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PURPLE-BLUE PIGMENTATION PRODUCTION AS A SIGN OF IMMUNE RESPONSE BY BLEACHED CORALS TO AVOID STRESS CAUSED BY ELEVATED SEA SURFACE TEMPERATURE

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ABSTRACT

Coral reefs are extensively studied around the world with regard to their taxonomy, distribution, diversity, bleaching events, diseases, conservation, and restoration aspects. However, exhibition of blue pigmentation by corals under certain stressed condition such as high temperature and bleaching events has not been widely investigated. In the present study, during a massive bleaching event of coral reefs in 21 islands of Gulf of Mannar Marine Biosphere Reserve, corals such as *Acropora* sp. and *Turbinaria* sp. and some other encrusting corals have displayed purple blue pigmentation in response to high temperature and to avoid complete bleaching of their food supplying symbiotic zooxanthellae. This documentation from this environment is being reported for the first time and thus further immunological and genomic studies are required to study the variation in the zooxanthellae in bleached and non-bleached corals as well as blue pigment showing and non-pigmented corals. The compound responsible for blue pigmentation is needed to be analyzed further which could be employed for other industrial and biomedical applications.

Contribution/Originality: This study documents the purple blue pigmentation displayed by corals such as *Acropora* sp. and *Turbinaria* sp. and some other encrusting corals in response to high temperature. This is a sign of adaptation of corals to avoid stress and survive from massive bleaching event occurred in Gulf of Mannar, India.

1. INTRODUCTION

Coral reefs are biodiversity rich hotspots in the ocean. Since the early 1980s, coral bleaching had been a major concern for the coral health due to its negative impact on reefs globally. In recent times, the frequently occurring bleaching events caused by climate change are known to damage corals enormously. The increased sea surface temperature (SST) is one of the major factors which triggering coral bleaching, where the symbiotic zooxanthellae (Symbiodinaecea) living inside the tissues of corals are expelled out due to unfavorable and stressed environmental conditions. Massive coral bleaching events destroying many reef habitats around the world were reported during 1998, 2005 to 2010 and 2016 [1]. Coral reefs in Gulf of Mannar Marine Biosphere Reserve (GOMMBR), Southeast coast of Tamil Nadu, India, are facing potential threats from bleaching events, sedimentation, invasive algal blooms and boring organisms like sponges. Recently, despite no El Niño, massive coral bleaching event have also been recorded in Australia, French Polynesia and GOMMBR due to elevated SST in 2019. Corals display different colours such as pink and blue due to various stress factors including damage or breakage of coral fragments, fish

bites, sedimentation, coral interactions, and algal growth [1, 2]. During a massive bleaching event 2019, distinct blue pigmentation exhibited by different corals in GOMMBR is documented for the first time and being reported in this study for further investigations.

2. MATERIALS AND METHODS

Field surveys were performed in 17 Islands under Mandapam, Keezhakkarai, Vembar and Tuticorin regions of Gulf of Mannar Marine Biosphere Reserve, southeast coast of Tamil Nadu, India. Underwater surveys were conducted by SCUBA diving and snorkelling and bleached corals with distinct and unusual purple blue pigmentation were photographed using Nikon Coolpix. Blue pigmentation usually occurring live *Acropora* corals is distinct from blue pigmentation occurring during bleaching events. Pigmentation was differentiated in underwater observations meticulously. Water temperature was recorded using Manta+ Water Quality Sonde instrument.

3. RESULTS AND DISCUSSION

During the bleaching event, different corals such as *Porites* sp., *Acropora* sp., *Turbinaria* sp., encrusting *Porites* sp. and digitate *Acropora* sp. Figure 1a-g respectively, are observed to produce purple or violet blue pigmentation in response to elevated SST. Production of purple blue pigmentation in corals is due to immune response of coral tissues to various stresses like sedimentation, entanglement of fish nets and interaction of coral fragments [1, 2]. However, in this study, we observed that this pigment production in bleached corals is due to elevated SST. This occurred in response to heatwave during summer 2019, recording maximum temperature range of 32°C to 36°C. During this bleaching event many *Porites* sp., *Acropora* sp., *Turbinaria* sp., encrusting *Porites* sp. and digitate *Acropora* sp. corals displayed this blue pigmentation.

