

Short Communication

Underwater bloom of toxic cyanobacterium *Lyngbya majuscula* Harvey ex Gomont, 1892 on coral reefs in Hare Island, Gulf of Mannar Marine Biosphere Reserve

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Tuft blooms of toxic cyanobacterium *Lyngbya majuscula* Harvey ex Gomont, 1892 prevalence was documented from coral reefs of southern Hare Island in Gulf of Mannar region, south east coast of Tamil Nadu. *Lyngbya majuscula* was observed to be overgrowing and dominating dead coral reefs, rubble, rocks, and other floral substrates. The persistence of *L. majuscula* blooms on dead reefs in southern Hare Island appears to inhibit coral recruitment, as evidenced by the presence of coral recruits in bloom-free areas and their absence in areas with blooms. Further, long-term monitoring and seasonal studies are needed to understand the impact of *L. majuscula* blooms on reef structure and communities.

[**Keywords:** Cyanobacteria, Gulf of Mannar, Hare Island, *Lyngbya majuscula*, Underwater blooms]

Introduction

Coral reefs are hotspots of marine biodiversity providing livelihood to coastal communities around the world. Such an important ecosystems found around the world are reportedly being destroyed due to the impacts of global climate change. Therefore restoration of corals is an alternative and essential step to rebuild the dead reefs. Assessment of underwater reef biota is also a key step to avoid contact of bloom forming toxic algae and other invasive sponges with recruiting corals. Marine cyanobacterial species have both negative and positive effects on corals and coral reef communities¹. In recent times, harmful algal blooms, particularly the benthic blue green cyanobacterial genus *Lyngbya* have become a severe threat to coral reef environments². This cyanobacterial genus *Lyngbya* can form blooms abundantly under favourable environmental conditions such as light, temperature and nutrients via aerobic

nitrogen fixation. Significantly, *Lyngbya majuscula* has been reported around the world to cause smothering to corals in tropical and subtropical reefs in recent times²⁻⁴.

Although Gulf of Mannar (GoM) has been explored greatly by several authors, yet many other research areas particularly biodiversity of cyanobacterial species from reef environment are still to be disclosed. Reportedly, the non-heterocystous cyanobacterial species, *Lyngbya majuscula* was observed as epiphyte on *Kappaphycus alvarezii*⁵. Toxic *Trichodesmium* bloom causing 100 % mortality to *Artemia salina* was reported from the coastal waters of Gulf of Mannar⁶. Several other bloom forming dinoflagellate and cyanobacterial species documented along the Indian coast were also reported in a review⁷. However, blooms formed in the coral reef environment were less studied, because not many researchers are working on coral reef associated algae and invasive species. Therefore, this study have initiated studying the impact of cyanobacterial blooms on coral reefs of GoM.

Material and Methods

Field surveys were performed in three islands viz. Hare Island, Manoli and Manoliputti Islands in Mandapam group of islands under GoM, during October and November 2018. Underwater observations were carried out by snorkelling and diving. The Line Intercept Transect (LIT) method was used by employing a 10 meter long tape measure to survey coral cover, species composition, and other reef characteristics. Tuft blooms of cyanobacteria *Lyngbya majuscula* found along the transect were observed at southern part of Hare Island (09°11.779' N and 079°04.420' E) and was recorded using underwater camera Nikon Coolpix. Interactions of this toxic *Lyngbya majuscula* bloom with other invasive macroalgae were also documented by underwater photography. Species identification was made based on previously published taxonomic literature and descriptions⁴.

Results and Discussion

Blooms of marine benthic toxic cyanobacteria, *Lyngbya majuscula* overgrowing both live and dead branching corals were observed in southern side of the Hare Island in the Gulf of Mannar region (Fig. 1).

