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PRELIMINARY REPORT ON A RECONNAISSANCE SURVEY OF THE MAJOR COASTAL AND MARINE ECOSYSTEMS IN GULF OF KUTCH*

Introduction

The region of Gulf of Kutch was possibly more an arid zone in the pleistocene, almost approaching to a desert condition, than what it is at present. The gulf is believed to be the result of a wide indentation or subsidence that allowed encroachment of the sea in the geological past. The whole area is still supposed to be seismically unstable. The Gulf of Kutch covers an area of *circa* 7,350 sq. km with a maximum depth of 60 m. The tidal range varies from 3.06 to 5.89 m with an average of 4 m. The intertidal zones are sandy and muddy or with sandstones of vast expanse and prolonged exposure. There is a clear indication of a relative change in the levels of land and sea in the past as is evidenced by the presence of raised coral reef at Okha still intact near the Railway Station. Whether this relative change is due to a local disturbance or part of a global phenomenon in the holocene is still a disputed question.

Our knowledge of the marine biology of the Okhamandal coast at the dawn of this century is mainly due to James Hornell who submitted a report to the erstwhile Government of Baroda in 1909. Subsequently many workers have dealt with the marine ecology, biology and geology and living resources of this area. The present report is based on a six weeks survey carried out in the Gulf of Kutch mainly around Okha and Jamnagar in 1978 with a view to obtaining additional information on the major marine and coastal habitats, particularly the coral formations and the mangroves. The prevailing physical features, animal communities and the visible ecological impact on the ecosystems due to human interference are briefly discussed.

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Intertidal sandstones

The coast of Okha has a vast expanse of intertidal elevated sandstones. At low tides these get exposed to considerable width. At Okha near the Marine Biological Station a general paucity of the fauna is observed on these sandstones, while at Adatra there is a profusion of animal life with a clearcut zonation of certain groups. The uppermost or the littoral fringe zone harbours *Littorina* spp. along with a few hermit crabs. Below the littoral fringe there is a level platin, 50 to 70 m wide that harbours mainly gastropods such as *Astrea semicostata, Thais rudolphi, Nerita* spp., *Cerithidea fluviatilis* and *Trochus niloticus.* This represents the upper eulittoral zone. Besides molluscs the common animals noticed are a few crabs. Below this a distinct zone of small barnacles (Fig. 1) of 30 to 40 m width is seen. The surface coverage is roughly 50% on an average. Nodular and encrusting calcareous algae are found mixed with the barnacles which also aid in the calcification of the sandstones here. Below the zone of barnacles there is a distinct zone (width 20 to 30 m) of the sedentary mollusc, *Vermetes.* The tubes of this mollusc form a thick encrustation and is found mixed with the tube dwelling polychaete, *Eunice tubifex.* Calcareous algae are also present. In the fringe zone both barnacles and *Vermetes* mingle. The lower part of the sandstones bed, below the zone of *Vermetes* shows signs of erosion by wave action getting themselves cut into knife-edged hollows (Fig. 2). The subtidal zone has a thick growth of algae mainly *Caulerpa recemosa.* The area below the sandstone was chiefly muddy in February 1978 harbouring mostly *Cerithium* spp. In the rock pools of the sandstones there are patchy growth of corals including *Favia pallida, Goniastrea pectinata* and *Platygyra daedalea.* A species of mussid coral *Acanthastrea* (probabaly *A. hillae)* was also noticed. Its presence is noteworthy since the species is known previously only from the Pacific.

