



# Marine Benthic Diversity of the Gulf of Kutch, Gujarat: A review

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## Authors' contributions

This work was carried out in collaboration among all authors. Author PH designed and conceptualized the study, collected and investigated the data, wrote original draft, Reviewed and edited the manuscript, did formal Analysis. Authors KV and SK Supervised the study, wrote, reviewed and edited the manuscript. All authors read and approved the final manuscript.

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## ABSTRACT

The present paper reviews and compiles a list of benthic fauna in the Gulf of Kutch (GoK). The literature on the GoK coastal waters was reviewed from 1945 to 2024. The comprehensive literature review for this checklist paper was compiled from research articles, books, field guides and doctoral thesis, and reports from various searches. The scientific names of species were checked after cross-referencing species names with the WoRMS database. The benthic faunal comprises Gastropods, Bivalve, Scphalalopod, Polychaetes, Sipuncula, Echinoderm, Anomuran, Brachyuran, Isopods, Amphipods, Foraminiferans, Porifera, Anthozoan, Sea spiders, Nematodes, Platyhelminthes, Stomatopod from the Gulf of Kutch. The review presents an updated inventory

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detailed in the case of Gastropods (233 species, 61 families), Bivalves (123 species, 31 families), Five species of Scaphalopod belonging to two families, Placophora (two species, one family), Brachyurans (152 species, 30 families), Malacostrata (seven species, three families) Polychaetes (65 species, 28 families), Sipuncula (three species, two families), Amphipods (46 species, 20 families), Porifera (43 species, 28 families), Prawns and shrimps (45 species 14 families), Isopods (Two species, two families), Echinoderm (39 species, 23 families), two species of Platyhelminths belonging to single family, Cnidarian 13 species, seven families, Anomuran (hermit crab seven species belonging to one family), Sea slug and Nudibranch (46 species, 18 families), Nematodes (four species, four families), Foraminiferans (19 species, seven families). The lack of comprehensive data on the current macrobenthic faunal diversity status underscores the need for further research and expertise in this field.

**Keywords:** *Macrobenthos; seagrass; diversity; protected area; west coast.*

## 1. INTRODUCTION

The community of organisms inhabiting the sediment are called benthos [76]. The term "benthos" indeed derives from the ancient Greek word "βάθος" (bathos), meaning depth, which was introduced by Ernst Haeckel [140]. Based on the distribution of these organisms in marine ecosystems, they are classified into three types: Endo-benthos, Epi-benthos and Hyper-benthos [78] [106]. Based on their feeding patterns, they are broadly categorized into autotrophic, such as the one feeds on seagrasses and algae; heterotrophic, are organisms preying on and filter feeders; feeders on organic matter in the sediment; or decomposers, such as bacteria and scavengers [93,95,97]. Benthic organisms that eat the organic material in sediments are called deposit feeders (e.g., holothurians, echinoids, gastropods; those that feed on the plankton above are the suspension feeders (e.g., bivalves, ophiuroids, crinoids), and those that consume other fauna in the benthic assemblage are predators (e.g., starfish, gastropods) [9,17,27-34,57].

Benthic faunas are divided into Macrobenthos (0.5- 1 millimeter), meiobenthos (0.1 and 1mm), and microbenthos (less than 0.1 mm), depending upon size. They play an essential role in marine ecosystems in nutrient cycling, sediment oxygenation, organic matter decomposition, and as food for fish [23,56,59,79,80,82]. Many biotic and abiotic factors influence benthic species' presence and population density within a given assemblage [7,11-15,25,26,67-69,108,110]. Benthic invertebrates, which are organisms that live on or in the bottom sediments of bodies of water, can indeed be categorized into two main groups based on their position relative to the sediment: infauna and epifauna [88,140]. The species diversity list results show that mollus, especially gastropods, were highest, followed by crustacean true crabs (brachyuran) in the study

area. Since most crabs are very closely associated with coral reef ecosystems for food, shelter, or reproduction [10,18-22].

