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Short Notes

Assessment on Recovery of Coral Reefs in Palk Bay of India After 2019 Coral Bleaching Events– A Case Report

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ABSTRACT

Coral reefs in Palk Bay faced severe bleaching of massive corals due to elevated sea surface temperature which ranges in between 32.0°C-36.0°C during the month of March to May in this year. Data provided maximum 95% of coral bleaching hits Palk Bay reefs that dominantly affect the massive corals *Porites* sp., *Dipsastraea* sp. and *Favites* sp. The main cause of coral bleaching in Palk Bay was increased sea surface temperature during summer. Rapid health monitoring surveys were conducted in three sites of Palk Bay to estimate the coral cover and its associated biota which in turn provide a clear indication of pre beaching bleaching, bleaching and post bleaching status of the reef.

Keywords: Corals, Bleaching, Sea surface temperature, Recovery, Reef resilience.

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INTRODUCTION

Coral reefs are considered as tropical underwater rainforest due to its significant contribution to ecosystem service and economical values which provide livelihood to millions of people all over the world (Cinner et al. 2016, Hughes et al. 2017). Reefs are home and nursery grounds for 25% of all marine organisms in cluding fish. This ecosystem occupies less than 1% of the ocean floor but it provides the shelter 250000 known species including more than 4000 species of fishes and 700 species of corals worldwide. In India, 2546 species of reef fishes and 334 species of hard corals where reported so far. The region of reef ecosystem is the primary productive areas for coastal populations due to the development of both capture and culture fisheries. Species of fish families Serranidae, Lutjanidae and Caringidae are the most commonly exploited fisheries in India reef ecosystem. Theirfore, regular health monitoring of coral reefs is exclusively important to procect it and assess increase threat to this ecosystem.

Unfortunately, the health of tropical reefs undergoes severe mass scale loss due to subsequent bleaching events and local anthropogenic stress over the past few decades (Holbrook et al. 2018, Camp et al. 2018). However, coral reefs in Gulf of Mannar and Palk Bay also faced back to back thermal stress leading to bleaching of corals since 2005 and significant coral mortality was recorded in 2010 bleaching events (Edward et al. 2018). In 2016, Palk Bay and Gulf of Mannar also faced severe bleaching events which doesn't cause mass mortality but 71.0% of corals in Palk Bay completely bleached during this time (Krishnan et al. 2018).In Palk Bay, massive corals are more affected and susceptible to bleaching rather than branching or other forms of corals which are degrading slowly after the post beaching effect of seaweeds on the bleached corals and microbial activity. In recent times, severe heat waves rapidly kills coral animals and dissolute the skeleton structure immediately by the effect of bleaching and microbial activity which quickly transform into a degraded reef and diminish the chances of recovery of corals from the heat stress (Leggat et al. 2019). Therefore, rapid coral reef health monitoring program along the offshore area of Palk Bay was carried out since January 2019 to August 2019 with principal objective of estimating the physico-chemical parameters of reef waters, live and dead coral cover, bleaching vulnerability of corals.

MATERIALS AND METHODS

Three locations (Site1: N09°17.440 E 79°07.995; Site 2: N 09°07.728 E 79°07.915; Site3: N 09°17.548 E 79°08.207) in Palk Bay were selected to evaluate the health status of corals and monthly sampling were done at three locations. A 20m long transects were laid in triplicate to each location and estimate the benthic cover with help of international standard code and procedure for reef survey (English and Wilkinson Baker 1997).

Table1. Month-wise Percentage cover of Bleached and Non Bleached corals in Palk Bay.

