

# Species Diversity and Environmental Relationships of Marine Macrobenthic in Gulf of Kutch, Gujarat, West Coast of India

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**Abstract** Research work is focused on the taxonomic composition of macrobenthic in three marine water Shelf (Vadinar Shelf, Okha Shelf and Kandla Shelf) Gulf of Kutch Coastal water during November 2011 to December 2012. In present investigation 39 species of macrobenthic were to the different groups i.e., Polychaetes, Crustaceans, Nematodes, Mollusca. Observation study period in the Shelf Vadinar, the macrobenthic was composed of nine taxa of Polychaetes, three taxa of Nematodes, three taxa of Crustaceans and three taxa of Mollusca, while in Kandla Shelf ten taxa of Polychaetes, six taxa of Nematodes, three taxa of Crustaceans, three taxa of Mollusca and in Vadinar Shelf thirteen taxa of Polychaetes, nine taxa of Nematodes, three taxa of Crustaceans and three taxa of Mollusca, were encountered respectively. Comparison of the obtained results with those of earlier investigations occurred during November 2011 to December 2012 showed that changes have occurred in the interval. The total macrobenthic composition is significantly changed in all the three water bodies. Comparison of diversity and density in three Shelf was studied with diversity indices.

**Keywords:** macrobenthic, trophic status, anthropogenic, Kutch, Gujarat, India

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## 1. Introduction

Biodiversity is the variety of organisms considered at all levels and includes genetic and ecosystem variants, which comprise arrays of species, genera, and families, as well as communities of organisms within particular habitats and the physical conditions under which they live. Because of intensive exchange of nutrients between their water columns and sediments, shallow Shelf are sensitive to anthropogenic [1]. Under the influence of anthropogenic usually associated with a loss of structural diversity and, as a result, a decrease in biodiversity at the higher trophic levels takes place [2,3,4]. While oligotrophic Shelf is generally clear and hypertrophic Shelf frequently turbid, shallow Shelf at intermediate nutrient concentrations may exhibit either Clearwater or turbid states [5].

Biological studies have been increasingly employed in monitoring water quality in Shelf. Phytoplankton, macrobenthic, macrophytic plants and fishes were used considerably in biomonitoring of Shelf ecosystems. Indian continental Shelf ecosystems were investigated extensively for plankton from mid 20<sup>th</sup> century [6,7]. These studies show that the dominant plankton and their seasonality are highly variable in different coastal waters in Indian Coasts according to their nutrient status, age,

morphometry and other locational factors. Studies reveal different groups of macrobenthic have their own peak periods of density, which is also affected by local environmental conditions prevailing at the time. Macrobenthic by their heterotrophic activity plays a key role in the cycling of organic materials in aquatic ecosystems and used as bioindicators. The bioindicators are evaluated through presence/absence, condition, relative abundance, reproductive success, community structure community function or any combination [8]. Anthropogenic of marine coastal aquatic ecosystems can greatly alter the structure of macrobenthic communities. Hence, macrobenthic has been used as an indicator of a Shelf's trophic state [9].

Changes in the marine aquatic environment accompanying anthropogenic pollution are a cause of growing concern and require monitoring of the surface waters and organisms inhabiting them [10]. Composition and structure of macrobenthic community are affected by anthropogenic [11]. And these communities have potential value as indicators of changing trophic [12]. Suggest that 'the most efficient method to advance knowledge in limnology is through comparative studies of different types of Shelf within the same geographical area'. But there is no literature from Gulf of Kutch region water bodies. Hence the present work was undertaken to analyze the changes in macrobenthic communities those which have occurred over a period due to the changed

trophic status with aim of contributing to the knowledge of marine water biodiversity in Gulf of Kutch region.

## 2. Materials and Methods

Macrobenthic samples were collected from three Shelf habitats of Gulf of Kutch. Sample collection was made during the period of November 2011 to December 2012. Macro benthic samples were collected with the help of Van Veen Grab Sampler size is 0.4m<sup>2</sup>. Quantitative samples of the animals inhabiting subtidal sediments are usually taken by a grab. The grab, which is lowered vertically from the stationary boat, capture the epifauna and infauna down to the depth excavated by the grab. This sample is washed in a container of filtered sea water and sieved through (mesh size 0.5 mm) and the entire content were first stained in Rose Bengal and then preserved in formaldehyde. Samples were fixed in 4% formaldehyde. Organisms were identified to the greatest possible

taxonomic level (Genus/species), using an optical microscope and a specialized bibliography [13]. Trophic status was analyzed using  $Q_{B/T}$  quotient (Sladeczek 1983). In comparing the faunastic composition of macrobenthic we used the Sorenson similarity index (S) (Hellawell 1977).  $S = 2C/A+B$

