Journal of Research in Biology

An International Scientific Research Journal

ISSN No: Print: 2231 –6280; Online: 2231- 6299

Original Research

New recruitment of *Acropora* Oken, 1815 in South Andaman: A proof of recovery of Corals after 2010 mass bleaching

Authors:
Bitopan Malakar[1] and Venu S[2]

Institution:
1. Research Scholar, Department of Ocean Studies and Marine Biology, Pondicherry University, Port Blair -744112, A & N Islands, India

2. Assistant Professor, Department of Ocean Studies and Marine Biology, Pondicherry University, Port Blair -744112, A & N Islands, India

Corresponding author:
Bitopan Malakar

ABSTRACT:

Mass bleaching of corals in 2010 seriously affected the corals in Andaman group of islands. Rise in Sea Surface Temperature (SST) was the primary reason due to less than normal rainfall during the bleaching period. Now three years after the bleaching episode the corals in South Andaman seems to recovering. The primary indicator of recovery being the new recruitment of corals especially *Acropora* spp. (branching corals) throughout the reef areas along with the increase in overall live coral cover. Multiple surveys were conducted in three stations viz. North Bay, Chidiyatapu and Marina Park along the eastern coast of South Andaman during this study and all the sites were found to have new recruitment of *Acropora* spp. which were severely affected during 2010 mass bleaching.

Keywords:
Acropora spp., Bleaching, Corals, Recovery, Recruitment

Web Address:
http://jresearchbiology.com/documents/RA0525.pdf

Article Citation:
Bitopan Malakar and Venu S
New recruitment of *Acropora* Oken, 1815 in South Andaman: A proof of recovery of Corals after 2010 mass bleaching
Journal of Research in Biology (2015) 5(3): 1699-1706

Dates:
Received: 9 Feb 2015 **Accepted:** 26 Mar 2015 **Published:** 15 May 2015

Journal of Research in Biology

INTRODUCTION

Andaman and Nicobar Islands are present in the Bay of Bengal and consist of 572 islands and islets. Andaman Islands have the status of Union Territories under the Republic of India and are well known for tropical rainforests, mangroves and coral reefs. Andaman islands have approximately 11,989 km² (Turner *et al.,* 2001) of coral reefs which are among the most diverse in the Indian Subcontinent. Bleaching of corals have been reported in 1998, 2002, 2005 and 2010 from these islands groups (Krishnan *et al.,* 2011). Periodic bleaching of corals have been studied and reported (Winter *et al.,* 1998, Baird and Marshall 1998, Hoegh-Guldberg 1999, Berkelmans and Oliver 1999, McField 1999, Arthur 2000, Kumaraguru 2003, Berkelmans *et al.,* 2004, Pratchett *et al.,* 2008, Vivekanandan *et al.,* 2008, Krishnan *et al.,* 2011, Marimuthu *et al.,* 2011) worldwide since late nineties with more and more understanding on the phenomenon of bleaching than ever before. Bleaching not only hampers the growth of corals but also adversely affects the reef community (fishes and other organisms including invertebrates) in coral reefs (Ohman *et al.,* 1998, Wilkinson 2000, Wilson *et al.,* 2006, Pratchett *et al.,* 2008). Degradation of corals (death and disease) caused by bleaching can enhance the growth of macroalgae (phase shifts) whereby destroying the complex ecosystem in coral reefs which have been reported from around the world (Jones *et al.,* 2004, Szmant 2005).

Raghuraman *et al.,* (2013) have reported 424 coral species out of which 143 species are from the family Acroporidae (highest among all families present in the region) from Andaman and Nicobar Islands. *Acropora* spp. contribute to the larger percentage of branching corals and is widely reported from all these islands. Turner *et al.,* (2001) reported that *Porites* spp. dominated coral reefs in North and South Andaman while *Acropora* spp. dominated in the Middle Andaman. Krishnan *et al.,* (2011), reported mass bleaching of 2010 due to rise in SST and found that the branching corals were worst affected during the course of bleaching (Fig. 1).

