

INDIAN CORAL REEFS: DIVERSITY, ANTHROPOGENIC INFLUENCES AND CONSERVATION MEASURES

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ABSTRACT

India is a country well known for its Biodiversity rich ecosystems. The coral reef ecosystems are indeed very unique and are home to a multitude of organisms. Currently there are 5 major reefs in India that include Gulf of Kutchch, Gulf of Mannar, Palk Bay, Lakshadweep Islands and Andaman and Nicobar islands and minor reefs are distributed along the intertidal regions of Ratnagiri, Malvan and Redi, South of Bombay, west of Mangalore and the Hermatypic corals along the shore are reported from Quilon in the Kerala Coast to Enayem in Tamil Nadu. But these rich abodes are facing a number of anthropogenic threats and the current status of the Indian reefs is also discussed in this review.

KEYWORDS: Economic and Environmental, Anthropogenic, Wildlife Protection

INTRODUCTION

Coral Reefs-Abode of Rich Biodiversity

Corals reefs are geological formations that have been constructed from the accumulated skeletons of limestone secreting animals and plants. They are most biologically diverse of marine ecosystems. Even though they just cover only 0.1-0.5% of the worlds ocean floor, they are home to one -third of the marine fishes presently recorded. They are generally found in tropical and sub tropical areas across the planet mostly in the shallow oceanic waters near land. These excellent marine ecosystems provide a large number of services and direct economic and environmental benefits to a number of human population living in the land near to the coral reefs.

Reefs are the centres of high biological productivity sites of CO₂ sink, rich biodiversity that help in shoreline protection, they also are source of calcium carbonate deposits and centres of scientific research. In addition to the above they also provide raw materials for deriving pharmacological products especially life saving drugs (Gopinadha Pillai, 1997). Coral reefs in India are mainly concentrated in Gulf of Kutchch, Gulf of Mannar, Palk Bay, Lakshadweep Islands and Andaman and Nicobar islands. In addition to these, there are patchy reefs in Malvan (Maharashtra Coast), submerged reefs in Andhra, Orissa and Kerala and near-shore Chennai. In Lakshadweep the atoll reefs dominate ad all other coral reefs of India are fringing reefs.

Based on biodiversity assessments made by the recent survey in 2013 conducted by Zoological survey of India the fauna and flora known so far from our Indian reefs comprises 1284 species of fishes, 3271 species of mollusc, 765 sps. of echinodermata, 519 species of sponges, 274 species of corals, 607 species of crustaceans and 624 species of algae. The Andaman and Nicobar reefs are the least disturbed so are the most diverse of the Indian Ocean reefs. About 7.5% of total Indian fauna have been recorded from Andaman and Nicobar islands which include 3% of the terrestrial fauna and 4.6% marine fauna (Alfred, 1998).

Moreover coral reefs formations are less significant in the east coast of India due to the influx of freshwaters from the east flowing rivers into Bay of Bengal and because the sea around the east coast is also very shallow. One more important reason behind this is that the human settlement is also very high which severely disturb the coral reef formation and biodiversity. Coral fauna require a warm, shallow and well illuminated and well oxygenated waters and they are found in waters with the surface temperature range of 23°C-25°C.

Let us now look into the coral reefs of India in the order of their coral area coverage:

Andaman and Nicobar Islands

Location: Located in southeast of Bay of Bengal are 350 islands that have been considered as emerged part of a seismic mountain chain.

Reef Type: Mostly all islands exhibit narrow, linear and extensively well developed fringing reefs (Vineeta Hoon, 1997).