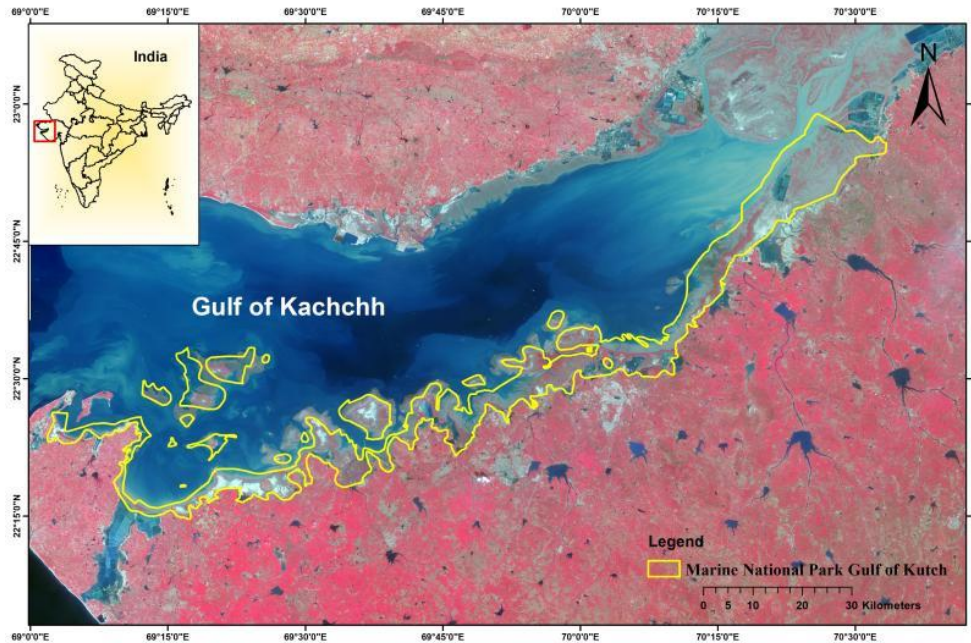
Benthic communities in subtidal habitats exhibit temporal variation due to various environmental factors. Here's how some of these factors can influence benthic communities over time [43-53,61,62-65,103-105]. Intertidal communities in coastal habitats are strongly influenced by the nature of the substrate, which refers to the type of material that forms the bottom surface of the habitat. Excess organic load, often from pollution or eutrophication, can harm intertidal and benthic organisms [54,90,91,144-148]. Many local and global factors influence the variety and abundance of benthic organisms. Here's a breakdown of how different factors affect benthic communities [1-6,24,92]. Macrobenthos are crucial in benthic ecosystems [55]. Communities of benthic organisms are essential indicators of environmental stress because they are susceptible to pollutant exposure [58,99-102]. The present study attempts to compile a checklist of benthic invertebrates of the GoK based on available literature.

### 1.1 Study Area

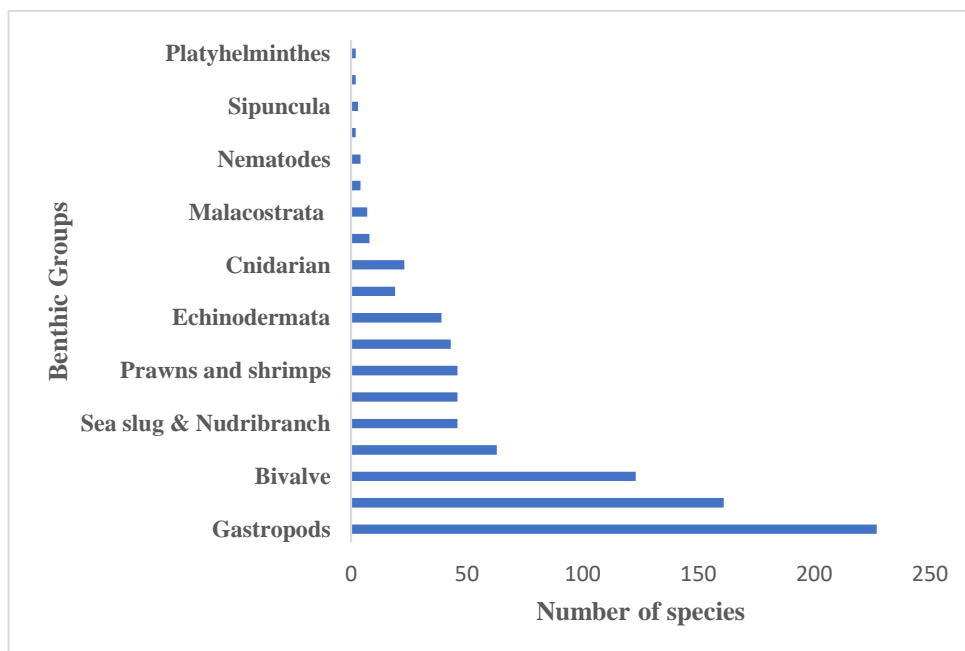
The GoK is an inlet of the Arabian Sea, bordered by the Kathiawar peninsula to the west and the Kutch region to the east. The temperature of the Gulf waters varies between 24°C and 30°C [87]. The high evaporation rate and the release of salty water from the adjoining salt pans of Rann of Kutch make the eastern part of the Gulf of Kutch more saline (40%) [71-75,87,149-157]. The Gulf's unique environmental conditions, including its wide temperature range and high salinity, contribute to a distinct ecosystem compared to other reef ecosystems influenced by strong tidal currents [84-86]. It is a shallow water body with a depth of 60 meters at the mouth to less than 20 meters at the head of the Gulf.