Acropora is known to grow faster than most other corals (Veron 1986) with some of its species recorded growth of around 10 cm year^{-1} (Coles and Fadlallah 1991). Species from the family Acroporidae which are primarily branching are most vulnerable to bleaching effects (Glynn *et al.,* 1994, Drollet *et al.,* 1995). Krishnan *et al.,* (2013) studied the recovery process with respect to reef fishes' diversity during and after the bleaching event and compared to pre-bleaching data from three reefs areas of South Andaman. Marimuthu *et al.,* (2011) studied the recovery of anemones after the bleaching event. Marimuthu *et al.,* (2012) also studied the recovery process after 2010 bleaching with respect to sedimentation and benthic

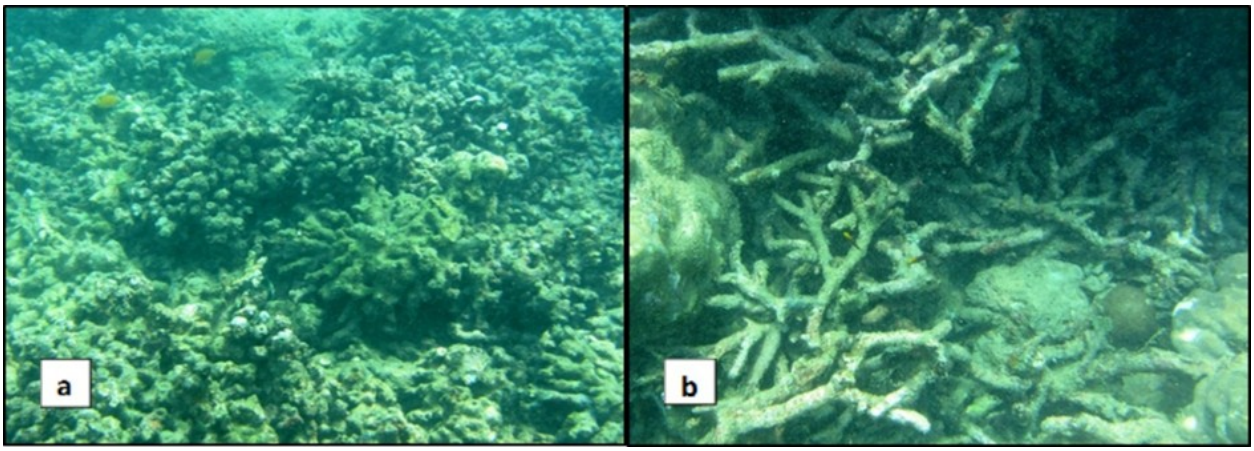

Figure 1: Rubble of dead branching corals in (a) Chidiyatapu and (b) North Bay reef areas

substrates in some reef areas of Andamans.

MATERIALS AND METHODS

Three stations namely Chidiyatapu (11°29'21"N, 92°42'29"E), North Bay (11°41'58"N, 92°44'42"E) and Marina Park (11°40'17"N, 92°44'56"E) in South Andaman (Fig. 2) were selected for the present study to understand the recovery of corals. Chidiyatapu and North Bay have a moderate extent of coral reefs. In North Bay, coral reefs are closer to the beach (20-30 m away) while in Chidiyatapu it is around 200 m away from the beach. Marina Park is located in Port Blair with an assemblage of man-made concrete structures erected along the shoreline with seawalls and pavements along with a jetty as a part of it. The walls of this park harbours a good variety of corals, reef fishes and other invertebrates. Anthropogenic pressure is more in Marina Park and North Bay when compared to Chidiyatapu due to closeness of human inhabitations along with tourism and fishing activities.

Belt transects (20 m X 5 m = 100 m²) (Hill and Wilkinson 2004) were used to estimate the new colonies of *Acropora* spp. Two transacts each were laid on the stations to estimate colonies of *Acropora* spp. Furthermore, line intercept transects (LIT) (Hill and Wilkinson 2004) were used to record live coral and other benthic substrates in coral reefs. Quadrat method (50 cm X 50 cm) (Hill and Wilkinson 2004) was used to estimate the cover of Crustose Coralline Algae (CCA) in all the sites. Colony sizes were measured along the LIT to get an idea of their growth with the help of a measuring tape. All surveys were carried out in the shallow depth to a maximum of 5 m by snorkelling. It is to be noted that corals in shallow waters were most affected during 2010 mass bleaching of corals when compared to corals in deeper waters (Krishnan *et al.,* 2011).