Total Area of Reef: 1021.46 sq.km (SAC, 2010)

Annual Rainfall: 300 cm/yr

Salinity: 33 ppt

Temperature: 27°-28.5°C

Reef flats are dominant by massive porites and favids that form the frame builders (Vineeta Hoon, 1997)

Tidal Amplitude: 2.5m (Dorairaj and Soundarajan, 1997)

Mahatma Gandhi Marine National park and Rani Jhansi Marine National Park are 2 marine protected areas for coral reef conservation

The Coral reef Ecosystem of Andaman and Nicobar are the most biodiverse reefs comprising:

235 Species of corals

111 Species of soft corals

112 Species of sponges

411 Species of crustaceans

1422 Species of molluscs

430 Species of echinoderms

750 Species of fishes

4 Species of mammals

14 Species of reptiles

50 species of Marine birds and **64** species of Algae (Rajan *et al.*, 2011) Leatherback, Hawksbill, Olive ridley and Green turtles are having their nesting sites in these reefs.

Major Threats

- Uncontrolled exploitation of shells (Dorairaj and Soundararajan, 1977).
- Terrestrial runoff and siltation due to developmental activities.
- Coastal pollution from agriculture and urban sources.
- Destructive fishing techniques by foreign poachers, crude bombs containing Ammonium/Potassium Nitrate are dropped into coral reefs.
- Reef subjected to blast fishing
- Threat of target fishing where mainly groupers and snappers are overfished and this leads to stock depletion.
- Most important is tourism threat that result in solid waste accumulation, increased sedimentation, coral damages caused by diverse, boats and snorkelling activities.
- In December 2004, extensive damages caused by earthquake and tsunami. In Nicobar islands reefs were impacted by tsunami as corals were uprooted and covered with beach sands.
- Coral bleaching in Little Andaman island reef in Dungeon creek site led to a situation where the live coral cover was only 12%. (Jeyabhaskaran 1999). In 2010 also coral bleaching was observed in this region (Krishna *et al.*, 2011).

Lakshadweep Coral Reefs

Location: In Arabian Sea situated between the Lat 8°-12°N and Long 71°-74°E consisting of 36 islands, 14 atolls, 3 platform reefs and 2 prominent submerged coral banks islands vary from 0.1-4.4 sq.km in size. (ZSI, CBD COP-11, 2012)

Reef Type: Mainly atolls except one platform reef in Androth Island. 14 atolls include Baliyapaniya Cheriyanianyam, Chetlet, Bitra, Kiltan, Kadmat, Ameni, Perumal Par, Bungaram, Agatti, Kavaratti, Suheli Par, Kalpeni and Minicoy. Except the first 2 all others within boundaries have low lying islands on east and lagoon on the west connected to open ocean by 1 or 2 channels.

Total Area of Reefs: 933.7 sq.km including lagoon area of 510 sqkm (SAC, 2010)

Salient Features: Sea Surface temperature : 28-31°C

Sea Water Salinity: 34-39 ppt.

Annual Rainfall: 1600 mm (Mamadiar, 1977)

Tides Amplitude: Spring tidal range about 1.2m, Neap tidal range of 0.3m (Chandramohan *et al.*, 1993)

Biodiversity Profile

152 Species of Meiofauna

69 Species of Polychaetes

17 Species of sipuncula, 7 species of Insecta,

168 Species of Molluscs

72 Species of echinoderms (Ghosh, 1991)

104 Species of corals (Pillai, 1989)

4 Species of turtle (*Eretmochelys imbricata* (Hawksbill Turtle), *Lepidochelys olivacea*, *Chelonia mydas*, *Dermochelys coriacea* (included in IUCN red list)

100 species of flora (Rao, 1991) consisting of seaweeds algae and seagrass)

Notable feature of coral fauna of Lakshadweep is absence of *Foliosa* and *Echinopora tamellosa*. Massive coral species: *Porites solida*, *Porites lutea* and *Diploastrea* sp. Are common in minicoy (Gopinatha Pillai, 1986)