While the average depth is 30 meters, the minimum depth is up to four meters. Marine National Park and Sanctuary (MNP & S) are situated along the southern coast of the Gulf of Kutch in Devbhumi Dwaraka, Jamnagar and Morbi districts between 20° 15' N to 23° 40' N and 68°20' to 70°40' E [60]. Established in 1980, the marine sanctuary spans about 457.92 square kilometres, spanning from the mouth of the Gulf

near Okha towards the head near Jodiya (Fig. 1). Out of 42 islands, 36 are covered under the national park and 6 are covered under sanctuary which encompass a variety of habitats [66] [96]. The area also has many islands fringing with corals and mangroves, seagrass meadows, and rocky shores, providing disturbance-free habitats for many nesting bird species (Fig. 5)[158-168].



**Fig. 1. Marine National Park and Sanctuary, Gulf of Kutch, Gujarat**



**Fig. 2. Number of species reported from the Gulf of Kutch, Gujarat**



## 2. MATERIALS AND METHODS

The literature on the Gulf of Kutch coastal waters was reviewed. The checklist for this review was compiled from research articles, reports, and field guides on the various aspects of benthos from online databases, research journals, reports, Doctoral dissertation, institutional repositories, etc., from 1945 to 2024 (N=168). As part of the ongoing CAMPA Recovery of Dugong and their habitats implemented by the Wildlife Institute of India, the survey was carried out for detailed ecological assessment of seagrass habitats in the projects for associated fauna from 2020- 2023. A Nikon Coolpix P900 waterproof camera was used to photograph animals during a survey, especially for fieldwork in marine environments and macrobenthos, and it was photographed using a stereomicroscope Olympus SZX16. They were identified using the relevant available literature and taxonomic guides. Names of species were checked after cross-referencing species names with the WoRMS database.

## 3. RESULTS

The review covers a wide temporal range, allowing researchers to track changes and trends in macrobenthic communities over time. By compiling data from published research papers and reports, the review ensures that information from 1946 to 2024 was drawn from credible sources and contributes to the scientific

understanding of the Gulf of Kutch ecosystem. Names of species were checked after cross-referencing species names with the WoRMS database. The Macrobenthos were studied mainly from rocky shores, intertidal areas, corals and mangroves. The first attempt to study the seagrass-associated fauna of the Gulf of Kutch was made by the Wildlife Institute of India (Fig. 4,6). The review presents an updated inventory detailed in the case of Gastropods (233 species, 61 families), Bivalves (123 species, 31 families), Five species of Scaphalopod belonging to two families, Placophora (two species, one family), Brachyurans (152 species, 30 families), Malacostrata (seven species, three families) Polychaetes (65 species, 26 families), Sipuncula (three species, two families), Amphipods (46 species, 20 families), Porifera (43 species, 28 families), Prawns and shrimps (45 species 14 families), Isopods (Two species, two families), Echinoderm (39 species, 23 families), two species of Platyhelminths belonging to single family, Cnidarian 23 species , 14 families, Anomuran (hermit crab seven species belonging to one family), Sea slug and Nudibranch (46 species, 18 families), Nematodes (four species, four families), Foraminiferans (19 species, seven families) (Fig. 2). The lack of comprehensive data on the current macrobenthic faunal diversity status underscores the need for further research and expertise in this field. A systematic checklist of reported benthic faunal species, along with their locations reported from the Gulf of Kutch, is given in supplementary Tables 1-17.



