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Marine molluscan diversity and statistical analysis of Kundalika estuary, coast of India

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Abstract
Marine bivalve study undertaken of Kundalika estuary from five localities. The Kundalika river came from Himalayas and meets to the sea, in Raigad district. The diversity, taxonomy and statistical analysis from, muddy habitat, rocky substrata, and sandy beach, were studied, According to Shannon Wiener Diversity Index during October 2014 to September 2015. The bivalve molluscan species are playing an essential role as food as well as ecologically.

Keywords: diversity, bivalve, revdanda creek, coast of India

1. Introduction
Phylum Mollusca is one of the largest phyla of the animal kingdom. It contains 1,00,000 living species. Among the exploited bivalve molluscs resources of India, clams are widely distributed and abundant, the form subsistence fisheries all along the Indian coast and fished by men, women and children from the intertidal region to about 4m depth, they use to collect by handpicked. These organisms usually inhabit bottom substrates for at least part of their life cycle. Several species of Veneridae family clams that occur along the coast of Maharashtra *Placenta placenta* one is important for its food value. It contributes about 80% to the total production of clams landed annually mainly from Kalbadevi (Shirgaon creek) and (Kajali, Bhatye creek) estuaries along Ratnagiri coast, Maharashtra [1]. Bivalve provides an important source of protein for human besides fish, it can be found in many parts of the world such as marine, brackish, fresh and terrestrial areas. Marine bivalve consists of various species that is used for many purposes besides their nutritional source [2]. Amongst several marine living resources the shell fishes play a vital role in India's economy of their popularity is increasing due to their delicious and food value. The bivalves such as oysters, mussels and clams serve the nutritional needs of the coastal population. They are good source of minerals, protein and glycogen and are easily digestible compared to other animal foods [3]. The present paper investigates the coastal diversity of edible bivalve molluscs in creek, rocky shore, sandy beach, muddy areas, selected localities at Raigad district.

2. Materials and Methods
Site-I: Agrav
(Lat. 18°33.2841"North and Long. 072°56.905"East). The creek swampy muddy region, there is exposed inter-tidal mudflatabout 30-40m during low tide, in dense small mangroves trees *Avicinia marina* (Forsk.) Vierh., were present in the swampy area, village is about 40m away from high water mark on the northern direction, there is domestic water discharged, fishing activities there were.

Site-II: Revdanda
(Lat.18°32.571"North and Long.072°55 981"East). The estuary swampy muddy region, this is a part of estuaries mouth of big kundalika river after coming from Himalayas meets to the sea. there is exposed inter-tidal mudflatabout 10-20 m during low tide, about on the distance 20m from high water mark village is on the south-northern side Cement constructed jetty were present for the landing fish catch after fishing. Beside the jetty comes swampy area extended towards on the eastern side, in dense large mangrove trees of *Avicinia marina* (Forsk.) Vierh, *Avicinia marina var*. acutissima Stapf & Mokdenke ex Moldenke, *Avicenniaalba* Blume, *Avicennia officinalis* L., were present, but *Avicinia marina* (Forsk.) Vierh was dominant, due to nearest village there is domestic water discharged in to the estuarine water, due to fishing activities there is oil discharged.

Site-III: Nagaon
(Lat.18°36.647"North and Long. 072°58.627"East). The open fine sandy beach, this is longest sandy beach of the Raigad coast, attractive coastal area inviting to the tourist Maharashtra, India some tourist use to come out of the India, bivalves *Solenbrevis* Gray, 1842,*Culteluscultelus* (Linnaeus) were present at mid water mark, while gastropods *Umboniumvestarium* (Linnaeus) found during low tide at mid water mark to till low water mark, nearby 40-50m area open during the low tide, about 200 - 250m village is on northern side from the high tide mark, no domestic discharge, no fishing activities.

Site-IV: Raiwadi
The open fine sandy beach, about 20-30m area opens during low tide, in dense climbing mangrove plant *Ipomoea pes-caprae* (L.) Sweet., spread on beach just above the high water mark, about 90 - 100m village is on northern side from the high tide mark, no domestic discharge, no fishing activities.

Site-V: Akshi
(Lat. 18°37.772" North and Long. 072°53.890" East). The open fine sandy beach, this is long sandy beach of the Raigad district coast, attractive coastal area inviting to the tourist Maharashtra, India some tourist use to come out of the India, nearby 20-30m area opens during the low tide, in dense

climbing mangrove plant *Ipomoea pes-caprae* (L.) Sweet. spread on shore, about 300 - 400m village is on northern side from the high tide mark, due to nearest village there is domestic discharge occurrence, fishing activities is going on by boats.