Major Threats

- Pollution of Lagoon waters due to increased rate of siltation in lagoon of Minicoy due to sea erosion and increased human activity in lagoon.
- Bleaching event in 1998, recorded 80% coral mortality.
- Cyclones, Storms has been posing severe threat to reefs
- Explosion of *Acanthaster planci*, predator on corals.
- Increased population pressures on coral colonization (Jeyabaskaran, 2004, Arthur, 2008)
- Low Dissolved Oxygen Concentration and high BOD Value indicate environmental stress in these regions.
- Quarrying corals from the shore and reefs, pitting the ground and removal of surface soil are the major human impacts on the Lakshadweep coral reefs (Gopinatha Pillai, 1986).
- Mortality of corals due to sponge attack has been calculated as 80% for an area of 25 m² /yr (Thomas, 1997).

Gulf of Kutch Coral Reefs

Location: Lat.22°15'-23°40'N and Long. 68°20'-70°40'E.42 islands in its southern part of which 32 islands have coral reefs. Total area is 7350 km²

Reef Type: Mostly fringing reefs with patchy, platform and coral pinnacles at some places. The most degraded reefs. (Bahuguna and Nayak, 1998)

Total Area of Reefs: 352.5 Km²

Salient Features

Extreme temperature Variations is one such issue: In summer the sea surface temperature exceeds 35°C (Max.recorded:44.8°C and drops to 15°C in extreme winter (Min Rec: 7.8°C in Jan) that which causes coral mortalities.

Tidal Amplitude: 3.06-5.89 m with an average of 4 m.

Area between Okha (22°30'N; 69°00'E) and Khijadia covers 220.71 Km² that has been designated as Marine Sanctuary in 1980., now expanded to 457.92 km² in 1982.

Biodiversity Profile

736 species of fauna and flora have been listed from Gulf of Kutch (Rao and Sastry, 2005)

26 species of coral fauna, under 20 genera rich in algal diversity (120 species) dominated by Sargassum (Anjali Bahuguna *et al.*, 1992)

Sipunculans and echinurans are the common inhabitants of the coral and beach rock communities throughout the Gulf of Kutch.

70 species of sponges, 200 species of fishes, 27 species of Prawns, 30 species of crabs and some species of Lobsters and Barnacles, 200 species of molluscs, 3 species of turtles and 3 species of marine mammals. (Coral reefs of India state-of-the-art Report, ENVIS)

Major Threats

- Commercial fishing in the vicinity and subsistence fishing in core area.
- Coral collection for industrial and domestic use resulted in habitat destruction and heavy siltation.
- Commercial shell Collection –continued illegal exploitation. Felling and grazing of mangroves –siltation in reefs.
- Developmental activities –discharge of domestic and industrial effluents, dredging for port activities.
- Unguided educational and recreational activities.
- Destruction of coastal vegetation which is used as fodder for cattle and camels is a major problem enhancing coastal erosion. Sediments deposited on the substratum restrict the settlement of planulae (Gopinatha Pillai and Rajagopalan, 1979).

Gulf of Mannar Coral Reefs

Location: 8° 48'N, 78° 9'E & 9°14'N, 79°14'E on southeast coast of India 21 islands running parallel to a coastline at an average of 8 km from shore.

Type of Reef: Fringing reef at 50-500m from shore often without a well defined reef flat

Area of Reef: 75.93 sq km (SAC, 2010)

85.5sq km of seagrass bed (Uma Maheshwari, 2009)

Salient Features

Range of Rainfall: 792 to 1270mm

Temperature: 25°-30°C

Gulf of Mannar was declared the first Marine biosphere in India (in year 1989) with 560 sq km of core area (islands and surrounding reefs declared GOM Marine National park in 1980). The biosphere reserve is deemed a priority area under the authoritative reference work published by world bank, The Great Barrier Reef Marine Park authority and world conservation Union (Venkataraman, 2002).