Fig. 1. Pamban sea slug, *Marionia pambanensis* (Photo credits: Satya Swaroop Nanda)



Fig. 2. *Goniodiscaster scaber* found during Paga Reef of Marine National Park, Gujarat, during the survey



Fig. 3. Islands in the Gulf of Kutch, Gujarat, showcasing a diversity of habitats



Fig. 4. a) *Halophila ovalis* b) *Halodule uninervis* c) *Elysia ornata* associated with seagrass meadows

#### 4. DISCUSSION

The Gulf of Kutch has become a focal point for scientific marine biodiversity and conservation research. Researchers and marine biologists are continuously studying the ecosystem to understand its dynamics better and contribute to its protection. As a result of the region's high tidal fluctuations, so do the semidiurnal tides [132]. The Arabian Sea has unique currents, which may direct species towards the east and later toward the Gulf [81].

In contrast, its southern coast hosts petrochemical, thermal power stations, fertilizer plants, and cement manufacturing industries. Consequently, heavy vessel movement occurs in the GoK region. In recent years, the biodiversity of Marine Park & sanctuaries has been under threat due to the extraction of corals and sands by cement industries, increased turbidity of the water, oil refineries, chemical industries, and mechanized fishing boats [121]. Zoological Survey of India, GEER foundation, Gujarat Ecological Commission, local institutions and universities, and Gujarat Forest Department have initiated and collated information on *faunal* discoveries from the marine national park. Recently, there has been no collective information on the updated checklist [35-41]. The habitats surveyed in the marine national park were mainly confined to mangroves, coral reefs, and rocky and sandy intertidal areas. Parulekar 1988 reported 92 bivalves, 55 gastropods, three cephalopods, two scaphalopods and amphineurans and 14 species of Echinoderm reported from the Gulf of Kutch [98]. *Palmpsis*, *Astropecten*, *Asteria*, *Temnopleura*, and *Holothuria* were commonly reported by Parulekar in 1988 [98]. Among polychaetes, *Eurythoe*, *Terebelle*, *Polynoe*, *Iphione*, *Nereis* and *Hyas* sp., *Pilumnus* sp. were common [98]., Sukumaran and others reported 29 families of polychaetes Aphroditidae, Arbellidae, Ampharetidae, Lumbrinereidae, Spionidae, Syllidae, Cossuridae, Capitellidae, Cirratulidae, Dorvilleidae, Eunicidae, Flabelligeridae, Glyceridae, Hesionidae, Orbiniidae, Onuphidae, Opheliidae, Lumbrineridae, Magelonidae, Maldanidae, Nereidae, Nephtyidae, Phyllodocidae, Pilargidae, Polynoidae, Sabellidae, Sternapsidae, Sigalonidae, Sternaspidae, Serpulidae, Terebellidae from Mithapur-Okha, Vadinar, Sikka during April- May 2010 [138]. Sukumaran et al., 2013 also reported Pycnogonida, Tanaidacean, Cumacea, Hydrozoa, Turbellaria, Nematodes from

Mithapur-Okha, Vadinar, Sikka during April- May 2010 [138]. Among poriferan fauna, *Haliclona* sp. was commonly coral-associated fauna reported by Parulekar in 1988 [98]. Around 200 marine mollusc species from the Gulf of Kutch were reported by Singh et al., 2004 [133]. Mollusc were extensively studied from Okha, Beyt Dwarka, Balapur, Paga, Poshitra, Narara, Goose reef, Pirotan, Bhaidar, Ajad, Hanuman Dandi, Dedka Mundeka, Kalumbar, Chank, Noru reef. Foraminiferans were reported from Kharo Creek, Manadvi, Mundra and Tam reefs, and Paga reefs [142] [106]. Tanaidacean, Cumacean, and Foraminiferan, Sea spiders were reported for the first time as seagrass meadows reported from Tam reef, but were not identified [107]. The marine isopod fauna of Gujarat is imperfectly known. Information on the isopod fauna of India is very scattered. However, a perusal of the literature reveals 299 isopod species recorded from different parts of India [42,127-131].