Month	Bleached cover	Non bleached cover
Jan	1.50 ± 3.46	95.46 ± 0.36
Feb	1.69 ± 2.50	93.59 ± 2.99
Mar	12.41 ± 3.04	82.16 ± 3.65
Apr	37.41 ± 6.32	61.32 ± 2.56
May	89.45 ± 4.12	7.23 ± 6.56
Jun	71.51 ± 3.95	25.13 ± 5.00
Jul	41.32 ± 2.65	55.62 ± 1.32
Aug	4.63 ± 3.06	92.46 ± 3 00

RESULTS AND DISCUSSION

During January – February 2019, sea surface temperature in Palk Bay ranged between 28.7-31.0°C which abruptly increased to 32.0-36.0°C during March to May, 2019. No bleaching was reported till February 2019 in Palk Bay. After March, 2019,corals in Palk Bay started to bleach slowly and in May 2019, 85.0-93.0% of corals were completely bleached in this reef (Table1). Average live coral cover during the pre-bleaching state was 57.2%. Average bleached coral cover in Palk Bay reef was recorded as 12.41±3.04%, 37.41±6.32%, 89.45±4.12% during

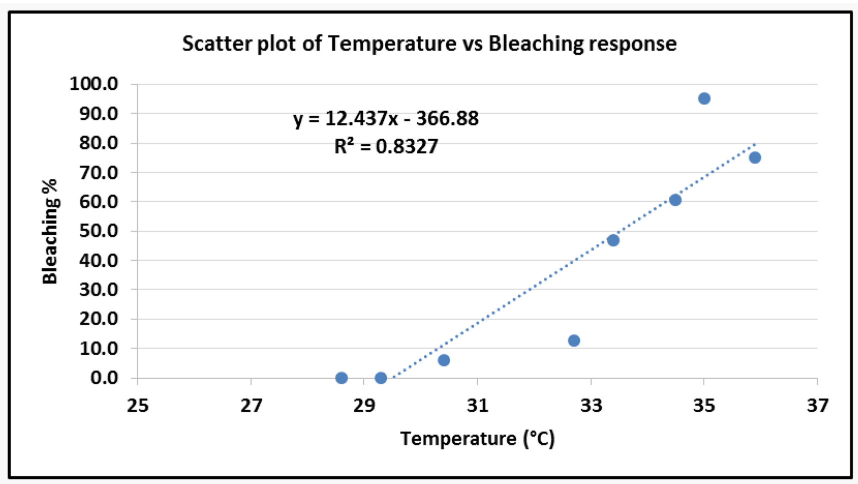

Fig.1. Bleaching response of Palk Bay reef with effect of SST.