Live animals were collected twice in each season monsoon, post monsoon, winter and summer July 2014 to June 2015. Also SCUBA diving equipment's are used for underwater observation by Dive Master for this study. From selected study localities of Raigad district coast, as Soon after fishing or collection, they were brought to the laboratory and the shells were brushed to clean the fouling biomass and mud. They were then stocked in filtered seawater pumped in the laboratory from the estuary for observation then animal preserved in 70% alcohol for taxonomical identification of external structure of typical shells, especially, lunal, umbo, Internal parts such as teeth, adductor muscles, hinged scars. The shells were identified from Zoological Survey of India, Kolkata. Also using the following reference: Annotated checklist of Indian Marine Molluscs (Cephalopoda, Bivalve and Scaphopoda) Part-1 Ramakrishna and A. Dey. Occasional Paper no. 320, ZSI -2010. [4]. Guidance of Dr. Sherly Slack, Australia.

3. Results

For this study as per as required The SCUBA one is the important tool used for the underwater study of the diversity, we went underwater vertically and horizontally in the Sea, for collection of alive species. Among five localities after taxonomical study, class bivalve belongs to fiveorders, Nine families and Fifteen species are recorded. One species from Arcidae, which is belong to Order Arcoida two species from MYTILIDAE family which is belongs to Order MYTILOIDA. Four species from Veneridae family. One species from family Solenidae, One species from family Cultelidae, One species from family Corbiculidae while three species from family Donacidae. These above five families are belongs to Order VENEROIDA. Two species from Ostridae family which is belongs to Order STREOIDA. One speciesfrom family Anomiidae which is belongs to Order PTERIOIDA. Total sixteen genus and sixteenalive species of edible bivalve have recorded during the study period. The data presented on edible molluscs from different habitats like rocky shore, sandy coast, muddy, swampy with mangrove associated species. According to localities two species from Agrav, eleven species from Revdanda, five species recorded from Nagaon, five species from Raiwadi while from Akshi sandy coast six species were recorded with variations in size also. The local fisherman/women use to collect these species for the mainly for two purpose as a food, whiledry shells for commercial purpose as well as ornamental use also.

According to Shannon Wiener Diversity Index

Table 1: Showing the Shannon Wiener diversity Index of study localities.

No. of sample	pi=sample/sum	ln (pi)	pi*ln (pi)
2	0.068	-2.688	-0.182
11	0.379	-0.970	-0.367
5	0.172	-1.760	-0.130
5	0.172	-1.760	-0.130
6	0.206	-1.579	-0.345
sum=29			Sum = -1.154

H=1.154

H_{max}= ln(N) = ln(5)=1.609

Evenness = H/H_{max} = 1.502/1.609 =0.717

Result: Shannon diversity index (H) = 1.154

Evenness = 0.717

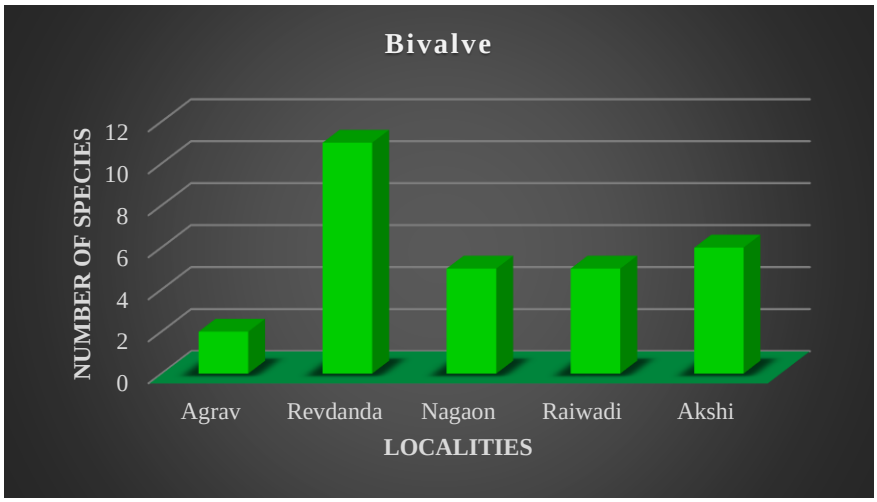

Fig 1: Bivalve Species According to Localities on the Coast of Raigad District.

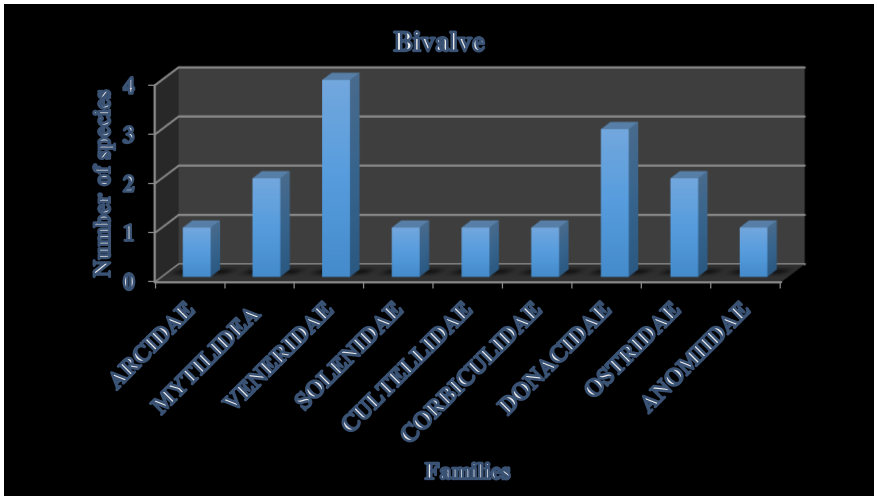

Fig 2: Bivalve Species According to Families on the Coast of Raigad District.