Where A is the numbers of species present in one population, B is the number of species present in the other population, and C is the number of species present in both populations. As control we used Jaccard index (CJ) (Hellawell 1977).

$$CJ = J / a + b - J$$

Where 'a' is the number of species present in one population, b is the number of species present in the other population, and J is the number of species present in both populations. The data which was generated by our survey between 2011 and 2012 was compared with the earlier species composition list for three Shelf.

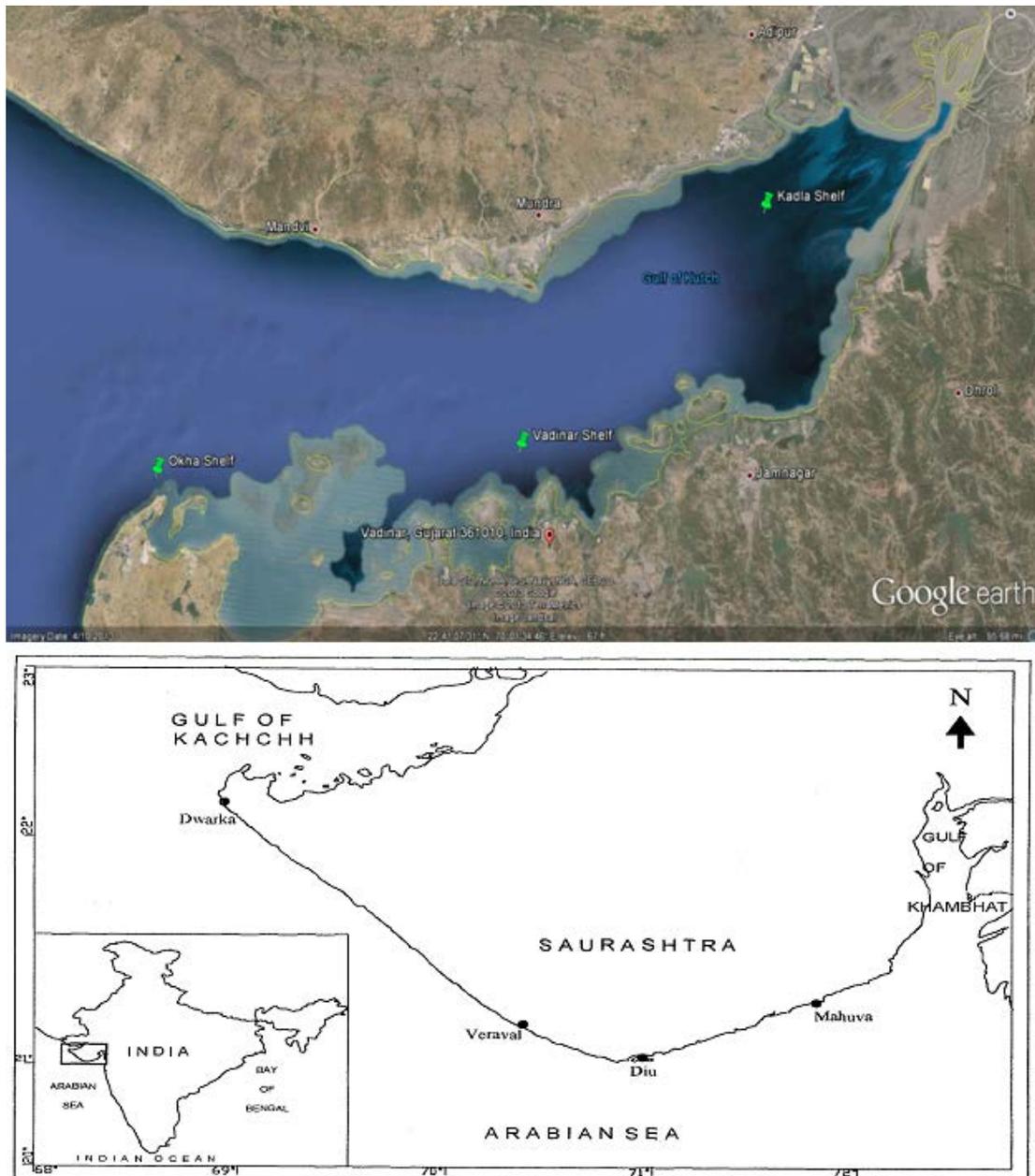


Figure 1. Map of Gulf of Kutch with sampling locations

### 3. Results

**Table 1. Macro benthic composition in three Shelf in comparison with earlier reports**

Species/year	Vadinar Shelf		Kandla Shelf		Okha Shelf	
	2011	2011	2011	2011	2011	2011
	-	-	-	-	-	-
	2012	2012	2012	2012	2012	2012
<b>Polychaetes</b>						
<i>Aphelocheata</i>	+	-	+	+	+	+
<i>Capetellidae</i>	+	-	+	+	-	+
<i>Cirratulidae</i>	+	+	+	+	+	-
<i>Cossuridae</i>	+	+	+	+	-	+
<i>Eunicidae</i>	+	-	-	+	+	+
<i>Flabelligeridae</i>	-	+	-	+	+	-
<i>Magelonidae</i>	+	+	-	-	+	+
<i>Paraonidae</i>	-	-	+	+	-	+
<i>Phyllodocidae</i>	+	+	-	+	+	+
<i>Sabellidae</i>	-	+	+	-	+	+
<i>Syllidae</i>	-	-	-	+	+	-
<i>Ampharetidae</i>	+	+	-	+	-	+
<i>Capitellidae</i>	-	+	+	+	-	+
<i>Cirratulidae</i>	+	-	+	-	+	-
<i>Magelonidae</i>	-	+	-	-	+	+
<i>Maldanidae</i>	-	+	+	+	-	-
<i>Nephtyidae</i>	-	+	-	+	+	+
<i>Onuphidae</i>	-	+	-	-	-	-
<i>Polynoidea</i>	-	+	-	+	+	+
<i>Linopherus sp.</i>	-	+	-	-	-	+
<i>T. Capitellidae</i>	-	+	-	+	-	+
<i>T. longiseta</i>	-	-	+	+	+	+