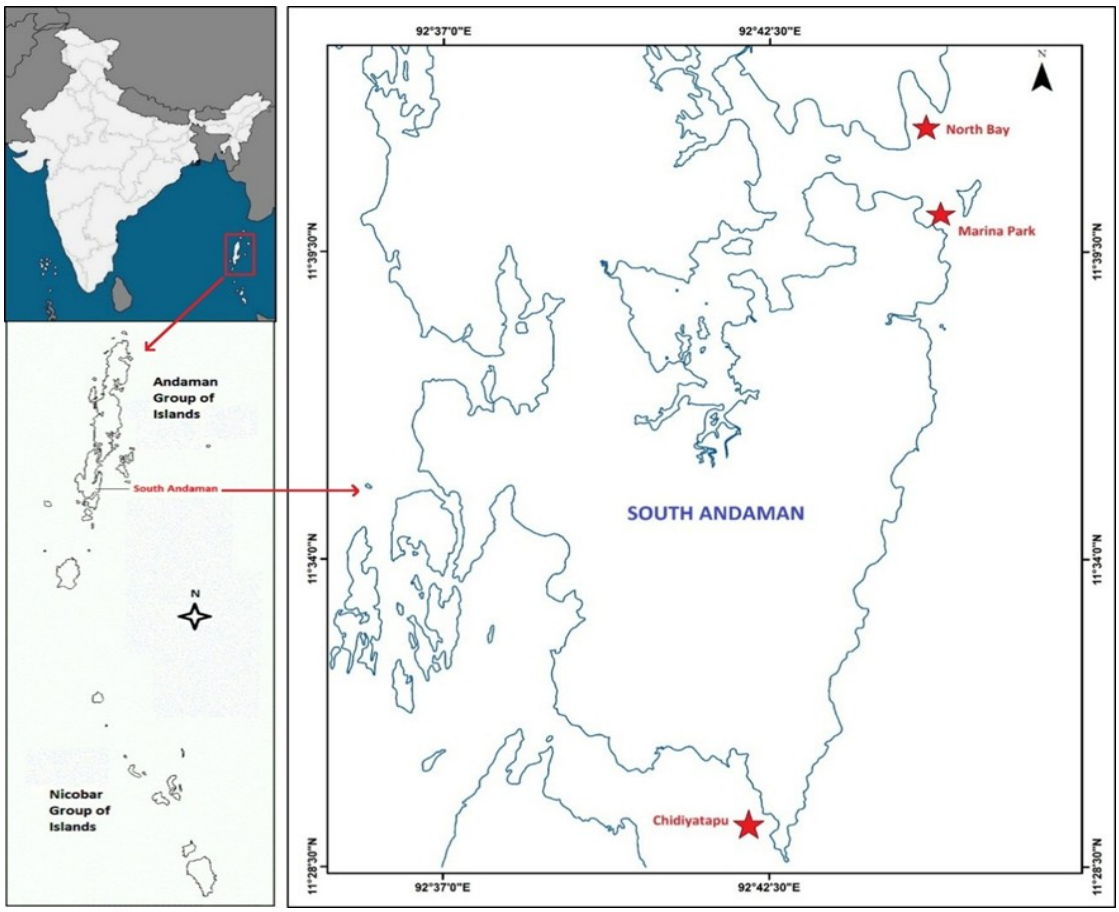

Figure 2: Map showing the location of South Andaman and the study stations

RESULTS AND DISCUSSION

During the present study, it was understood that the normalization of SST has driven new recruitment of corals, prominently *Acropora* spp. which were almost wiped out after the bleaching episode. Sustained normal rainfall over the three years when compared to 2010 bleaching period has helped in normalization of SST (Krishnan *et al.,* 2013) and hence helped in coral recovery. Part of the recovery can also be attributed to the abundance of Crustose Coralline Algae (CCA) in all the sites with highest percentage in the concrete walls of Marina Park.