Biodiversity Profile

1097 species under 254 families and 567 genera which includes 85 species of corals, 15 gorgonids, 16 sea anemones, 24 prawns, 3 lobsters, 21 crabs, 88 molluscs, 106 echinoderms, 2 hemichordates, 2 cephalochordates, 78 tunicates, 553 fishes, 6 reptiles, 63 birds, 6 mammals (Venkataraman *et al.*, 2002)

Endemic Hemichordata Phycodera fluva flagship species such as Dugong dugong, 3 species of dolphins, 2 species of whales, at least 5 species of turtles and 68 elasmobranchs (Venkataraman *et al.*, 2002).

Major Threats

- Depletion of resources
- Degradation to coral reefs and surrounding islands due to lack of ecosystem approach to fisheries, failure to implement the core objectives of Biosphere reserve (Rajan & Venkataraman, 2012)
- Exploitation of a large number of gorgonids (106 tonnes from 1975-1992), brachyuran crabs, chanks (1-1.5 million/year), trading large number of seaurchin, brittle stars, sea lilies, sea anemones, 60 species of ornamental fishes as aquarium animals.
- Severe depletion of valuable fisheries due to excessive demand and thereby causes non-target biomass dominates the total catch (ZSI, 2011)
- Trawler fishing has more impact on marine resources (Rajagopal, 2011)
- Use of prohibited fishing gear and techniques near islands-Dynamite/Blast fishing, pair trawling, purse seining, use of roller nets, dragnets and seaweed collection
- Developmental activities in shore, industrial pollution, sewage disposal, waste dumping, heavy sedimentation, excessive algal growth, occurrence of coral diseases.
- Once Mandapam and Tutucorin area were 2 important bases for collection and stacking of coral stones. After establishment of national Marine Park Authority, coral quarrying has been completely stopped in Mandapam but in Tutucorin area it is still going on.
- Dugong hunting/exploitation in Kilakarai by using special bottom set gill nets. Valivalai, thirukkaivalai (Gill nets) and shore seines are also used for capturing dugong (Silas and Fernando, 1985). This may surely lead to species extinction.
- Heated waters released from thermal power plant has also affected the reefs by increasing the coastal water temperature by 3-4°C (3000 tonnes per day dumping of ash that which has severely affected recolonization of *Acropora formosa*.

Palk Bay Coral Reefs

Location: Reef parallel to land (E to W direction) between Lat 9° 17'E and 79° 8'E.

Reef is from Munakad (as a wall like formation of 1-2m breadth and run east upto Tonithurai to a distance about 5.5 km (where its width attains >300 m) east to Pamban pass, starts near Thangachimadam and ends near Agnitheertham (Rameshwaram) (Mahadevan and Nagappan Nair, 1969)

Type of Reef: Gopinatha Pillai (1969) classified the reefs of palk Bay into 5 Zones viz., shore, lagoon, shoreward slope, reef crest ad seaward slope. Corals varies in each of these zones. Living corals are absent in lagoon and shore. Encrusting and massive coral types are seen in shoreward slope. This Zone supports a good number of reef dwellers (sponges, bryozoans and calcareous algae).

Salient Features

Annual Rainfall: 820 to 1650 mm

Average Temperature: 24.6-29.1°C

Tidal Elevation: 1m

Biodiversity Profile

61 species of Marine macroalgae belonging to 3 major groups *viz.*, green algae (14 genera and 28 species), brown algae (8 genera and 13 species) and red algae (17 genera and 20 species)

Hallimeda opuntia is dominant algal member of the reef species of Caulerpa and Sargassum are the next most common algal species of reef (Gopinatha Pillai, 1969). 20 species of Boring sponges from Gulf of Mannar and Palk Bay belonging to 9 genera. Cliona is most dominant species both in number and distribution (Thoman 1969).

17 boring bivalve species (under 10 genera of six families) (Appukuttan, 1973) .73 species of Molluscs are associated with corals in the Palk Bay. 65species of coral have been recorded with a large number in the family Acroporidae. Turtles and Dugongs are also found and Palk Bay is a breeding ground of Indian Squid (Vineeta Hoon, 1997).