<i>T. Cirratulidae</i>	-	+	-	+	-	+
<b>Nematodes</b>						
<i>Diplolaimelloides sp.</i>	+	+	-	+	+	+
<i>D. laevis</i>	-	+	+	+	-	+
<i>Desmoscolex sp.</i>	-	+	+	+	+	+
<i>D. logispina</i>	-	+	-	+	+	-
<i>Metadasyneimoides sp.</i>	-	-	+	-	-	+
<i>Monia brachiata</i>	+	+	-	+	+	+
<i>M. reticularis</i>	-	+	+	-	+	+
<i>Belbolaimus sp.</i>	+	+	-	+	-	+
<i>Daphanosoma excisum</i>	+	-	-	-	+	+
<i>Calomicrolaimus sp.</i>	-	-	+	+	-	+
<i>C. reticulatus</i>	-	+	-	+	+	+
<i>C. barroisi barroisi</i>	-	+	+	-	-	-
<i>Lantonopsis australis</i>	-	-	-	+	+	+
<i>Pselionema sp.</i>	-	-	-	+	+	-
<b>Crustaceans</b>						
<i>Melita zeylanica</i>	+	-	+	+	+	+
<i>Megalpa</i>	-	-	+	+	+	-
<i>Decapoda Sp</i>	+	+	-	+	+	+
<i>Quadrio visiobengalensis</i>	+	+	-	+	-	-
<i>Anthuidae</i>	-	+	-	+	+	+
<i>Isopoda</i>	+	-	+	-	-	+
<b>Mollusca</b>						
<i>Aplacophora</i>	+	+	+	-	+	+
<i>Limopsis sp.</i>	+	-	+	+	+	+
<i>Bivalvia</i>	-	+	+	+	+	+
<i>Thyasira sp.</i>	+	+	-	+	-	+
<b>Total</b>	<b>22</b>	<b>31</b>	<b>24</b>	<b>35</b>	<b>29</b>	<b>36</b>

On the basis of the results presented in Table 1, it can be easily explain that the changes have occurred in the total macro benthic composition in the entire three Shelf. Out of 102 species which were recorded by earlier

workers only 73 species were registered during study period. Among Polychaetes group out of 50 species only 31 species were listed in the present study, while in the Nematodes group out of the 30 reported species 21 recorded again and in the Crustaceans group out of 12 species reported earlier 12 species were rerecorded. Among the Mollusca group out of 10 species reported earlier 9 species were recorded again.