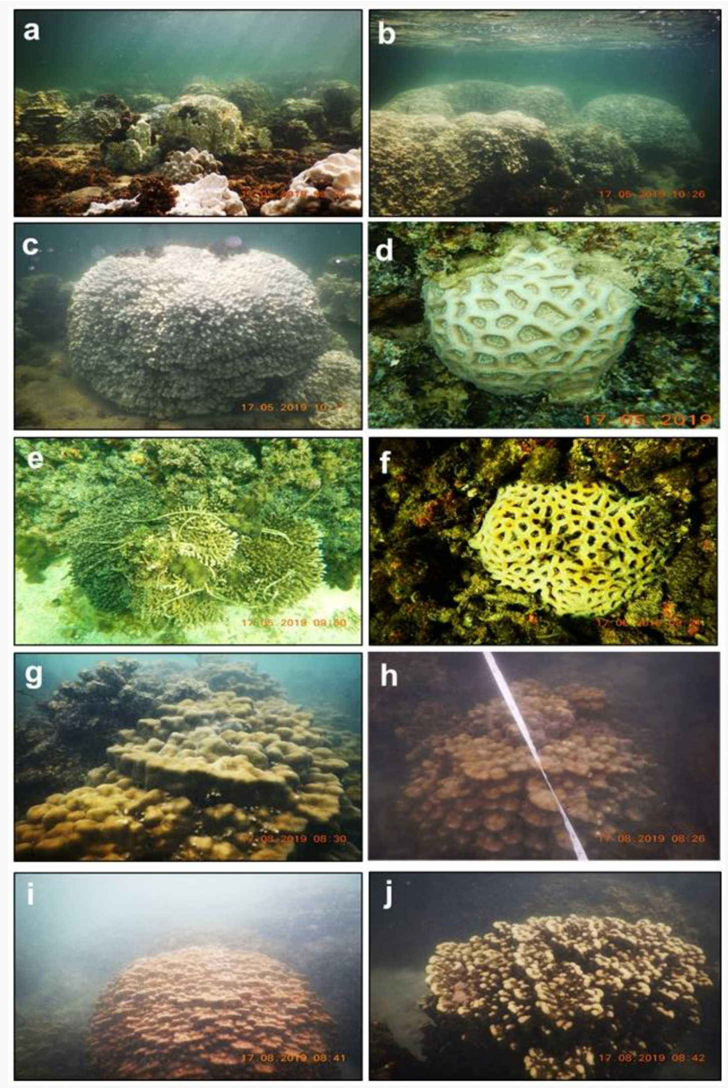

Fig. 2. a-e: Bleaching observed in Palk Bay reef during May 2019. a-c: Massive corals *Porites* sp. d. bleached *Dipsastraea* sp. e. healthy Acropora sp. during May, 2019; f-j: Recovery of bleached corals during August, 2019; f:Recovered *Dipsastraea* sp. from heat stress; g-j: Huge massive corals get back to its healthy condition.

the month of March, April and May respectively (Table1). Interestingly, after May 2019, sea surface temperature was also gradually drop down to 30°C in August whereas, it was recorded 35.9°C in June and 33.4°C in July. Simple Liner Regression analysis in between temperature and intensity of coral bleaching was also estimated which positively correlated (R^2= 0.8327) during this study period. Scatter plot of temperatures (independent variables) against bleaching response (dependent variables) showed that bleaching vulnerabilitytriggers rapidly with abrupt changes in thermal stress and when temperature goes down corals started to recover slowly and complete recovery was found when temperature drop to 30.4°C (Fig.1). Among the coral species, massive corals *Porites* sp., *Dipsastraea* sp. and *Favites* sp. were completely bleached in the reef In coral reefs, recovery of corals from thermal stress mainly depends on the existence of favourable environmental condition and resistance capability of native coral species in those regions (Lundgren 2011). In present study, recorded sea surface temperature during the summer months (March to June) cross over the normal SST ranges upto 5°C which is extremely vulnerable for corals to bleach immediately and as usual coral bleach entirely in Palk Bay reef. But significantly, temperature also drops down to 4-6°C after the month of June and finally in August, temperature reduces upto 30°C. Therefore, such quick response to the environmental changes by corals might be increase their adaptability to fight against the SST anomalies by global warming impacts. According to earlier report, bleaching in Gulf of Mannar and Palk Bay becomes an annual event which doesn't cause mass mortality to the corals but it reduces the resilient capacity of corals (Edward et al. 2018, Krishnan et al.2018). But unfortunately, this annual bleaching due to extreme heatwaves trigger the mass mortality of coral species to many tropical reefs worldwide (Hoegh- Guldberg 1999, Eakin et al. 2009, Leggatet al. 2019). In Palk Bay, bleaching is depth and species specific and annual bleaching mostly affect the massive corals such as *Porites* sp., *Dipsastraea* sp., *Favites* sp. which usually more resilient than branching Acropora corals. Different coral species have different level of stress tolerance due to several dependent factors such as symbiont type and past thermal account of the site which in turn predict the bleaching severity of a reef ecosystem (Guest et al. 2012). Usually, fast growing branching corals *Acropora* sp., *Montipora* sp. and *Pocillopora* sp. are more susceptible to bleaching rather than slow growing massive coral genera such as *Porites* sp. *Dipsastraea* sp., *Favites* sp. (Marshall and Baird 2000, Guest et al. 2012). Interestingly, Acropora corals were not even bleached during 2019 bleaching event observed in Palk Bay reef. No bleaching was observed below the depth of 4m in the reef. Therefore, it might be assumed that consequent bleaching events in Gulf of Mannar and Palk Bay develop the bleaching resistance adaptability in branching corals rather than massive corals. Moreover, massive coral genera *Porites* sp., *Dipsastraea* sp., Favites sp.are also developed resilient capability to restructure the healthy reef in response to favorable environmental condition which happened within three months after bleaching in the present study.Hence this successful recovery of entire Palk Bay reef is an indication of positive reef resilience that helps to develop a successful alternative management of coral reef conservation such as coral restoration program for the local administration responsible for environmental protection. NCCR also take up initiative to continuously monitor the health of coral reefs in Gulf of Mannar and develop effect management intervention strategy, whenever necessary.