Major Threats

- During the North east monsoon large degrees of silt settlement leads to damage to the corals of this area (distribution and diversity of the coral reef associated plants and animals)
- Presence of excess algae does not allow the planulae to settle and algae thus becomes the space competitors for the growing Coral population in coral reefs.
- Processing industries near the reef areas release cold, dirty or sewerage water directly to sea. Whenever these industries are found, the reef ecosystem changes have become more visible.

Apart from the afore mentioned major reefs there are patches of reefs in the inter-tidal areas of the central west coast of the country. Coral patches have been recorded in the intertidal regions of Ratnagiri, Malvan and Redi, South of Bombay (Qasim and Wafer, 1979) at the Gaveshani Bank, 100 km west of Mangalore (Nair andQuasim, 1978). Hermatypic corals along the shore are reported from Quilon in the Kerala Coast to Enayem in Tamil Nadu (Pillai, 1996). Corals also occur on the east coast between Parangipettai (Porto Novo), south of Cuddalore (10° 50'N, 79 80'E) and Pondicherry these communities have not been surveyed (Ramanujam & Adhiyapatham, 1985).

There are 17 genera and 29 species of Hermatypic corals in the west Coast patches of India. Porites, Cosanarares, Turbinaria, some favids and Pseudosiderastrea were reported from Intertidal regions of `Ratnagiri, Malvan and Redi, South of Bombay and at Gaveshani Bank, near Mangalore. All of these genera are massive and encrusting without any representation of ramose forms (Pillai, 1996).

Salinity drops to 20 ppt during monsoon in these habitats and the siltation rate is high. This restricts growth of ecologically sensitive forms of ramose corals (Bakus *et al*, 1994). Hermatypic corals along the shore are reported from Quilon in the Kerala coast to Enayem in Tamil Nadu. Pocilipora spp. is the most common genus in this area. Accropora is found with representation of 3 species. Pseudosiderastrea and Ponies spp are also found.

A recent investigation has shown that 29 species in 17 genera of Scleractinians occur in this area (Pillai, 1996). Current status of several of these coral areas is still unknown.

CONSERVATION AND MANAGEMENT OF CORAL REEF AREAS IN INDIA

The protection of coral reef has been stressed under Wildlife Protection act, 1972 and Environmental Protection Act, 1986 and Coastal Regulation Zone Notification (CRZN) of 1991 coming under it. Other acts like Indian Forests Act, 1927, Forest Conservation Act, 1980 and Indian Fisheries Act also offer a sort of relief in the conservation of Coral reefs of India. But there is no separate legal status for coral conservation even under Wildlife Protection Act. Ministry of Environment and forests has taken charge of Marine national Parks which have coral reefs in them. The State forest department, fisheries departments and recently the state coastal management authority at the state level are taking up the responsibilities for coral reef conservations in India.

It has been stated under CRZN that areas that are ecologically sensitive and important such as national parks, sanctuaries, reserve forests, wildlife habitats, mangroves, corals, coral reef areas; areas close to breeding and spawning grounds of fish and marine life, areas of outstanding beauty/areas rich in genetic diversity, areas likely to be inundated due to rising sea level consequent upon global warming and such other areas, as may be declared by the central and state government at the state or Union Territory level from time to time. Moreover, CRZ notification of 1991 places restriction on industries, operations and processes in the CRZ areas that extend up to 500 metres from the high tide line and the land lying between the low tide line and the high tide line. Setting up of new industries, manufacturing and handling or storage or disposal of hazardous substances, setting up/expanding fish processing units including warehousing, land reclamation, bunding / disturbing the natural course with similar obstructions except those required for coastal erosion, mining of lands, rocks and other substrate materials, harvesting or drawing ground water and construction mechanisms within 200 metres of high tide level; 500 metres it shall only be permitted when done manually through ordinary wells for drinking, horticulture, agriculture and fisheries, construction activities in ecologically sensitive areas specified in Annexure 1 of notification are all prohibited.