Number of colonies per 100 m² in Marina Park, North Bay and Chidiyatapu showing good recruitment of new *Acropora* colonies throughout South Andaman (Table. 1). Chidiyatapu and North Bay have shown better recovery than Marina Park.

Colony sizes vary depending on their growth after the bleaching episode in 2010. But sizes of colonies are much smaller than full grown colonies suggesting almost all which have grown after the bleaching of 2010 following the recovery process with the normalization of SST. Present study has recorded the rubbles of dead *Acropora* colonies throughout all the study area which were previously reported as perished after the bleaching of 2010. The average sizes in all the sites are more or less similar suggesting uniform recovery in South Andaman. North Bay has the most uniform growth with less standard deviation compared to the other two sites (Table. 2). But larger sized colonies were observed in Marina Park and Chidiyatapu (Table. 2) than North Bay. Newly recruited species of *Acropora* (Fig. 3) that were mostly recorded from all the stations are *Acropora aspera, Acropora cerealis, Acropora humilis, Acropora gemmifera, Acropora nasuta, Acropora formosa*, *Acropora nobilis*, *Acropora robusta*, *Acropora breuggemanni* and *Acropora grandis*. Most of these species were reported to be bleached and subsequently dead after the bleaching episode. Other species from the family Acroporidae like *Montipora* spp. and *Astreopora*

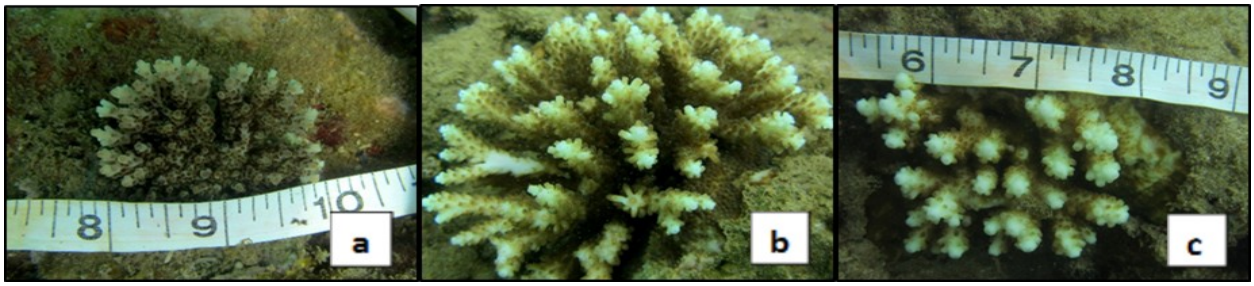

Figure 3: New colonies recorded from all the three stations (a) Marina Park, (b) North Bay and (c) Chidiyatapu (tape measurements in inches)