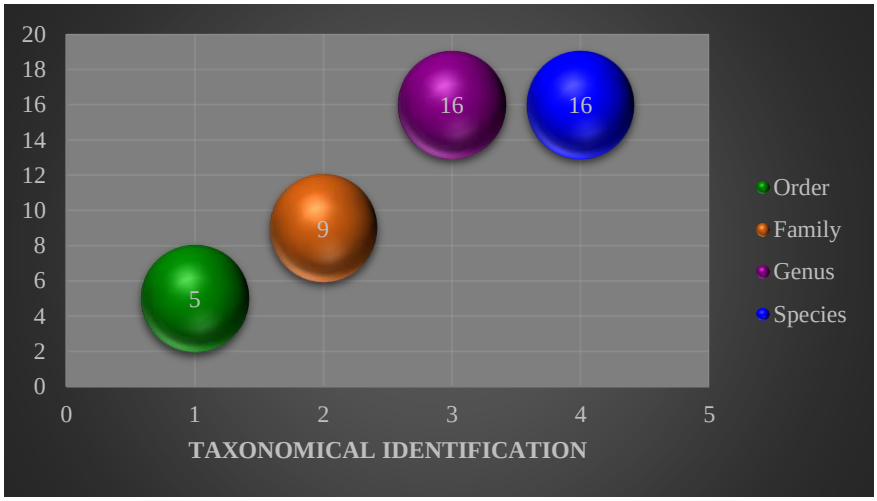

Fig 3: Taxonomical Study of Bivalves from Study Sites.

According to table no 1 The Shannon diversity index (H) is 1.154, while evenness is 0.717 recorded, according to Fig no. I. the Revdanda have more diversity because of estuarine water, and according to Fig no II Veneridae family was dominant. The oysters were recorded on the mud banks, mud flats, sandy muddy area swamps, prop-roots and pneumatophores.

4. Discussion

Decomposed material of the plant litter from August onwards is an important component of nutrient cycling in wetlands and it harbors a large number of diverse species [5]. The lowest density was in the month of July because of monsoon season. In monsoon, due to self-dilution of the body fluid, the sensitive molluscs were unable to adjust the fluctuating osmotic balance quickly hence their mortality was high. After the month of July because of adjustment by animal the mortality rate of molluscs decreased gradually, it means density of molluscs increased. It also understood that in the month of July, the salinity and temperature dropped down which made the condition adverse for the molluscs [6]. The observation of Bivalves populations in ecosystem is important to evaluate their condition [7]. In Malaysia some of marine bivalve such as *Anadara granosa* is being cultured for commercialization. In Sarawak mangrove forest covered 173,792 ha of the land which is suitable for molluscan habitat [8]. Studies on mangrove associated molluscan fauna of various Indian peninsular estuaries viz. Godavari and Krishna estuaries [9], Mahanadi estuary [10]. The assemblage of oysters were to occur on the mud banks, mud flats, sandy muddy area swamps, prop-roots and pneumatophores and mussel were found attached to wherever hard substratum is available such as prop-roots and pneumatophores and oysters beds [11]. *Crassostrea cattuckensis* of medium (88.99 mm shell length) size from Bhatye estuary at Ratnagiri were collected in monsoon winter and summer seasons [12]. The numerical abundance and biomass of molluscs can be equally impressive [13]. Twenty threemolluscan species recorded from the mangrove forest from Hong Kong [14]. Twenty nine bivalves recorded from the mangrove root systems on the Atlantic coast of Colombia & Wood-boring bivalves are also common in the mangrove forest [15]. Twenty five species of molluscs (Thirteen gastropods and Twelve bivalves) were recorded from Krangad estuary, South East Coast of India. [16]. A total account of Sundarban fifty sixspecies of molluscs including thirteen gastropods and twenty five bivalves were recorded [17]. Twelve bivalvesmangrove associatedrecorded at Ratnagiri, Maharashtra, India [18]. Nineteenbivalves from nine families recorded from selected sites of Raigad district Coast [19].

5. Conclusion

According to Fig no I Revdanda and Akshi probably have suitable habitat to support large number of edible molluscs diversity. Maximum number of species was observed from mud flats along the mangroves. Due to the estuaries more diversity found here especially the oysters (*S. cucullata and C. catuckensis*) were found attached to wherever hard substratum is available. According to Fig number II family Veneridae found abundantly. While according to Fig no III sixteen species and sixteen genus from nine families from five orders recorded. The present study of bivalve species of Revdanda study sites has greater commercial value and biodiversity importance. The total number and type of edible molluscs probably is influenced by habitat and geographical condition. So, there is urgent need to sustainable utilization and conservation of bivalve species.

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