06 Scleractinian coral diversity in Indian reefs, their threats and conservation

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Introduction

The researches on the various aspects of corals (belonging to the Phylum Coelenterata) and coral reefs of the seas around India, including the oceanic atolls and continental islands have a span of more than a century. More than a hundred scientific reports are available in various Indian and foreign publications on the reef corals and coral reefs of India and also on the living reef associated resources of our waters.

The value of coral reefs, both for the biosphere and human species is well established. Reefs are centres of high biological productivity, sites of CO_2 sink, ecosystem of very high biodiversity, shore line protectors, source of huge deposit of $CaCO_3$, centres of scientific research; additionally they provide us with many natural raw materials for pharmacological products or life-saving drugs. The values of coral reefs as tourist spots are also all the more important. However, it seems that we in this country, except for overexploiting the limestones and resources they harbour, made very little efforts to utilize them in the correct perspective.

CLASSIFICATION OF THE TAXON

Phylum Coelenterata

Phylum Coelenterata includes a group of animals with 'hollow intestine' with diploblastic body consisting of an outer layer or ectoderm and an inner layer called endoderm enclosing a jelly-like mesoglea (in advanced forms mesoglea with muscle fibers and cells) in between. Organs and organ systems are absent and the organization is said to be of tissue grade for carrying out various functions of the body.

Individuals may be sessile or free swimming and occur singly or in colonies. They are radially or biradially symmetrical. The presence of stinging cells (nematocysts) is considered to be a peculiarity with this group so also alternation of generation and polymorphism. The individuals may be of two forms-polyps with tubular body and medusae with umbrella like body. Skeleton, when present, may be of $CaCO_3$ and/or gorgonin.

Many species of coelenterates have come into the limelight recently on account of their biomedical value. Prostaglandins or derivatives thereof, isolated from alcyonaceans now serve as 'wonder drugs' to many a disease in man and animals.

Phylum Coelenterata is divided into 3 classes: Hydrozoa, Scyphozoa and Anthozoa based on their body pattern and evolutionary trends. Life cycle, in Hydrozoa, includes both polyp and medusoid stages, in class Schyphozoa the medusoid stage dominates with polyp stage reduced or even absent and the life cycle includes only polyp stage in class Anthozoa .

Of the above three classes corals belonging to the class Anthozoa are coming under the purview of this report.

Class Anthozoa

This is the largest class of the phylum and the members are dominantly marine. The ectoderm may secrete an exoskeleton of $CaCO_3$ or gorgonin or both.

This class is divided into two subclasses: Hexacorallia and Octocorallia.

Subclass Octocorallia

Includes a group of brightly coloured sessile animals. Tentacles and mesenteries 8 or in multiples of 8; polyps dimorphic in some.

Colony may be simple or plant like. In some skeleton may be divisible into axial and cortical; made of $CaCO_3$ and gorgonin. This subclass includes animals popularly called soft coral (alcyonarians) blue coral (Coenothecalia) horny coral (gorgonids) and sea pen (Pennatulacean).

Subclass Hexacorallia

This subclass embraces solitary and colonial forms; tentacles and mesenteries 6 or in multiples of 6; dimorphism is unknown. Exoskeleton solid, massive; made of $CaCO_3$. This sub class includes sea anemones, true corals or stony corals, black coral (antipatharia) etc.

Order Scleractinia

The order Scleractinia includes all post-Paleozoic fossil and recent corals. It includes solitary and colonial forms with polyps. The Scleractinia are distinguished by a calcareous external skeleton consisting essentially of radial partitions or septa situated between the mesenteries and secreted by the ectodermal body layer within upward infoldings of the basal part of the polyp wall, together with a more or less developed external sheathing and variously developed attendant supporting structures. As in all other anthozoans, scleractinian corals are exclusively marine in habitat. They are commonest in warm, clear, shallow waters of the tropical zone, but some are adjusted to shallow or deep, cold water and may be found in all latitudes.

Veron (2000) reported 18 families, 111 genera and 793 species of Scleractinia from the world in his three pictoral volumes on the 'corals of the world'. Wallace (1999) reported 114 species of the genus *Acropora* in her book on 'Staghorn corals of the world'. Of the 794, or so reef corals that are known in the world, 600 are found in the region bound by Indonesia , Malaysia, the Phillipines and the southern Japan Of these 794 species, 101 required new names and 2 required re-naming. Subsequently in 2002 a new volume containing taxonomic details of new species was published.