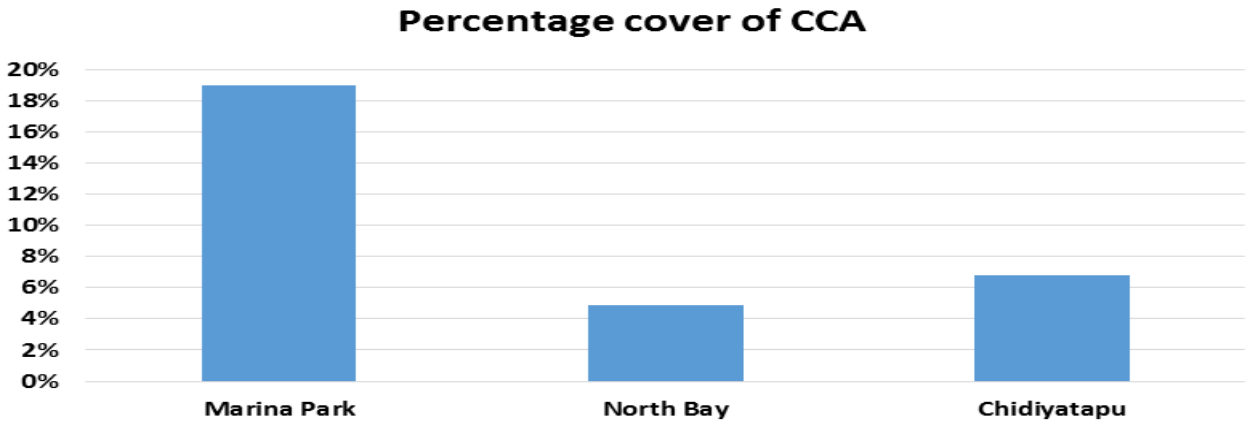

Figure 4: Percentage cover of CCA in all the stations

Table 1. No. of *Acropora* colonies per 100 m²

Transects	Marina Park	North Bay	Chidiyatapu
1	31.0	47.0	51.0
2	43.0	45.0	42.0
Average	37.0	46.0	46.5

Table 2. Size of *Acropora* colonies recorded (in cm)

	Marina Park	North Bay	Chidiyatapu
Smallest Colony	04.20	03.81	03.43
Largest Colony	034.0	18.79	32.0
Average size	12.14	09.33	10.99
Standard Deviation	08.11	04.03	07.78

Figure 5: A new *Acropora* colony growing over CCA in Marina Park

Table 3. Present percentage cover of benthic substrates

Components	North Bay	Chidiyatapu
Live coral	45.75	39.75
DC	26.50	39.25
DC+Algae	4.25	7.50
Sand	11.50	3.0
Rubble	7.50	7.25
Sponge	3.0	1.0
Others	1.50	2.25

*Others - Anemones, Soft Corals, Giant Clams, Zoanthids etc.

spp. were rarely sighted in the study stations.

CCA is known to help in the new recruitments of corals (Adey 1998, Harvey 2005, Farr 2009, Vermeij 2011) and so the percentage cover of CCA was estimated with the help of quadrat method. Among the two reef sites, Chidiyatapu has 6.83% of CCA while North Bay has 4.90% (Fig. 4). Marina Park even though has the highest percentage (19.0%) of CCA over the walls of the park and the jetty, yet harbours the least number of colonies per 100m² (37.0). This may be due to the obvious reason that it is not a natural reef habitat. Species from the family Corallinaceae of CCA dominated in all the stations.

Krishnan *et al.,* 2011 reported just 1.11 % and 1.09 % of actual live coral cover from North Bay and Chidiyatapu respectively during the bleaching event of 2010 while rest of the available live coral either partially or fully bleached. Again Krishnan *et al*., 2013 reported 40.45 % and 32.73 % of live coral in North Bay and

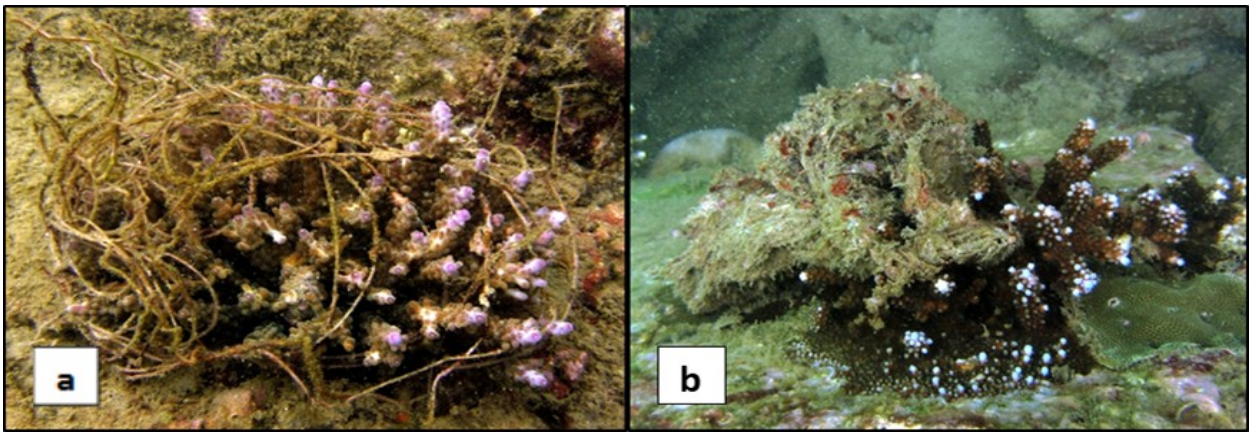

Figure 6. a) Net entangled *Acropora* colony b) Cloth piece entangled *Acropora* colony

Chidiyatapu respectively which was one year after (2011) the bleaching event and confirmed the recovery of most partially or fully bleached corals. The percentage cover of benthic substrates (Table. 3) at present provides a clear evidence of the overall recovery process compared to other study. Live coral was 45.75% and 39.75% in North Bay and Chidiyatapu respectively. While dead coral was 26.50% and 39.25% in North Bay and Chidiyatapu respectively. Rubble of dead corals (mostly of branching corals) were more or less similar in both the sites.

