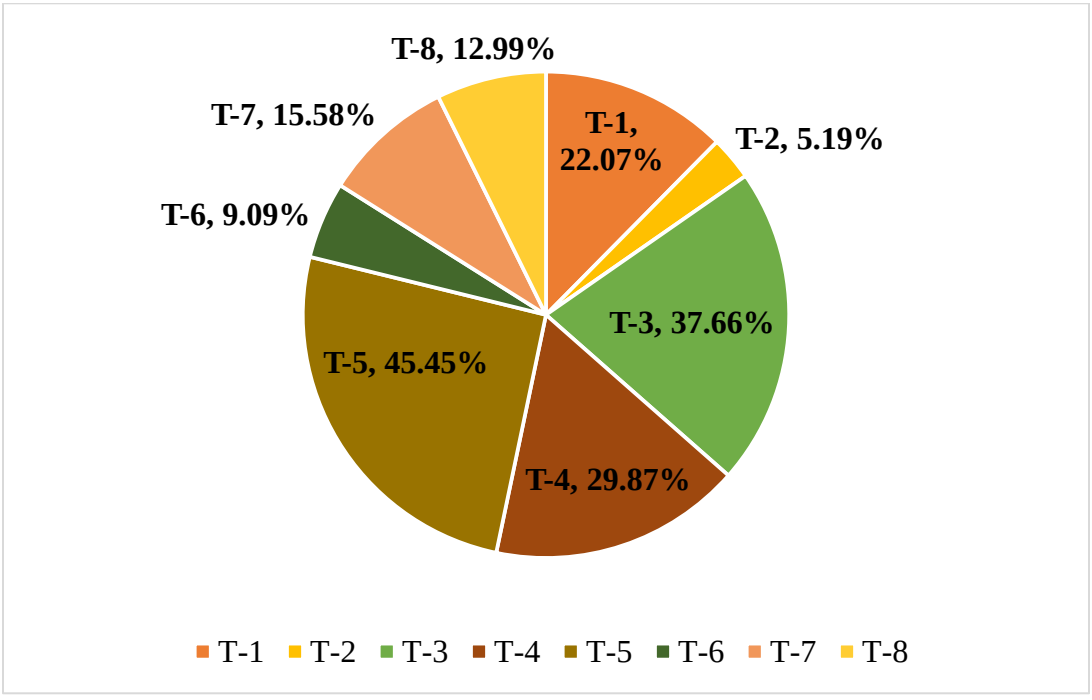

Figure 6. Occupied species (%) each transect (T-Transect)

The highest diversity was observed in transect 4 (**H= 2.814, Ds= 0.9158)** and moderately high diversity was observed in other transect **e**xcept transect-2 (**H=0.3153, Ds=0.1237**) in bivalves **(Table 4).**

Table 3. List of identified bivalve species under different order during the study period with their scientific name

Species	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6	Transect 7	Transect 8
Agaronia nebulosa				✓				
Anadara antiquata	✓			✓	✓		✓	
Tegillarca granosa				✓				
Anadara indica							✓	
Tegillarca nodifera				✓				
Anadara pilula				✓	✓		✓	
Ancilla ampla					✓			
Tellinimactra edentula				✓	✓			
Babylonia japonica	✓							
Babylonia spirata	✓			✓				
Barbatia amygdalumtostum			✓					
Barbatia candida					✓			
Barnea candida					✓			
Bullia vittata			✓					
Cardites bicolor			✓		✓			
Cerithidea obtusa						✓	✓	✓
Cerithium columna	✓		✓					✓
Chama sp.					✓			
Conus boeticus					✓			
Indothais lacera	✓		✓	✓	✓			
Cymia sp.								✓
Cypraea sp.					✓			
Hecuba scortum			✓	✓				
Donax variabilis					✓			
Gemmula speciosa				✓				
Gemmula vagata	✓		✓					
Glycymeris reevei				✓				
Littoraria melanostoma			✓			✓	✓	✓
Lyncina carneola							✓	
Macomangulus tenuis			✓	✓				
Mactra luzonica				✓				
Mactra maculata				✓				
Mactra turgida				✓			✓	
Mactra violacea				✓	✓			
Mammilla melanostoma			✓		✓			
Nassarius foveolatus			✓					
Nassarius nodiferus			✓					
Nassarius stolatus	✓		✓				✓	
Neosiliqua winteriana					✓			
Nerita albicilla					✓			
Nerita balteata						✓		
Agaronia gibbosa			✓	✓				
Paratapes textilis			✓					
Paratectonatica tigrina	✓		✓		✓	✓	✓	
Phalium areola	✓		✓					