Faunal diversity and distribution in India

The scleractinia corals of India have a richer diversity when compared to the other reefs of the tropical world. Pillai (1996) the pioneer in Indian coral research recorded a total of 199 species divided among 71 genera, from India, which is given in the Table1.

However, Venkataraman *et al.* (2003) after making extensive studies throughout India reported more new records in the coral reefs of India when compared to the previous reports made by Pillai (1996). The revision of families and genera by the recent workers (Wallace, 1999; Veron, 2000) have made some of the earlier reported species as synonyms to the revised ones. Hence, in the book 'Handbook on hard corals of India" (Venkataraman *et al.*, 2003) a total of 208 species, which includes 15 families and 60 genera have been reported and this is represented in the Table 2. Further Raghuraman

Table 1: The comprehensive list of genera and species of corals of India listed by Pillai 1983).

Area	Genera	Species	Sources
Lakshadweep	27	105	(Pillai and Jasmine, 1989
Gulf of Kutch	24	37	(Pillaai and Patel, 1988)
Southeast coast of India	37	94	(Pillai, 1986)
Andaman and Nicobar Islands	59	135	(Pillai, 1983)
West coast of Kerala and Tamilnadu	17	29	(Pillai and Jasmine, 1995)
Total for India	71	199	

Table 2. Distribution of total number of families, genera and species of Scleractinian corals in the four major coral reefs of India.

	Gulf of Kachchh	Lakshadweep	Palk Bay and Gulf of Mannar	Andaman and Nicobar Islands	Total
Families	8	12	13	15	15
Genera	20	34	27	57	60
Species	36	91	82	177	208

With courtesy Venkataraman *et al.*(2003)

Comparison of the scleractinian corals in the major reefs of India

	Gulf of Kachchh	Lakshadweep	Palk Bay and Gulf of Mannar	A&N Islands	Total
Families	10	13	14	19	19
Genera	27	37	40	86	89
Species	49	104	117	424	478

Raghuraman *et al.*, 2012

et al. (2012) have reported 478 species which include 19 families and 89 genera (Table 3).

Among the four major reef areas of India, Andaman and Nicobar Islands are found to be very rich and Gulf of Kachchh the poorest in species diversity. Lakshadweep Island have more number of species than the Gulf of Mannar. About 97%of Indian genera has been recorded from Andaman and Nicobar Islands. Whereas other reefs constitute merely 40%. This indicates the high degree of coral diversity in Andaman and Nicobar Islands. Interestingly Andaman and Nicobar Islands have all the families (100%) which are recorded from other major reefs of India.

Corals families recorded in Indian Reefs

No.	Family	India	
		Genus	Species
1	ACROPORIDAE Verrill, 1902	4	143
2	ASTROCOENIIDAE Koby, 1890	2	4
3	POCILLOPORIDAE Gray, 1842	3	15
4	EUPHYLLIDAE Veron, 2000	3	7
5	OCULINIDAE Grey, 1847	1	4
6	MEANDRINIDAE Gray, 1847	1	1
7	SIDERASTREIDAE Vaughan and Wells, 1943	4	14
8	AGARICIIDAE Grey, 1847	6	32
9	FUNGIIDAE Dana, 1846	11	48
10	PECTINIIDAE Vaughan and Wells, 1943	5	13
11	MERULINIDAE Verrill, 1866	3	8
12	DENDROPHYLLIDAE Grey, 1847	7	26
13	CARYOPHYLLIIDAE Gray, 1847	6	11
14	FLABELLIDAE Bourne, 1905	2	2
15	RHIZANGIIDAE Orbingny, 1851	2	2
16	MUSSIDAE Ortmann, 1890	7	23
17	FAVIIDAE Gregory, 1900	18	81
18	TRACHYPHYLLIIDAE Milne Edwards and Haime, 1848	1	1
19	PORITIDAE Grey, 1842	3	43
	Total	89	478

Present knowledge and GAPS

Gulf of Kachchh: Among the 89 genera recorded in India only 27 are reported so far from this area. *Montipora venosa, Cosinaria monile, Hydnophora exesa, Turbinaria peltata, Goniastrea pectinata, Platygyra sinensis, Cyphastrea serialia, Porites compressa* and *Goniopora stutchjburyi* are some of the common species found in all the islands of Gulf of kachchh. *Acropora humilis* reported earlier is not found in the recent investigations. Species such as *Acanthastrea hillae* are reported only from Gulf of Kachchh. Hence, the diversity of scleractinian corals in this region is very poor when compared to all the other three major regions of India.