Threats to these growing colonies were observed in all the three stations (Fig. 6) to the growing *Acropora* and other branching coral colonies i.e. entangling with anthropogenic debris like discarded nets and lines used for fishing, cloth pieces and plastics. The authors removed such debris from close to 50 *Acropora* colonies from Marina Park & North Bay, both being in closer vicinity to human inhabitation and tourism activities. Chidiyatapu has the least disturbances from anthropogenic activities as the adjoining land area is under a forest reserve.

CONCLUSION

This study reveals the recovery of *Acropora* spp. (branching corals) since the mass bleaching of 2010 with the recruitment of many new colonies throughout different reef areas of South Andaman. This has become a very good indicator of the recovery process which correlates with the increase in live coral cover as reported by various authors. Though Marina Park is a man-made structure yet settlement of coral colonies especially branching corals were observed due to the abundance of CCA over the walls. But proper monitoring effort should be continued so as to understand how many of these new colonies survive and grow into larger colonies in the coming years with the ever changing marine environment.

REFERENCES

Adey WH. 1998. Coral reefs: algal structured and mediated ecosystems in shallow, turbulent, alkaline waters. J Phycol 34(3): 393–406

Arthur R. 2000. Coral bleaching and mortality in three Indian reef regions during an El Niño Southern Oscillation event. Current Science, 79 (12): 1723-1728.

Baird AH, Marshall PA. 1998. Mass bleaching of corals of Great Barrier Reefs. Coral Reefs, 17(4): 376.

Berkelmans R, Oliver JK. 1999. Large scale bleaching of corals on the Great Barrier Reef. Coral Reefs 18(1): 55–60

Berkelmans R, De'ath G, Kininmonth S, Skirving WJ. 2004. A comparison of 1998 and 2002 coral bleaching events on the Great Barrier Reef: spatial correlation, patterns, and predictions. Coral Reefs 23(1): 74-83

Coles SL, Fadlallah YH. 1991. Reef coral survival and mortality at low-temperatures in Arabian Gulf – new species-specific lower temperature limits. Coral Reefs 9 (4): 231-237

Drollet JH, Faucon M, Martin PMV. 1995. Elevated sea-water temperature and solar UV-B flux associated with two successive coral mass bleaching events in Tahiti. Mar Freshw Res 46(8): 1153–1157

Farr T, Broom J, Hart D, Neill K, Nelson W. 2009. Common coralline algae of northern New Zealand: an identification guide. NIWA Information Series No. 70. p.124

Glynn PW, Imai R, Sakai K, Nakano Y, Yamazato K. 1994. Experimental responses of Okinawan (Ryukyu Islands, Japan) reef corals to high sea temperature and UV radiation. Proceedings of the 7th International Coral Reef Symposium, Guam, pp. 27–37

Harvey AS, Woelkerling WJ, Farr TJ, Neill KF, Nelson WA. 2005. Coralline algae of central New Zealand: An identification guide to common 'crustose' species. NIWA Information Series No. 57. p.145

Hill J, Wilkinson C. 2004. Methods for ecological monitoring of coral reefs. Australian Institute of Marine Science, Townsville, Australia. p.117. ISBN No: 0 642 322 376.

Hoegh-Guldberg O. 1999. Climate change, coral bleaching and the future of the world's coral reefs. Mar Freshwater Res 50(8): 839–866.