Even though all the laws concerning Wildlife Protection include the protection of major ecosystems, there is no direct stress on coral reef conservations. So the recommendation for law reform and policy making for coral reef conservation and management in the country essentially concern amending the Wildlife (Protection) Act 1972 to include species of coral in the schedules and specifically state that the extraction of coral is prohibited under the provisions of Chapter VA of WPA. Moreover, the CRZ notification essentially covers coastal areas extending 500 metres from High tide line and the land lying between the Low tide line and High tide line in the landward side, The areas extending beyond the coral and coral reefs on seaward side remain unprotected. The major coral reef areas could be declared Ecologically sensitive under EPA 1986 and strict restrictions could be imposed on dangerous industries.

Government agencies as well as local communities who are residing in close proximity of the ecologically sensitive areas of coral reefs and wetlands should take up a national level policy that would guide conservation efforts to protect these important ecosystems (Devaki Panini, 1997).

CONCLUSIONS

In general all the reefs in India are facing impacts attributed to local activities, however with varying degrees. Siltation and eutrophication has been the major factor of reef degradation in Gulf of Kutchh. In Lakshadweep dredging activities are solely causing the siltation which is far less threatening the ecosystem compared to Gulf of Kutchh as less

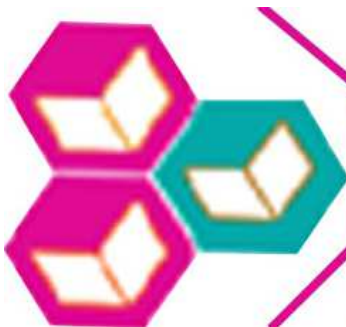
intensive dredging and the disturbed particles are heavy (of coral skeletal origin) and do not remain suspended in water column to be transported to reef zone, whereas in Gulf of Kutch fine clayey particles are deposited and that disturbs the reefs. In Andaman and Nicobar mainly siltation and eutrophication is through deforestation activities, sewage discharge and ground water discharge associated with monsoons. In India Gulf of Mannar is by far the most stressed of reefs due to the shore based pollution, intensive fishing, illegal harvesting of protected resources have severely degraded these reefs, resulting in loss of species, alteration in species dominance and many algae dominated reefs. It is predicted that the current rates of overexploitation and destructive practices are to be controlled to prevent the complete degeneration of coral reefs in India by 2014 (Rajasriya et al., 2004). A thorough understanding of the current status of the reefs and the reef dwelling and associated communities is very important to conserve the Indian reefs that which are home to a multitude of species.