Lakshadweep Islands: thirteen families, 37 genera and 104 species are reported from these islands. Species such as *Acropora humilis, A. formosa, A. intermedia, A. hyacinthus, Pocillopora verrucosa, Euphyllia glabrescens, Galaxea fascicularis, Psammocora contigua, P. haimeana, Pavona maldivensis, P. clavus, Fungia danai, Podobacia crustacea, Hydnophora microconos, Favites abdita,Gonaistrea retiformis, Platgyra daedalea, P. sinensis, Leptastrea bottae, Porites solida, P. lichen* and *P. minicoensis* are common in these islands.

Gulf of Mannar and Palk Bay: Fourteen families, 40 genera and 117 species are reported from this area . Among the 89 genera recorded in India, only 40 are reported so far. Species such as *Montipora monasteriata, M. informis, M. spumosa, M. turgescens, M. venosa, M. verrucosa, M. digitata, M. millepora, M. manauliensis, Acropora digitifera, A. secale, A. intermedia, Pocillopora verrucosa, Porites mannarensis, P. exserta and Goniopora stutchburyi are common in these islands. Species such as Montipora millepora, M. jonesi, M. manauliensis, M. edwardsi, M. exserta, Porites exserta* and *P. mannarensis* are reported only form Gulf of Mannar and Palk Bay.

Andaman and Nicobar Islands: Nineteen families, 89 genera 424 species are reported from these islands. All thenineteen families are represented. Out of 89 genera reported from India *Acropora* is the dominant genus found in Andaman and Nicobar Islands.

There are 20 species common to all the four major coral reefs of India. They are *Montipora foliosa, M. turgescens, M. venosa, M. hispida, Acropora humilis, Turbinaria mesenterina, Symphyllia radians, Favia stelligera, F. pallida, F. favus, F. speciosa, Favites halicora, F. complanata, Goniastrea pectinata, Platygyra daedalea, P. sinensis, Leptastrea purpurea, Cyphastrea microphthalma, Porites lutea* and *P. lichen*.

Destruction to coral biodiversity

The coral reefs all over the world are undergoing deterioration due to both natural and anthropogenic factors. This has created an awareness of all countries with corals reefs. Settlement, industrial pollution, exploitation of reef resources, tourism, dredging of lagoon and reefs, siltation due to deforestation are some of the major man made causes for the destruction of the reefs and mass mortality of corals all over the world. Natural causes include cyclones/tsunami or killer waves, diseases such as black band and white band diseases, bleaching of live corals due to temperature rise, predation by Acanthaster planci and prolonged exposure due to the tidal fluctuations that kill extensive areas of corals sometimes on reef flats. The Indian reefs are no exception to the worldwide deterioration of reefs. As early as 1975 Pillai pointed the ecological and man made interference on south Indian reefs . Pillai (1990) and James *et al*., (1989) and Pillai and Madan Mohan (1986) described the environmental stress on Lakshadweep reefs. The problems of Gulf of kutch is well brought out by Rasheed (1985) and those of Andaman reefs by Dorairaj *et al*. (1987). Pillai and Jasmine (1991) again described the status of the south Indian reefs. Pillai (1996) again described the status of the South Indian reefs. Venkataraman *et al*.(2003) has given

an overall picture of the threats to 'Coral reefs of India'

Sedimentation

Coral and sand mining in Gulf of Mannar (Turicorin group of islands) and in Andaman islands have caused sedimentation and siltation on coral reefs. In fact the destruction of coral reefs in Palk Bay and Gulf of Mannar due to quarrying is perhaps unparalled in history (Pillai 1975) and this is the most important and the least studied man made factor affecting coral biodiversity. In the Gulf of Kutch mining for calcareous sand in Pirotan Island has caused severe damage to reefs and the absence of *Acropora* spp. in Gulf of Kutch is probably due to excessive silting. Pillai (1971) has shown that silting influence small corals such as *Acropora* spp. and *Montipora* spp. in the Palk Bay as they are unable to thrive in areas of sedimentation. Very few studies have focused on the chemical aspects of sediment on corals.