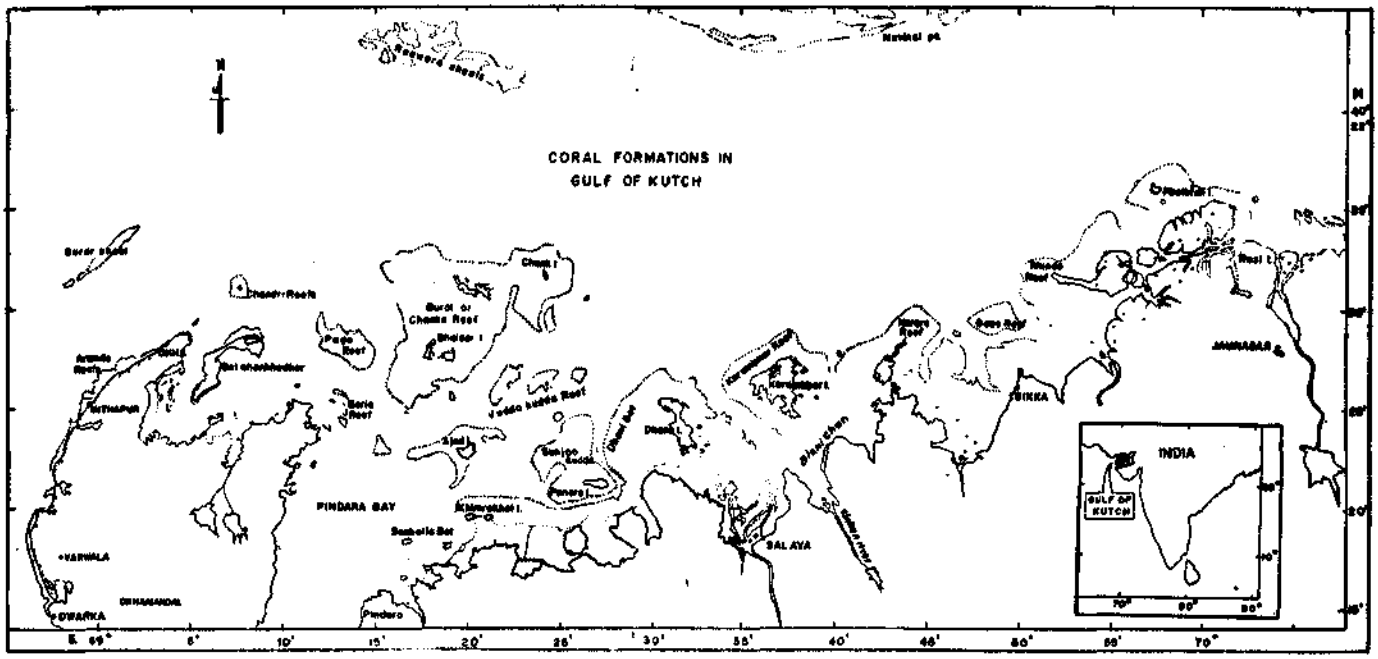
The intertidal zones of Poshitra at several places is sandy and with mud flats. At Dholani there is abundance of *Crassostrea ?cristagalli* (Fig. 3). They grow there in the shape of "miniature atolls" 3 to 4 m long and wide with the walls about 0.5 m thick and high, enclosing a central pool of water. The upper layer get exposed at low tide and they are surprisingly analogous to a coral atoll in growth form.

Coral formations

Fringing barrier or atoll types of reefs do not occur in the Gulf of Kutch. The present day coral growths of this area are of patchy type either on intertidal sandstones or on the surface of wave-cut, eroded, shallow banks, extending between longitudes 69 to 70°E and latitudes 22°20′–35′N (Map). The coral formation of Gulf of Kutch represent one of the extreme

Morphology of the patch reefs

The growth of corals in Gulf of Kutch, as already stated, is confined to intertidal sandstones or on the surface of totally submersible wave-cut banks. When exposed, the shores are delimited as in Paga and Boria by a sand bar about 0.5 m above the general level of the bank. The sand bar is composed of a mixture of calcareous and siliceous sand, the former mainly derived from the fragments of molluscan shells, corals and calcareous algae. There is a central lagoon–like area holding water to a depth of 0.25 to 0.5 m where corals and other animals thrive. A vague similarity in shape can be drawn to a typical coral atoll. There is no terrestrial vegetation both in Paga and Boria as is the case with several other small banks. The surface is often strewn with loose boulders which are mostly derived from the erosion of the land.