REFERENCES

1. Arthur, R. (2008) Patterns of Benthic recovery in Lakshadweep atolls. In: Ten years after bleaching-facing the consequences of climate change in the Indian Ocean. CORDIO Status report 2008. Coastal Oceans Research and development in the Indian Ocean/Sida SAREC. Mombasa. <http://www.cordioea.org> Obura, D.O., Tamelander, J., & Linden, O. (eds) 39-44.
2. Bahuguna, A & S. Nayak, (1994) "*Coral reef Mapping of the Lakshadweep Islands*" SAC (ISRO), Ahmedabad, India.
3. Bahuguna, A & S. Nayak, (1994) "*Coral reef Mapping of Tamil Nadu using satellite data*" SAC (ISRO), Ahmedabad, India.
4. Bakus, G.J., Wright, M., Schulte, B., Mofidi, F. Yazdandoust. M., Gulko, D. Naqvi, W., Jagtap, T., Goes, J., Naik. C. 1994. *Coral Reef Ecosystems*. New Delhi: Oxford & IBH Publishing Co. Distributed by A. Balkema, Rotterdam
5. Chandramohan, P., N.M. Anand and B.V. Nayak, 1993. Shoreline dynamics of the Lakshadweep islands. *Indian J. Mar. Sci.*, 22: 198-202.
6. Coral reefs of India State-of -the-art report Environmental information System centre (for estuaries, mangroves, coral reefs and lagoons) 1998.
7. Dorairaj, K. and Soundararajan, R. (1977) Proceedings of the Regional Workshop on the Conservation and Sustainable Management of Coral Reefs, 55-62.
8. Dorairaj, K. and Soundararajan, R. (1997) Status of coral reefs of Mahatma Gandhi Marine National Park, Wandoor, Andamans. *Proc. Regional Workshop on the Conser. Sustain. Manag. Coral Reefs* (Vineeta Hoon, ed.), organised by M.S. Swaminathan Research Foundation and BOBP of FAO/UN, 55-63.
9. Gopinadha Pillai, C.S. and M.S. Rajagopalan, 1979. Preliminary report on a reconnaissance survey of the major coastal and marine ecosystem in Gulf of Kachchh. *Mar. Fish. Infor. Serv. Tech. and Ext. Ser.* (CMFRI) Cochin, 14: 16-20.
10. Gopinadha Pillai, C.S. and M.I. Patel, 1988. Scleractinian corals from the Gulf of Kachchh. *J. mar.biol. Ass. India*, 30(1&2): 54-74.

11. Jeyabaskaran, R. (1999) Report on Rapid assessment of coral reefs of Andaman & Nicobar Islands. GOI/UNDP/GEF Project on Management of Coral Reef Ecosystem of Andaman and Nicobar Islands. Published by Zoological Survey of India, Port Blair. 110 pp.
12. Krishnan, P., Dam Roy, S., George, G., Srivastava, R.C., Anand, A., Murugesan, S., Kaliyamoorthy, M., Vikas, N. and Soundararajan, R. (2011) Elevated Sea Surface temperature during May 2010 induces mass bleaching of Corals in the Andaman. *Current Science* 100(1); 111-117.
13. Mahadevan, S. and K. Nagappan Nair, 1969. Distribution of the coral reefs in the Gulf of Mannar and Palk Bay and their exploitation and utilization. *Proc. First Inter. Symp. Corals and Coral Reefs* (C. Mukundan and C.S.G. Pillai, eds.). *J. mar. biol. Ass. India*, 181-190.
14. Nair, R.R. and S.Z. Qasim, 1978. Occurrence of a bank with living corals of the Southeast Coast of India. *Indian J. Mar. Sci.*, 7: 55-58.
15. Pillai, G.S.G. 1986. Recent corals from the southeast coast of India. *Recent advances in Marine biology, Today and tomorrow pub.* N. Delhi: 107-201
16. Pillai, G.S.G and S. JASMINE 1996. Scleractinian corals of the erstwhile Travancore coast. *J. mar. biol. Ass. India* 37(1 &2): 109-125.
17. Pillai, C.S.G. (1996) "Coral reefs of India: Their Conservation and Management, in (Pillai CSG and Menon N.G. eds) "*Marine Biodiversity, Conservation and Management*," CMFRI, Cochin, India. Pillai, C.S.G., Jasmine, S. 1989. The coral fauna. *Central Marine Fisheries Research Institute Bulletin* 43: 179- 194
18. Pillai, C.S.G. 1996. Coral reefs of India, their conservation and management. In *Marine Biodiversity Conservation and Management*, eds. Menon, N.G., Pillai, C.S.G., pp. 16-31. Cochin: Central Marine Fisheries Research Institute
19. Qasim, S.Z. and Sankaranarayanan, 1970. Production of particulate organic matter by the reef on Kavaratti atoll (Laccadives). *Limnol. Oceanogr.*, 15(4): 574-578.
20. Qasim, S.Z., Wafar, M.V.M. 1979. Occurrence of living corals at several places along the west coast of India. *Mahasagar*. 12: 53-58
21. Rajagopalan, R. (2011). Issues regarding livelihoods in Gulf of Mannar National Park and Biosphere Reserve, in Report of the Bi-Natioal Stakeholder Consultation on Sustaining the Gulf of Mannar Ecosystem and its Resources(BOBLME). Rameshwaram.
22. Rajan, R. and Venkataraman. K. (2012) Consevation measures and stakeholder conflicts: sustainability of resources in Gulf of Mannar Biosphere reserve, Southeast India. In: *Oceans, Coasts, Islands: Achieving the Aichi Biodiversity Targets*. Convention on Biological Diversity, Subsidiary Body on Scientific, Technical and Technological Advice. 16th Meeting, Montreal, 30 April to 5 May 2012, UNEP/CBD/SBSTTA/16/INF/39, 25 April, 2012, pp 72-74. <http://www.cbd.int/doc/meetings/sbstta/sbstta16/information/sbstta-16-inf-39-en.pdf>
23. Rajan, R., Jeyabaskaran, R., Venkataraman, K. (2011) Indian Coral Reefs: Functions, threats and management issues' In: *Marine Biodiversity in India*, S. Kannaiyan & K. Venkataraman (eds.) Published by: Associated Publishing Co., New Delhi, India.