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REFERENCES

Camp E.F., Schoep V., Mumby P.J., Hardtke L.A., Rodolfo-Metalpa R., Smith D.J. and Suggett D.J.(2018) The Future of Coral Reefs Subject to Rapid Climate Change: Lessons from Natural Extreme Environments. Front Mar Sci 5:4. doi: 10.3389/fmars.2018.00004.

Cinner J.E., Huchery C.,MacNeil M.A., Graham N.A., McClanahan T.R. and Maina J.etal.(2016)Bright spots among the world's coral reefs. Nature 535:416–419. doi: 10.1038/nature18607.

Eakin C.M., Lough J.M. and Heron S.F. (2009) Climate, weather and coral bleaching. In: ven Open M.J.H. andLough J.M. (eds). Coral Bleaching: Patterns, Processes, Causes and Consequences Springer, Berlin, Heidelberg, 2009, pp. 41—67.

Edward J.K.P., Mathwes G., Raj D., Laju R.L., Bharath M.S., Arasamuthu A., Dinesh Kumar P. Bilgi D.S. and Malleshappa H. (2018) Coral Mortality in Gulf of Mannar, Southeastern India, due to bleaching caused by elevated sea temperature in 2016. Curr. Sci. 114(9): 1967—1972.

English S.C. and Wilkinson Baker V. (1997) Survey Manual for Tropical Marine Resource. Australian Institute of Marine Sciences, Townsville, Australia, pp. 390.

Guest J.R., Baird A.H., Maynard J.A., Muttaqin E. and Edwards A.J. et al.(2012) Contrasting Patterns of Coral Bleaching Susceptibility in 2010 Suggest an Adaptive Response to Thermal Stress. PLoS One 7(3): e33353. doi:10.1371/journal.pone.0033353.

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

Holbrook S.J., Adam T.C., Edmunds P.J., Schmitt R.J., Carpenter R.C., Brooks A.J., Lenihan H.S. and Briggs C.J.(2018) Recruitment drives spatial variation in reef recovery rates of resilient coral reefs. Scient. Reports 8(1):73387348.

Hughes T.P., Kerry J.T.,Álvarez-Noriega M.,Álvarez-RomeroJ.G., Anderson K.D. and Baird A.H.et al. (2017) Global warming and recurrent mass bleaching of corals. Nature 543: 373—377. doi: 10.1038/nature21707.

Krishnan P., Purvaja R., Sreeraj C.R., Raghuraman R., Robin R.S., Abhilash K.R., Mahendra R.S., Anand A., Gopi M., Mohanty P.C., Venkataraman K. and Ramesh R. (2018) Differential bleaching pattern in corals of Palk Bay and the Gulf of Mannar. Curr. Sci. 114 (3): 679—685.

Leggat W.P., Camp E.F.,Suggett J.D., HeronS.F., Fordyce A.J., Gardner S., Deakin L., Turner M. and Beeching L.J.et al. (2019) Rapid coral decay is associated with Marine Heatwave mortality events on reefs.Curr. Biol.29: 1-8. https://doi.org/10.1016/j.cub.2019.06.077.

Lundgren P.(2011) Genetics and genetic tools in coral reef man agement: A synthesis of current research and its application in the management of coral reefs, Research publication no.107, Great Barrier Reef Marine Park Authority, Towns ville.

Marshall P.A. and Baird A.H.(2000) Bleaching of corals on the Great Barrier Reef: Differential susceptibility among coral taxa. Coral Reefs 19: 155—163.