Dredging

Dredging projects have been particularly damaging to reefs primarily through the initial physical disturbance, habitat alteration and the subsequent problems associated with sedimentation. The deleterious effects of dredging in the lagoon and reefs of Lakshadweep have been pointed out by Pillai (1986). James *et al*. (1989) reported severe damage to the corals in the lagoon of Minicoy and Kilton atoll and this was effected by dredging.

Pollution

Research carried out in many areas have documented coral mortality, decreased fecundity and recruitment failure in response to chronic oil pollution (Venkataraman *et al*., 2003). Industrial wastes discharged into the sea water near Tuticorin islands, effluents from Chattam Sawmill and match factories around Port Blair and in middle Andaman are reported to have caused heavy damage to corals (Dorairaj *et al*. 1987). Many areas in Andaman and Nicobar islands and Gulf of Mannar area have large quantities of sediment laden freshwater run off impinged on coastal reefs, causing high levels of coral mortality. The overall impact of sewage pollution on coral reef community of Keelakarai coast in Gulf of Mannar has recorded dead corals due to the luxurient mat formation of green algae

Temperature stress and bleaching

The global climatic stresses also play a decisive part in the coral reef crisis. In the Indian context a study by Arthur (2000) recorded bleaching in 3 Indian coral reef regions in relation to SST's using quantitative assessment methods between April and July, 1998. Based on this study the Gulf of Kutch reefs showed an average of 11% bleached coral with no apparent bleaching -related mortality. In contrast, bleached corals comprised 82% of coral cover in lagoon reefs of Lakshadweep & 89% of the coral cover in the Gulf of Mannar reefs. Bleaching related mortality was high at 26% in Lakshadweep & 23% in Gulf of Mannar. This coral mass mortality will have profound ecological and socio-economic implications and highlights the need for sustained monitoring for coral reef conservation in India.

Coral diseases

World over, four types of coral diseases have been identified - white band and black band diseases, bacterial infection and shut down reaction. So far white band disease has been reported from Andaman & Nicobar and Lakshadweep islands. In addition, a new disease called Pink line disease has been reported from Lakshadweep (Venkataraman *et al*., 2003), Palk Bay (Sandhya *et al*., 2009) and Thirumullavaram, Quilon waters (CMFRI, 2010). White band disease is reported from many reefs in Andaman and Nicobar islands (Muley *et al*., 2000). Black and white band diseases have also been observed in shallow coral areas and there are reports of pink band disease too (Raghukumar and Raghukumar, 1991).

Fishing with destructive methods

Destructive fishing activities such as blast fishing, trap fishing, shore seines, trawling etc. have severely damaged many of the Gulf of Mannar's richest and most diverse coral reefs which was once the ' Paradise of marine Biologists' and now are 'ghost islands' (Edward *et al*., 2004; Venkataraman *et al*., 2003).

Crown of thorns starfish infestation

The predation of coral polyps by the crown of thorns *Acanthaster planci* was recorded in the 1980's and early 1990's at Andaman & Nicobar islands (Pillai 1986). Though the above echinoderm occur in Indian reefs, no large scale infestation was noticed after these out breaks

Tourism

Tourism has damaged reefs in many ways at Lakshadweep and in Gulf of Mannar. The influx of tourists contributes to the problem of waste disposal and coral reef destruction.

Conservation and management strategies: Action taken

For the purpose of conservation and management of the coral biodiversity many steps have been undertaken in India.

- Identification of marine protected areas and their demarcation and protection.
- Coral Reef Monitoring Action Plans prepared and launched. Other significant international activities such as the Coral Reef Degradation in the Indian Ocean (CORDIP), India–Australia Training and capacity building programme (IATCB), initiated.
- National wide mapping of coastal areas by remote sensing techniques combined with land surveys to assess the rate of degradation initiated.
- Amendment and enactment of National policies (National Biodiversity strategy and Action Plan and National Biodiversity Bill) with relevance to the protection of respective ecosystem.
- Export trade control order.

- Six workshops, two symposia, one seminar and one national conference have disscused the problems of coral reefs and have made several recommendations for their conservation and management. However, most of them remain in paper only.
- In addition several national and state level committees with a view to protecting our reefs have been formulated.

Suggested reading

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