Gulf of Kutch showing the areas of coral formations

northern limits of corals in the Indian Ocean, excepting some parts of the Red Sea and the Persian Gulf. Observations were made at Okha, along the mainland coast and at Paga (Long. 69°10′E; Lat. 22° 28′N), Boria (Long. 69°14′; Lat. 22°24′N) both of which are shallow banks and Pirothtan Island (Long. 69° 58′E; Lat. 22°34-30′N). The corals of Gulf of Kutch are difficult to approach, particularly those on the banks due to the existence of vast intertidal mud flats which are difficult to negotiate by foot at low tides. The sudden influx of tidal waters also renders it risky to work on the exposed banks.

In Paga, the central pool is very shallow. The coral fauna includes, *Montipora venosa, Favites halicora, Favia* spp., *Platygyra daedalea, Symphyllia nobilis* and *Turbinaria* spp. None of the common Indo-Pacific hermatypic genera like *Acropora, Pocillopora, Stylophora* and *Seriatopora* was observed in living condition. There is total absence of true ramose corals. Visual estimate of coverage is roughly 20%. Intermittent with coral colonies there are many large sea anemones *(Discosoma)* (Fig. 5) on sandy patches. Five to ten individuals could be counted in about a sq. m. At the time of the survey in February

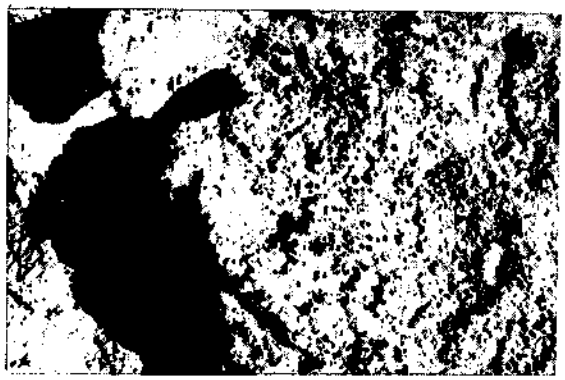


Fig. 1 Sandstones at Adatra Reef, Okha showing the barnacle zone.

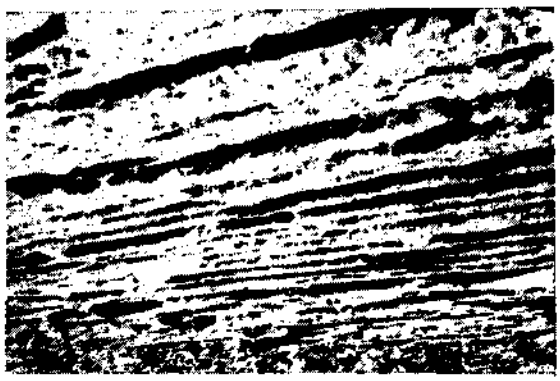


Fig. 2 Erosion of sandstones in the form of knife-edged ridges and hollows.

Fig. 3 Miniature atoll shaped growth of *Crassostrea* at Poshitra Point.

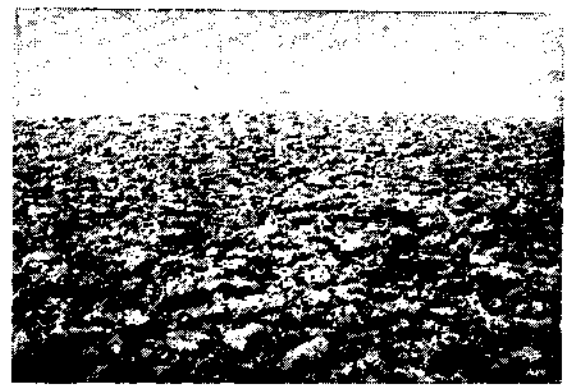


Fig. 4 The loose, dead boulders exposed at low tide at Boria.

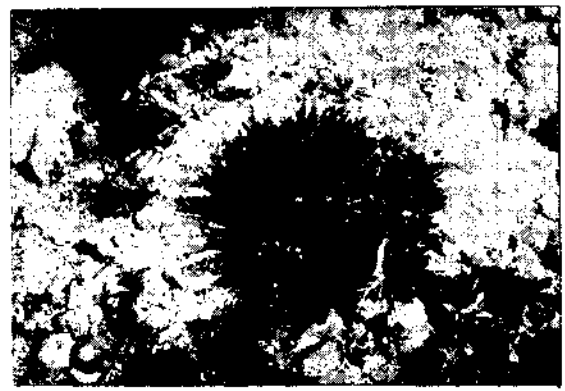


Fig. 5 The large sea anemone *(Discosoma)* at Paga Bank.