Jones GP, McCormick MI, Srinivasan M, Eagle JV. 2004. Coral decline threatens fish biodiversity in marine reserves. Proc Natl Acad Sci USA 101(21): 8251–8253

Krishnan P, George G, Immanuel T, Malakar B, Anand A. 2013. Studies on the recovery of bleached corals in Andaman: Fishes as indicators of reef health. In: Venkataraman K, Sivaperuman C, Raghunathan C (eds.) Ecology and Conservation of Tropical Marine Faunal Communities, Springer-Verlag Berlin Heidelberg. pp. 395-407. ISBN No: 978-3-642-38199-7

Krishnan P, Roy DS, George G, Srivastava RC, Anand A, Murugesan S, Kaliyamoorthy M, Vikas N, Soundararajan R. 2011. Elevated sea surface temperature during May 2010 induces mass bleaching of corals in the Andaman. Current Science, 100 (1): 111-117.

Kumaraguru AK, Jeyakumar K, Ramakritinan CM. 2003. Coral bleaching 2002 in the Palkbay, Southeast Coast of India. Current Science, 85 (12): 1787-1793.

Marimuthu N, Dharani G, Vinithkumar NV, Vijayakumaran M, Kirubagaran R. 2011. Recovery status of sea anemones from bleaching event of 2010 in the Andaman waters. Current Science, 101 (6): 734-736.

Marimuthu N, Wilson JJ, Vinithkumar NV, Kirubagaran R. 2012. Coral reef recovery status in South Andaman Islands after the Bleaching Event 2010. J. Ocean Univ. China, 12(1): 91-96. Springer-Verlag Berlin Heidelberg.

McField MD. 1999. Coral response during and after mass bleaching in Belize. Bull Mar Sci 64(1): 155–172

Ohman MC, Rajasuriya A, Svensson S. 1998. The use of butterflyfishes (Chaetodontidae) as bio-indicators of habitat structure and human disturbance. AMBIO 27(8): 708–716

Pratchett MS, Munday MS, Wilson SK, Graham NAJ, Cinner JE, Bellwood DR, Jones GP, Polunin NVC, McClanahan TR. 2008. Effects of climate-induced coral bleaching on coral reef fishes: ecological and economic consequences. Oceanogr Mar Biol Ann Rev 46: 251–296

Raghuraman R, Raghunathan C, Venkataraman K. 2013. Present Status of Coral Reefs in India. In: Venkataraman K, Sivaperuman C, Raghunathan C (eds.) Ecology and Conservation of Tropical Marine Faunal Communities, Springer-Verlag Berlin Heidelberg. pp. 351-379. ISBN No: 978-3-642-38199-7

Szmant AM. 2005. Nutrient enrichment on coral reefs: is it a major cause of coral reef decline? Estuaries 25 (4b): 743–766

Turner JR, Vousden D, Klaus R, Satyanarayana C, Fenner D, Venkataraman K, Rajan PT, Subba Rao NV. 2001. Remote sensing and rapid site assessment survey. In: Coral Reef Systems of the Andaman Island. Government of India and United Nations Development Programme, Global Environment Facility, p.76

Vermeij MA, Dailer ML, Smith CM. 2011. Crustose coralline algae can suppress macroalgal growth and recruitment on Hawaiian coral reefs. Mar Ecol Prog Ser

422: 1–7

Veron JEN. 1986. Corals of Australia and the Indo-Pacific. University of Hawaii Press, Honolulu. p.644. ISBN No: 0-8248-1504-1

Vivekanandan E, Hussain Ali M, Jasper B, Rajagopalan M. 2008. Thermal thresholds for coral bleaching in the Indian seas. J. Mar. Biol. Ass. India 50 (2): 209 - 214

Wilkinson C. 2000. Status of coral reefs of the world 2000. Australian Institute of Marine Science, Townsville. p.280

Wilson SK, Graham NAJ, Pratchett MS, Jones GP, Polunin NVC. 2006. Multiple disturbances and the global degradation of coral reefs: are reef fishes at risk or resilient? Global Change Biol 12(11): 2220–2234

Winter A, Appealdoorn RS, Bruckner A, Williams Jr. EH, Goenaga C. 1998. Sea surface temperatures and coral reef bleaching off La Peraguera, Puerto Rico (Northern Caribbean Sea). Coral Reefs, 17(4): 377-382.