Pirenella alata								✓
Pirenella cingulata	✓		✓		✓	✓	✓	✓
Neverita duplicata			✓		✓			
Protapes gallus					✓			
Rapana rapiformis		✓	✓					
Rhinoclavis sinensis			✓					
Saccostrea cucullata								✓
Semele cordiformis				✓				
Semiricinula tissoti	✓							
Serratina capsoides							✓	
Siliqua radiata					✓			
Sinum delesserti				✓	✓			
Solen vagina					✓			
Sunetta menstrualis				✓				
Sunetta donacina				✓	✓			
Sunetta sp.					✓			
Telescopium telescopium	✓		✓		✓	✓		✓
Indothais blanfordi	✓							
Drupella rugosa	✓				✓			
Timoclea arakana					✓			
Vepricardium asiaticum					✓			
Trachycardium sp.					✓			
Clanculus albanyensis			✓		✓			
Turricula javana		✓	✓					
Turritella attenuata	✓							
Turritella columnaris		✓	✓	✓	✓			
Turritella duplicata	✓	✓	✓	✓	✓	✓	✓	✓
Turritella sp.					✓			
Turritella terebra			✓		✓			
Umbonium vestiarium			✓		✓			
Volegalea cochlidium	✓		✓					✓

Table 4. Species richness (S), abundance (A), evenness (E), diversity [Shannon-Weiner Index (H), Simpson's Index (Ds)] in different Transect

Transect	S	(%)	A	(%)	Ds	H	E_(e^H/S)
1	17	22.07	70	5.27	0.8988	2.509	0.723
2	4	5.19	75	5.65	0.1273	0.3153	0.3427
3	29	37.66	730	54.97	0.6827	1.615	0.1734
4	23	29.87	51	3.84	0.9158	2.814	0.7251
5	35	45.45	319	24.02	0.596	1.733	0.1616
6	7	9.09	30	2.26	0.7956	1.741	0.8148
7	12	15.58	24	1.81	0.816	2.101	0.6814
8	10	12.99	29	2.18	0.8133	1.961	0.7108

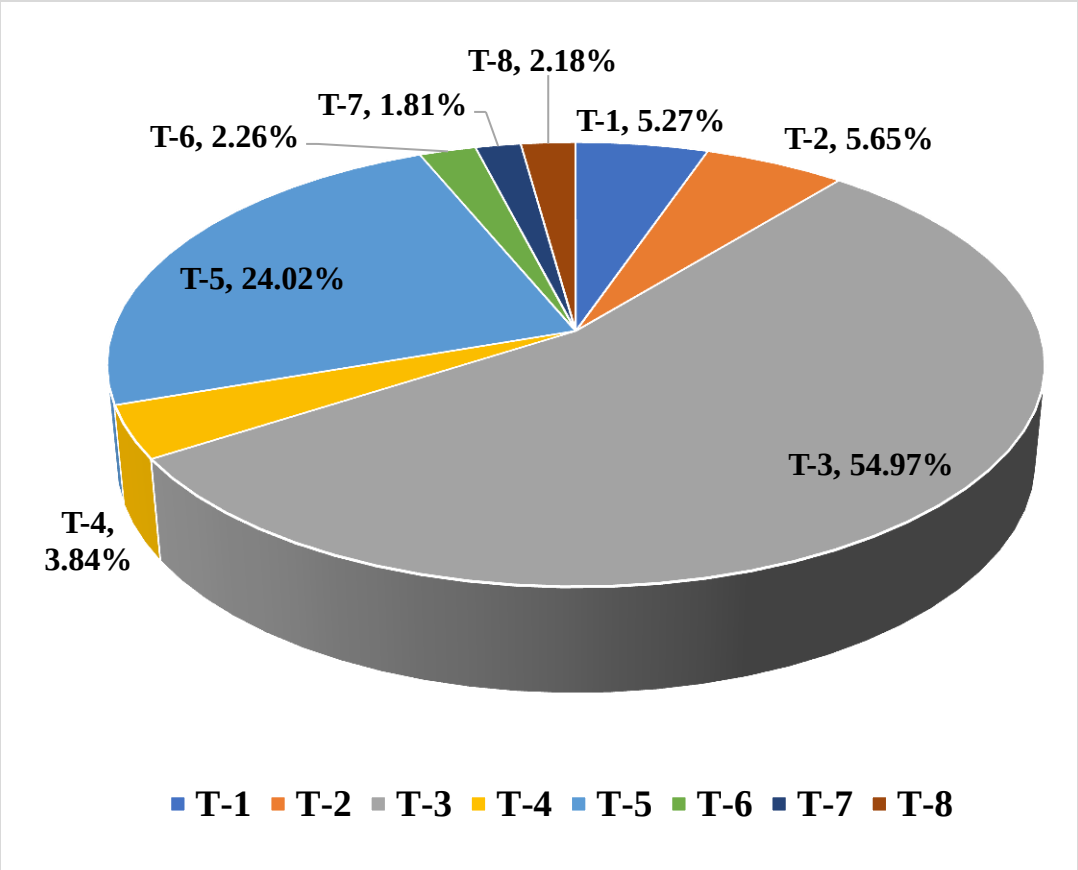

Figure 7. Number of individuals (%) in each transect (T-Transect)