Fig. 6 Low wooded *Avicennia* at Poshitra Point. (A camel is seen feeding on the leaves).

there was a rich growth of algae, which included, *Ulva reticulata, Caulerpa recemosa, Sargassam* spp., *Padina* sp., *Gracilaria edulis* and *G. crassa.* A seasonal succession of algal growth is reported from the Gulf in literature.

Boria is similar to Paga in surface features and formation. The elevation of the highest point (sand bar) at the lowest tide is about 0.75 m. Most of the surface is level, strewn with small boulders formed as a result of erosion. When exposed (Fig. 4), they were all found coated with a thick deposit of silt. These boulders are devoid of any animal life. The lagoon-like part is confirmed to the southern tip of the bank, separated from the open sea, by the sand bar when exposed. Among the dominant species of corals, *Montipora* spp., *Favia favus, Favites halicora, Goniastrea pectinata, Platygyra daedalea, Hydnophora exesa, Cyphastrea serialia, Goniopora nigra, Porites* spp. *Coscinaraea monile* and *Turbinaria peltata* were observed. *Turbinaria peltata* was the most common, a species wide spread in the Indo-Pacific, but nowhere abundant. Here also ramose corals are totally absent. Sea anemones, alcyonarians, and sea lillies were also found intermingled with corals. A large nudibranch *(Melibe)* was fairly common. Algae were represented by *Gracilaria verrucosa, Caulerpa scapelliformis* and *Ulva reticulata.* A noteworthy nature of the corals here was the fully expanded condition of the polyps of all the colonies under bright sun light.

Pirothtan Island represents the northern limit of the coral growth in Gulf of Kutch and the island is different from Paga and Boria structurally in the sense that it is not a submergible bank. The shore is fringed by mangroves with mud flats which get exposed at low tide. The living corals are confined to a small area at the north side of the island. But the eastern side has a vast area of dead corals with most of the colonies intact, giving a clear indication of a mass mortality in the recent past. The dead coral colonies are encrusted with algae and sponges. A species of *Octopus* which is used as bait for fish is very common here. At the northern side the living corals include *Favia pallida, Goniastrea pectinata, Platygyra daedalea, Cyphastrea serialia* and *Siderastrea lilacea.* Large colonies (0.5 to 1 m in diameter) of the flabellate species of *Porites compressa* were seen though their tops are dead. Most of the corals are found partly dead or covered by sediment. Massive *Porites* was once very common in this island, but most of it had been already removed for various purposes and only rarely living colonies are seen.

The Coral fauna of Gulf of Kutch in general

As far as is known, the coral fauna of Gulf of Kutch includes 26 hermatypic species divided among 20 genera. An updated list of the species will be published elsewhere. All the species recorded are wide spread Indo-Pacific forms. A total of 26 species seems to be very low when compared to the species number of many other Indo-Pacific areas. This low number is mainly due to the absence of Pocilloporidae and *Acropora* in Gulf of Kutch fauna. A few, semifossilised, tufted branches of *Acropora* (compares *A. variabilis)* were seen among the small shingle of the sand bar in Paga clearly indicating the occurrence of *Acropora* here in the past or in very deep water. The high turbid condition of the water is the main factor that prevents the growth of *Acropora* and several other small polyped corals here. Among the non-scleractinians, *Millepora, Heliopora* and *Tubipora* could not be seen. *Porites,* the most important reef builder has dwindled. The presence of large, dead, semi-fossilised, intact colonies of massive *Porites* on the raised reef of Okha indicates that the genus was thriving very well in the past.