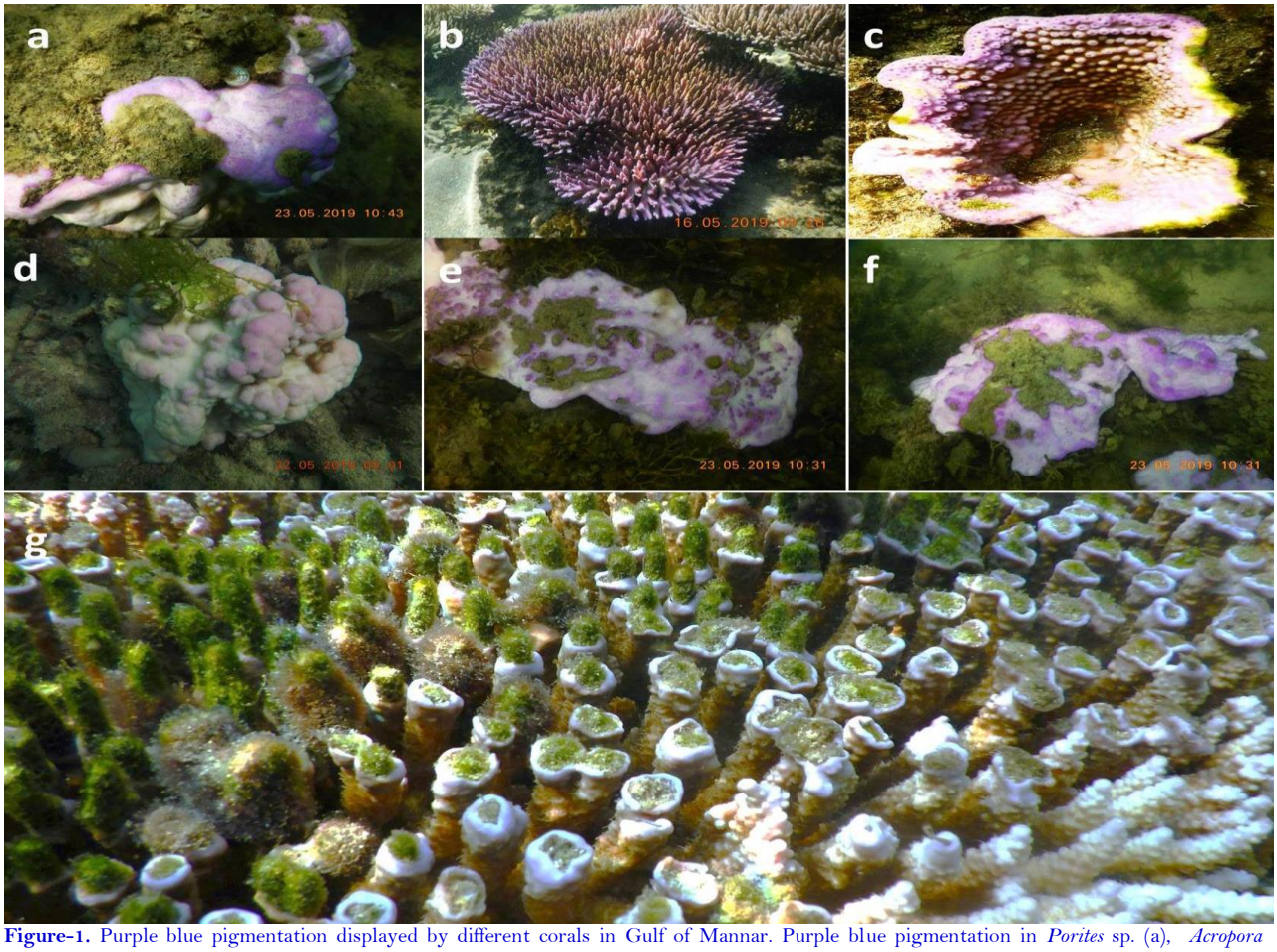

Figure-1. Purple blue pigmentation displayed by different corals in Gulf of Mannar. Purple blue pigmentation in *Porites* sp. (a), *Acropora millepora* (b), *Turbinaria* sp. (c), encrusting *Porites* sp. (d-f), and digitate *Acropora* sp. (g).

The observed pigmentation is not due to change of growth patterns (resting one coral tissue on another coral fragment), or mechanical disturbances, or worms infestations, and not similar to reflecting the expression patterns in axial polyps or other actively growing colony parts; but such observations were recorded in previous study [3]. However, in the present study the blue pigmentation is solely due to environmental stress caused by heatwave. This pigmentation was not due to trematodes infestation and there was no sign of presence of trematodes. The role of this blue pigmentation in these corals is likely to act as photoprotection for symbionts colonizing the newly grown tissues or might be indication of stress; as these similar observations were reported in previous studies [4, 5]. Although pink pigmentation is commonly seen many corals, some corals like pocilloporins display blue pigmentation upon reduction in zooxanthellae in the coral tissues [6]. In *Acropora eurystoma* from Eilat, Red Sea, the pink-blue spot syndrome is considered as a possible stress marker [4] and in *A. millepora* blue pigmentation occurs when breakage of coral fragments occurs [2]. Thus further biochemical and immune protein analysis of these corals are needed to perform to understand the role of pigmentation in avoiding stress conditions like elevated temperatures effectively.

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