Similarities among transects: Two large clusters and one small cluster were formed in Bray-Curtis index. Species diversity of Transect 2, 3,5 almost similar which was clay-sandy types habitat in sandy portion of the island, on the other hand transect 6, 7, 8 and 1 which was mangrove habitat formed another cluster. Transect 4 was sandy habitat separately formed another small cluster and joined with second cluster **(Figure 8)**.

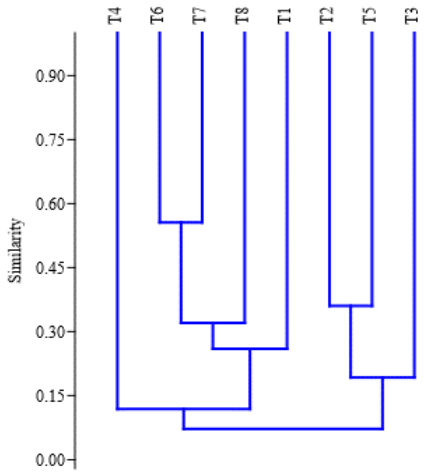

Figure 8. Similarity profile test among transects using Bray-Curtis index

Relative abundance: *Pirenella cingulata* was the most abundant species with the highest relative abundance of 28.84. *Turritella duplicate, Cerithium columna, Umbonium vestiarium*, *Paratectonatica tigrina* also the dominant species and the relative abundance were 27.64, 15.81 3.46 and 2.48, respectively **(Figure 9)**.

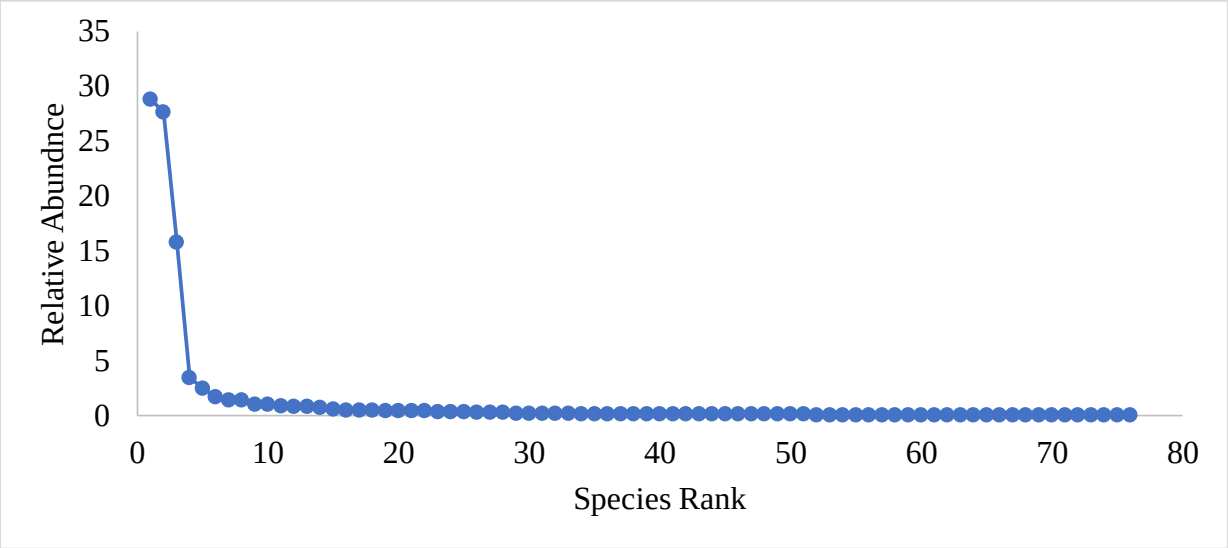

Figure 9. Relative abundance of Gastropods and bivalves observed inside transect

This study shows the current scenario of gastropods and bivalves diversity in Sonadia Island. From the transect data it was clear that there was a significant difference in species diversity among different habitats of the island. Plastic pollution and sometime over extraction of shell was identified as the main threats for the gastropods and bivalves diversity. Awareness creation among tourists and local people, especially young communities, may play a positive role for habitat and biodiversity conservation of the island.

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