The mangroves

The dry climatic conditions prevailing in the region for about 8 months in a year and poor rainfall (in a place like Jamnagar the thermal amplitude is about 12°C and average annual rainfall is around 470 mm) as well as human interference have acted as limiting factors to mangrove vegetation in the region although the estimated coverage is about 52,000 ha. Mangrove vegetation has developed along protected bays, creeks and muddy flats. The formations are isolated and discontinuous and occur from Kandla, Navalakhi in the north to Jodia, Jamnagar, Sikka, Salaya and Okha in the south along the coasts of the Gulf. The mangroves of Kutch in general is of the open scrubby type with low wooded *Avicennia marina* and *Rhizophora mucronata.* In Dwaraka, Poshitra and Dohlani (Fig. 6) mostly a single species is seen, i.e. *A. marina* while from Bedi Point to Pirothtan both *Avicennia* and *Rhizophora* were found mixed. The back mangroves at higher zones are composed of *Salicornia, Suaeda* and thorny shrubs like *Acacia* and *Prosopsis.* The soil is muddy and loose and very difficult to walk through. The resident fauna include two species of *Littorina* on the trunk and undersides of trees and a species of barnacle on the roots and breathing roots. At higher levels *Uca* is very common. On the mud flats the gastropods *Cerithidia fluviatilis* and *Cerithium* sp. are very common and some times form

very thick beds, as seen in Dholani. Around Poshitra Point large number of *Periophthalmus* and *Boleophthalmus* were found "walking" on the mud flats when exposed. Here a large form of echiuroid worm was in plenty. At Dwaraka the shallow waters were found to contain young ones of mullets and prawns which are collected as seeds for culture practices. A small fishery exists in the creeks between Bedi Point and Pirothtan Island with a luxuriant mangrove formation.

The impact of ecological and human interference on the major ecosystems

An inherent low biological productivity or destruction of biogenic carbonates by high tidal range is already known from Gulf of Kutch. There is very little influx of fresh water into the Gulf and the fluctuation of salinity is minimum. The most important physical factor that at present affect the marine life of Gulf of Kutch seems to be the high degree of sedimentation. The source of sediments is mainly of terregenous material, mostly resulting from erosion by wave action. The calcareous fraction is derived from the fragments of dead molluscan shells, corals and calcareous algae, Influx of sediments through streams and rivers are of minor significance. However, transport of sediments. in and out from the muddy mangrove soil and Intertidal flats by tidal waters is a significant factor that causes the suspension of silt and sediments in the inshore waters and over the banks. A high degree of silting is a major detremental physical factor that affects the growth of corals as well as many other filter feeding marine animals adversely. Large quantities of fine silt is found all over the rubbles and boulders on Paga and Boria at exposure time which is again stirred up by the rise of tide. In Pirothtan many corals are found partly covered by silt and there is clear indication of mass mortality of corals here only due to the deleterious effect of sediments. Many corals with large polyps can combat the bad effect of sediments, while others with small polyps like *Acropora* can never live in highly turbid waters. The absence of *Acropora* in Gulf of Kutch is mainly due to high degree of silting.

Existence of extreme physical conditions such as prolonged exposure due to very high tidal amplitude is a major factor that applies constraints on the colonisation of many marine animals. In extreme condition only those highly specialised, can thrive and diversity of species will be minimized. However, in the absence of interspecific competition the intensity of population of the species that get established will be high. This is what exactly is reflected in Adatra reef where the dominant animals include only balanids, *Vermetes* and a tube dwelling polychaete, that too with a clear-cut zonation.

Human interference is a major factor that alter or damage the marine and coastal ecosystems. Because of the poor annual rain fall and arid condition, fodder for cattle and camel has been a problem and mangrove trees are regularly poached for fodder by the villagers. In many places the trees are also cut for fire wood. In Pirothtan most of the corals, particularly, the massive ones, have been already quarried and used up for various purposes which has resulted in major destruction. Living colonies are very few. Further, large quantities of calcareous sand and clay are being taken from near this island causing a severe degree of sedimentation. This has caused the recent death of many corals here. Many freshly killed colonies were found either partly or fully covered by silt. Sediments kill the coral polyps either by choking the gastrovascular cavities or by completely covering the colony leading to asphyxia. Growth is restricted by preventing the settlement of planulae on the hard substratum when the latter is coated with silt or sediments. The higher rate of sedimentation in the inshore waters of Gulf of Kutch appears to be the most deleterious physical factor that affect the marine fauna at present.