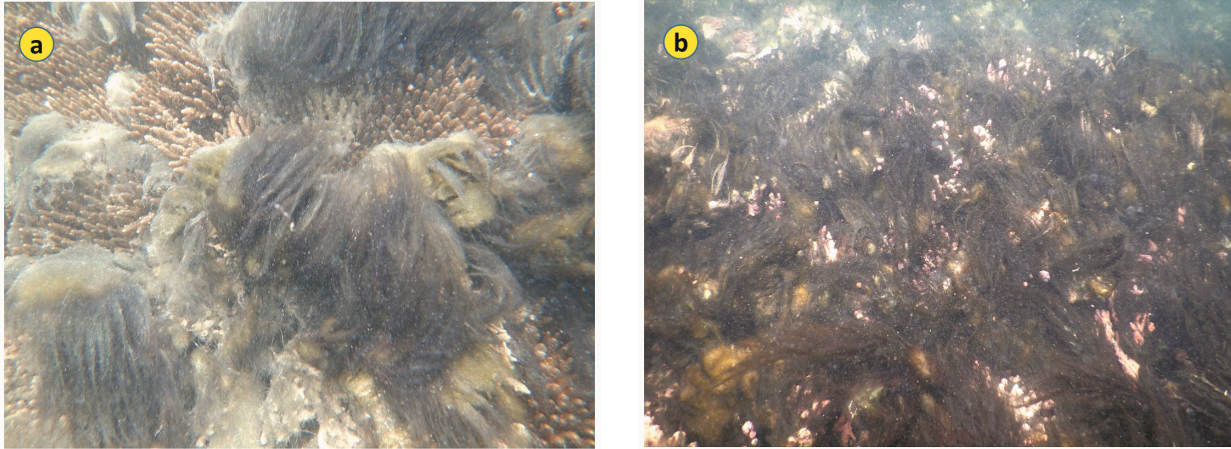


Fig. 1 — (a) *Lyngbya majuscula* overgrowing live *Acropora hyacinthus*; and (b) Continuous bloom of *L. majuscula* overgrowing dead *Acropora* reef

Interestingly, this cyanobacterium was not observed either on northern side of Hare Island nor in its near-vicinity islands (Manoli and Manoliputti Islands). The bloom was predominant in southern part of Hare Island (09°11.779' N and 079°04.420' E), occupying about 90 % of the investigated reef site in a 10 m transect. Its occurrence in the southern Hare Island was observed as patches and continuous on dead reef as well as on live corals. During the underwater surveys, the *L. majuscula* interactions with other bloom forming macroalgae like *Turbinaria ornata*, *Caulerpa sertuloides* and *Halimeda opuntia* (Fig. 2) were also documented.

The close association of this species with the dead reef area suggests that it may be playing a role in suppressing coral recruitment in that area. As indicated in previous studies, *Lyngbya* sp. is unpalatable to grazers and herbivore organisms because of deterring toxic compounds¹. Observations of current study suggest that *Lyngbya* sp. is an opportunistic invasive species, characterized by its rapid colonization and dominance over the dead reef area, thereby pre-empting the settlement of new coral polyps and hindering the natural regeneration process. This is consistent with the typical traits of opportunistic invasive algal species, which often exhibit fast growth rates, high reproductive capacity, and the ability to outcompete native species for resources; ultimately leading to the displacement of native coral communities and alteration of the ecosystem's structure and function. A previous study reported that blooms formed by dinoflagellate *Noctiluca scintillans* have resulted oxygen depletion leading to bleaching in corals⁸. Although the current

study haven't found bleaching of corals, it was observed that *Lyngbya* blooms found to cause smothering to corals. This might be the reason for declined recruitment of corals on dead corals occupied by *Lyngbya* blooms. While, recruitment of corals was obvious in *Lyngbya* free dead reef areas. Therefore, further observations are being monitored.

Few studies have found abundant distribution of cyanobacterial species including *Lyngbya* sp. in different estuarine waters in southeast coast of Tamilnadu^{9,10}. An earlier study reported its occurrence in various locations of Gulf of Mannar Marine Biosphere Reserve and found its negative impacts such as smothering, tissue damage, and tissue decolouration on major reef building corals *Porites*, *Acropora*, *Montipora*, *Echinopora*, and various other corals¹¹. However, apparently there was no estuary or discharges from terrestrial source in this study area. The formation of *Lyngbya majuscula* blooms is likely attributed to favourable local environmental conditions, which may have triggered or exacerbated their growth and proliferation. Coral reef associated fauna are known to feed on these bloom forming algae on dead and live reefs¹². Dead reefs provide a critical opportunity for coral recruitment, a crucial step in reef recovery. However, the outcome of the competition for space between corals and algae will ultimately determine the fate of the reef. If algae continue to dominate, as is the case with persistent algal blooms, it is likely that dead reefs will be transformed into 'ghost reefs' – barren, algae-covered landscapes devoid of coral life. This alarming prospect highlights an urgent need for effective management and conservation strategies to prevent the irreversible degradation of our coral reefs. Therefore, a long term reef monitoring is needed to