24. Rajasuria, A., Zahir, H., Venkataraman, K., Islam, Z., Tamelander, J. (2004) Status of Coral reefs in South Asia: Bangladesh, Chagos, India, Maldives and Sri Lanka. Status of Coral reefs of the World: 2004. (Ed) Clive Wilkinson, Australian Institute of Marine Science. 213-233.
25. Ramaiyan, V. And Adiyapatham, S. (1985) "Studies on the systematics of coral fishes from Porto Novo. *Proceedings of the 5th International Coral Reef Congress,*" Tahiti.
26. SAC., (2010) Coral Reef Atlas of The World, Vol. I Central Indian Ocean. Space Application Centre, Indian Space Research Organization, Ahmedabad, India. Pp 281.
27. Silas, E. and A.B. Fernando, 1985. The Dugong in India – is it going way of the Do Do? *Symp. Endangered Marine Animals and Marien Parks.* (Jan.). Cochin, India, 12-16.
28. Thomas, P.A., 1969. Boring sponges of the reefs of Gulf of Mannar and Palk Bay. *Proc. First Inter. Symp. Corals and Coral Reefs* (C. Mukundan and C.S.G. Pillai, eds.). *J. mar. biol. Ass. India*, 303-362.
29. Thomas, P.A., 1997. Destruction of coral reef by boring sponges. *Proc. Regional Workshop on the Conser. Manag. Coral Reefs* (Vineeta Hoon, ed.), organised by M.S. Swaminathan Research Foundation and BOBP of FAO/UN, 117-122.
30. Venkataraman, K., Srinivasan, M., Satyanarayana, CH. and Prabakar, D. (2002). Faunal Diversity of Gulf of mannar Biosphere Reserve. Conservation Area Series. Zoological Survey of India, Kolkata.
31. Vineeta Hoon, 1997. Coral reef of India: review of their extent, condition research and management status. In: *Proc. Regional Workshop on the Conser. Sustain. Manag. Coral Reefs* (Vineeta Hoon, ed.), organised by M.S. Swaminathan Research Foundation and BOBP of FAO/UN, 1-27.
32. ZSI (2011) Interim report of the study 'Status assessment of seacucumbers in Palk Bay and Gulf of Mannar' Zoological Survey of India, Marine Biology Regional Centre, Chennai, Submitted to Gulf of Mannar Biosphere Trust and Conservation of Forests and Director, Gulf of Mannar Biosphere Reserve, Ramanathapuram. Pp.1-21.
33. ZSI (2012) Fauna of Ecosystems of India Coral Reefs. Special Publication Series on the occasion of CBD CoP-11, 2012-India



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