**Table 2. Similarity in total macrobenthic as well as Nematodes, Crustaceans and Polychaetes group in six water bodies based on Jaccard similarity index (CJ) and Sorenson similarity index (S)**

	Vadinar. Shelf	Kandla Shelf	Vadinar Shelf
<b>Macrobenthic</b>			
CJ	29.2 %	34.1%	51.1%
S	45.2 %	50.8 %	67.69%
<b>Polychaetes</b>			
CJ	19 %	28.85 %	31.8 %
S	32 %	44.4 %	48.2 %
<b>Nematodes</b>			
CJ	36.3 %	21.4 %	46.1 %
S	53.3 %	35.2 %	63.1 %
<b>Crustaceans</b>			
CJ	40 %	50 %	60 %
S	57.1 %	66.6 %	75 %
<b>Mollusca</b>			
CJ	50 %	50 %	75 %
S	66.6 %	66.6 %	85.7 %

Vadinar Shelf a total of 22 taxa of macrobenthic were recorded in the present investigation whereas 31 taxa were reported earlier (Table 1). During 2011-12 this Shelf was reported 16 taxa of Polychaetes, 9 taxa of Nematodes and 3 taxa of Crustaceans and 3 taxa of Mollusca but now the composition presenting 09 taxa of Polychaetes, 06 taxa of Nematodes, 4 taxa of Crustaceans and 3 taxa of Mollusca. The lower values of Jaccard index (19%) and Sorenson index (32%) were recorded for Polychaetes group and higher values Jaccard index (50%) and Sorenson index (66.6%) of these indices were recorded for the group Mollusca (Table 2).

Kandla Shelf, 35 species of macrobenthic was recorded in this Shelf by earlier workers whereas in the study period only 24 species were recorded (Table 1). During 2011-12 Shelf was observed 17 taxa of Polychaetes, 10 taxa of Nematodes, 5 taxa of Crustaceans and 3 taxa of Mollusca but the present composition has changed to 10 taxa of Polychaetes, 7 taxa of Nematodes, 4 taxa of Crustaceans and 3 taxa of Mollusca. The lower values of Jaccard index (21.4%) and Sorenson index (35.2%) were recorded for Nematodes group and higher values of these indices for the group Crustaceans and Mollusca (Sorenson index =66.6 and CJ=50) (Table 2).

Vadinar Shelf, 36 species of macrobenthic was recorded in this Shelf by earlier workers whereas in the present study only 27 species were recorded (Table 1). During 1986-87 this Shelf was with 17 Polychaetes, 11 taxa of Nematodes, 4 taxa of Crustaceans and 04 taxa of Mollusca but the composition has changed to 12 taxa of Polychaetes, 8 taxa of Nematodes, 4 taxa of Crustaceans and 3 taxa of Mollusca. The lower values of Sorenson

index (48.2%) and Jaccard index (31.87%) were recorded for Polychaetes group and higher values of these indices for the group Mollusca (S= 85.7% and CJ=75.%) (Table 2).

#### 4. Discussion

Research study provides the evidences for the changes in the composition of macrobenthic (Table 1). The total macrobenthic composition has significantly changed in all three Shelf (Table 2). The lower values of Sorenson's and Jaccard's indices for total macro benthic composition reveal the change in community structure. In Shelf Vadinar total macrobenthic composition has significantly changed compared to earlier reports (Table 2). The status of Kandla, and Vadinar Shelf was also found similar (Table 2). Anthropogenic leads to the changes in community structure [14]. A similar trend was also reported by [15]. Previously researchers reported to [16,17], biotic communities respond to pollution or to anthropogenic in three main ways first one is biomass alters but community structure (species composition and relative abundance) does not. Second one is species remain the same but relative abundances alter and biomass may alter and third one is species composition and relative abundance alter and biomass may alter. Shelf Vadinar gradually losing its catchment area by increasing urbanization and due to pollution loading changes in the composition of macrobenthic.