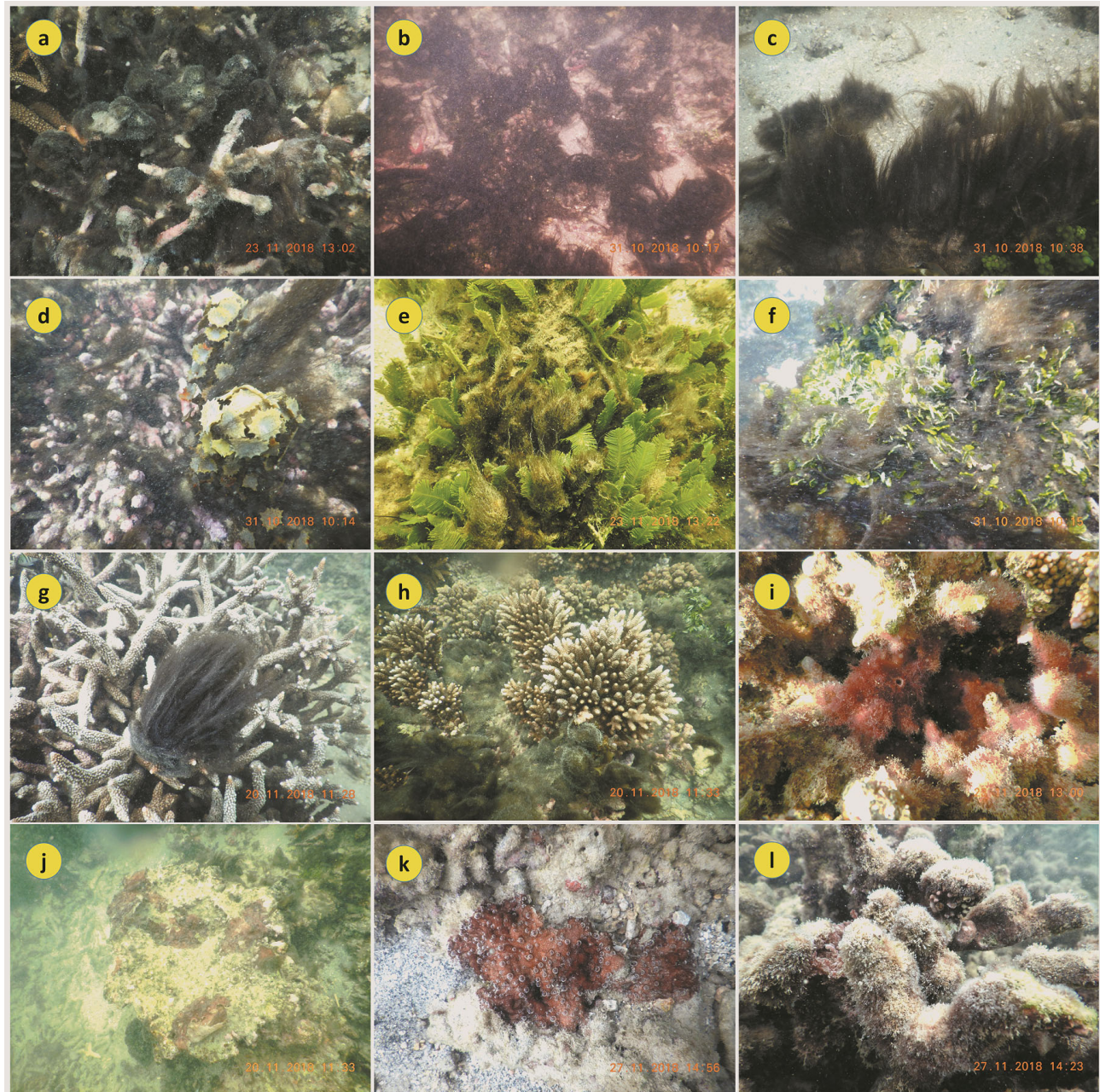


Fig. 2 — Interaction of *L. majuscula* with corals and macroalgae: (a) *L. majuscula* overgrowing dead *A. formosa* coral; (b) Profuse growth on coral rubbles; (c) Dead *Porites* sp. occupied by *L. majuscula*; (d) Interaction with *T. ornata*, (e) *C. sertuloides*, and (f) *H. opuntia*; (g) Live *A. formosa* with *Lyngbya*, and (h) *A. cytherea*; Cyanobacterial species growing on dead corals: (i) *Moorea* sp.; (j & k) Mats of *Leptolyngbya* sp. with air bubbles; and (l) Microfilamentous algae on dead *Acropora*

understand *Lyngbya* sp. dynamics in reef flat and its impact on corals and reef associated flora and faunal diversity. A recent study also showed *Lyngbya* sp. as a prolific producer of anticancer and anti-inflammatory compounds for biomedical applications^{13,14}. Therefore, these tuft filamentous cyanobacteria may be collected for biomedical applications. Further future research is aimed to study

seasonal distribution, genetic diversity and abundance of *Lyngbya* sp. from GoM group of islands to assess the extent of negative impacts on coral reefs and phase shift of coral species.

Acknowledgments

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Conflict of Interest

Authors do not have any conflict of interest.

Ethical Statement

Research permit on coral reefs has been obtained from the Principal Chief Conservator of Forests and Chief Wildlife Warden, Government of Tamil Nadu, Gulf of Mannar Marine National Park.

Author Contributions

CHR, KS & TS did field surveys. CHR: Conceptualization, manuscript writing, and visualization. TS, SK, & MVRM did manuscript editing and approval of the final version. TS & MVRM monitored the research.

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