The studies on the ecology of the macrobenthos with seasonal variation were conducted from 2007 to May 2008 in Mundra, Mandvi, and Kharo [143]. Seasonal variation in diversity, composition and density of macrobenthic fauna and associated environmental factors influencing this benthic community were studied during winter, summer and monsoon seasons [143]. Sanagoudra & Bhat (2013) studied species diversity and environmental relationships of marine macrobenthic along the continental shelf of Vadinar, Okha and Kandla [126]. A comparative study by Naz et al., 2016 compared the intertidal biodiversity of macrobenthos on the three different shores off Tragadi, Nana Layja and Luni of the Kutch coast [89,122-125]. Among foraminiferaneran, 16 species belonging to seven families were reported from Okha [16], and three species of genus *Nummulites* belonging to the family Nummulitidae were reported, respectively [126]. In recent years, Pandya et al., 2021 undertook a study on a spatio-temporal comparison of intertidal macrofaunal communities along the Mandvi coast [94,134-137].

The coastal vegetation provided general reviews of their specialized biology, which grows under different conditions with one ecosystem linked to the other, including the coral reefs [140]. Seagrass ecosystems provide food sources and function as nursery grounds for threatened species such as fishes, seahorses, sea turtles and dugongs [109] [111,112-116]. While



conducting surveys to document seagrass-associated benthic faunal monitoring in the marine national park, Gujarat, we discovered one individual of Biscuit Star *Goniodiscaster scaber* (Moebius, 1859) on the coral reef edge of Paga island (22.48686111 N 69.20612222 E) on 19 January 2022. *G. scaber* belongs to the family Goniasteridae. Only one adult individual was sighted and photographed while alive. The species was recorded previously in the intertidal zone of Sutrapada Dwarka (22.23869126 N 68.96269881 E) and Lafa beyt/Laku point (22.36924189 N 69.20001854 E) on the west coast of Gujarat [8]. The presence of this echinoderm indicates degraded seagrass habitats. This species is sensitive to high carbon dioxide concentrations in seawater, which can induce neurological, physiological, and behavioural deficiencies in marine animals [70] [77,117-120]. The polychaete worm *Capitella capitata*, *Nephtys capensis*, is also an excellent indicator of pollution and environmental disturbance [7] [54]. Marine polychaete *Eurythoe complanata* (Pallas, 1766) is considered an indicator species of heavy metal pollution [83,139,141].

## 5. CONCLUSION

Overall, studying the responses of marine species to pollution is essential for advancing our understanding of marine ecology, protecting marine ecosystems, and ensuring the sustainable use of marine resources for future generations. The lack of comprehensive data on the current macrobenthic faunal diversity status underscores the need for further research and expertise in this field. Exploring the marine benthic faunal diversity in the Gulf of Kutch holds immense potential for advancing our understanding of marine ecosystems. Growing developmental activities in the Gulf, including continuous traffic of ships, oil tankers, trawlers, etc., at Okha Port nearby, illegal fishing, and ghost nets, are serious threats. The effect of various anthropogenic activities and the role of the Marine National Park and sanctuary can be studied by extending the monitoring of this research, a first step in developing a regional program for monitoring metals in the marine protected environment. While the Gulf of Kutch is a critical marine ecosystem in India, it faces substantial threats from industrial activities, including petroleum and petrochemical operations. Addressing these challenges requires a multi-pronged approach that balances economic development with environmental

conservation and involves the participation of local communities, regulatory bodies, and environmental organizations [83]. The first step that should be taken is to focus on the systematics of these groups by exploring additional areas and habitats and then studying the ecology of those with ecological importance and economic significance. Once these biosystematics studies are established, measures for the preservation of such concerns will be addressed.

## CONFERENCE DISCLAIMER

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## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

## SUPPLEMENTARY MATERIALS

Supplementary material is available in the following link: <https://mbimph.com/index.php/UPJOZ/libraryFiles/downloadPublic/23>

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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