Polychaetes are prominent group among the macrobenthic of a coastal water body irrespective of its trophic status. This may be due to the less specialized feeding, parthenogenetic reproduction and high fecundity [18]. Among the macro benthic rotifers respond more quickly to the environmental changes and used as a change in water quality [19,20]. Polychaetes diversity is affected in all three Shelf. The low values of Sorenson index (32%) and Jaccard index (19%) in Vadinar Shelf reveals that the drastic change in the Polychaetes composition due to the disappearance of 10 species (Table 1). Sladeczek (1983) reported that the *Cirratulidae mudballs*, *C. Cirratulidae*, *C. Capitellidae* and *Cossuridae*, were present in oligotrophic conditions. Due to the continues inflow of nutrients from the surroundings, the Shelf reached anthropogenic state and sensitive species are disappeared from the Shelf. While in Kandla Shelf all *Cossuridae* species were absent except the *Capitellidae*. This Shelf was bigger Shelf but in course of time increase the development activities surrounding the Shelf it has become smaller and its water volume is come down. Therefore may species have been disappeared from the Shelf and similar results are investigated in Vadinar Shelf.

results also give evidence for eutrophic conditions of Shelf. The Vadinar Shelf showed highly eutrophic condition while, Kandla Shelf showed eutrophic state and Vadinar Shelf showed mesotrophic condition.

Higher results of Sorenson index (46.1%) and Jaccard index (36.1%) in Vadinar Shelf suggest that, this Shelf is not reached eutrophic state [21,22]. Reported the *Diplolaimelloides sp.* Richly abundant in high organic content water bodies. In this present study the presence of *Diplolaimelloides sp.* all Shelf can also be considered as an indication of increased organic content in the water bodies [23,24]. Similar reports are made by recorded that the decrease in the water level, live stock disturbances and anthropogenic activities increase the turbidity and thus inhibits the competitive abilities of Bivalve species. Boucher and reported that the *Limopsis sp.* is present only oligotrophic Shelf [25,26]. In the present findings the absences of *D.longispin* clearly indicate that Shelf is reached anthropogenic state [27].

In the present investigation least changes were observed in copepods and Mollusca [28,29]. The compositions of these groups are more or less similar to the earlier research. Although though among the three Shelf [30,31]. The Shelf Vadinar showed peak values of Jaccard index (60%) and Sorenson index (75%) for Crustaceans [32,33]. The Kandla Shelf and Vadinar Shelf showed low values of Jaccard index (40% and 50%) and Sorenson index (57.1% and 66%) respectively [34,35]. In the present study the maximum Jaccard and Sorenson index values of Mollusca were recorded in Shelf Vadinar (CJ=75% and S=85.7%) while lowest values were recorded in other Shelf [36,37]. These variations may be attributed to the water volume, as the water quality is significantly determined by the water quantity [38,39].

#### 5. Conclusion

All these results indicate that changes of conditions affecting faunal composition of the macro benthic occurred in the three Shelf this is mainly due to anthropogenic. The increase in the anthropogenic activities and urbanized catchment area and agricultural runoff are major cause for anthropogenic in these Shelf [40]. Management measures for MPAs require integration of invaluable baseline biodiversity data with contemporary ecological conditions to facilitate managers in creating effective tools capable of predicting changes and impacts on particular communities as well as conserving natural habitats so there is urgency to take conservation steps for preventing from further eutrophication [41]. Thus it is expected that the information provided by this study would help in site-specific conservation and management plans of the MNPS [42]. The danger due to oil spills from the multiple oil production and transport installations to the MNPS is a possibility. Therefore the results obtained provide a quality background data for environmental assessment in the event of any major anthropogenic disturbance, given the rapid pace of industrialisation in this sensitive zone. We strongly recommend to the concerned authorities of the coastal city corporation to take restoration programs and minimize the anthropogenic activities in and around the Gulf of Kutch Shelf.

Table 3. Calculation of Quotient  $Q_{B/T}$  of three Shelf

Shelf Name/ year	2011-12	Shelf condition	2011-12	Shelf condition
Vadinar	5:0 = 5	Highly eutrophic	2:3 = 0.6	Oligotrophic
Kandla	4:0 = 4	Eutrophic	4:3 = 0.7	Mesotrophic
Okha	3:1 = 2	Mesotrophic	4:4 = 0	Oligotrophic

Values of  $Q_{B/T}$  less than 1.0 mean oligotrophy, values between 1.0-2.0 mesotrophy and values over 2.0 eutrophy (Sladeczek 1983)

In present investigation we have prepared the trophic status by calculating  $Q_{B/T}$  quotient (Table 3). The  $Q_{B/T}$

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