Incursion of killer sponge *Terpios hoshinota* on the coral reefs of Lakshadweep archipelago

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Abstract

Our study documents the outbreak of killer sponge *Terpios hoshinota* on the coral reefs of Lakshadweep archipelago and highlights that the killer sponge has further extended its territory in the isolated atolls of the Indian subcontinent.

Introduction

Coral killing sponges have the potential to overgrow live corals, eventually killing the coral polyps, and thus leading to an epidemic⁴. The cyanobacteriosponge *Terpios hoshinota* Rützler & Muzik, 1993 first reported from Guam¹ and later described from the coral reefs of the Ryukyu archipelago (Japan)², is identified by its gray to blackish encrustations. Since its first occurrence, it has been observed in several coral reef localities around the globe viz. the Great Barrier Reef³, Papua New Guinea⁴, Taiwan⁵, Philippines⁶, Indonesia⁷, South China Sea⁸⁻¹⁰, Thailand⁹, Palk Bay (PB)/Gulf of Mannar (GOM) (India)¹¹⁻¹³, Maldives¹⁴, Mauritius¹⁵ and our present observation, confirms that the species has further extended its habitat into the pristine atolls of Lakshadweep (Figure 1) (Indian Ocean) and requires urgent attention.
Results and Discussion

During the coral reef surveys conducted at Lakshadweep in November 2016, Terpios hoshinota was observed overgrowing on several colonies of Acropora formosa, Acropora palifera, Cyphastrea sp., Favia lizards and Porites lutea (Figure 2 and 3) in the atoll encircling Bangaram and Thinnakara Islands. Out of 33 stations surveyed, 6 stations exhibited the presence of T.hoshinota incrustations (Figure 1). The coral colonies in the atoll were patchy and the depth varied between 2 to 12 meters. As depth increased, (i.e. >5 m) large boulder corals were observed whereas the shallow regions (<5 m) had greater coral diversity. Certain areas consisting of large Acropora beds, rocks, rubbles and dead reef were also observed. The affected corals displayed grayish/blackish encrustations of T.hoshinota forming a mat-like layer on live corals taking the shape of the coral in all cases. The osculum in the sponge, a primary character with a radiating network was clearly visible, the thickness of the mat was less than 1mm (Figure 1a). It was observed that the encrustations were propagating laterally and infecting the other live coral colonies. Further, in some colonies along with T.hoshinota, algal presence was also noted (Figure 3a) but the sponge was absent in the colonies which were completely covered with turf (Figure 3b). Other associated communities such as ascidians and clams remain unaffected but interestingly the calcareous serpulid tubes, though overgrew by the Terpios like sponge, the animal was unharmed (Figure 2d). Environmental parameters assessed in the atoll revealed that the area was unpolluted with an optimum level of dissolved oxygen (5.04~8.21 mg/l), and low turbidity (0.3 to 0.8 NTU). Sea surface temperature (SST) during the survey was 28.2°~30.1°C. It is important to note that, Bangaram and Thinnakara is one of the few atolls in Lakshadweep where tourism is permitted, as a result, limited amounts of diving and other water-related recreational activities can be seen in the area.

Previous studies suspected that the outbreak of T.hoshinota is related to increased water turbidity or due to high anthropogenic stress/pollution and its close proximity to mainland as seen in the south eastern reefs of India (~800km from Lakshadweep), in Guam and in Green island. However,
a similar conclusion cannot be applied in the case of Lakshadweep because of its isolated geography\(^{18}\) and
with comparatively less anthropogenic activities. As a result, our observation contradicts the above
statements and is more in line with the findings of Shi et al.\(^{8}\) who observed *T.hoshinota* outbreak in
unpolluted areas of Yongxing Island (South China Sea), highlighting the difficulty in establishing
negative co-relationship between water quality and killer sponge outbreak (Sun-Yin Yang pers comm.).
In terms of host selectivity, the killer sponge has affected several coral species in different parts of the
world\(^{11,13,15}\) and in the reefs of Palk Bay (PB), it has affected all genus surveyed\(^{11}\). In Vaan Island
(GOM) the dominant genus *Montipora* was the most susceptible\(^{13}\). Our observation though could not
reveal any specific host coral selectivity, we can speculate that the dense *Acropora* (ACB) beds in station
3, 5 and 6 were more easily overgrown because the killer sponge prefers branching corals as reported
from Mauritius\(^{15}\). We would further conclude that the coral composition in any specific location may play
an important role in determining its host.

*Terpios hoshinota* is a belligerent contender for space\(^{6}\) and is known to overgrow corals from its
base where it interacts with turf algae\(^{15}\). In stations 3, 5 and 6 (Figure 3a), we observed ACB colonies
with both algae (e.g. *Ceratodicyton repens*, *Dictyota* sp.) and killer sponge, however, the observation of
a massive turf algal cover dominating an area of ~0.35km of *Acropora* bed in *T.hoshinota* occurrence site
station 5 and 6 indicates towards a much complex ecological scenario. Such complexity between sponges,
corals and algae can be only understood through long term monitoring. Gonzalez-Rivero et al.\(^{19}\) stated
that sponges can act as a potential group that can facilitate and influence coral-algal shifts by acting as a
"third antagonist" as observed in Glover’s atoll (Belize). Based on our knowledge of the life history of
*T.hoshinota* we can just hypothesize the scenario in station 5 and 6 as follows: - (1) *T.hoshinota* invades
and overgrows the *Acropora* beds → (2) The coral dies which is followed by the death of the killer
sponge → (3) Turf algae takes over. (Figure 3a, b). Moreover, reports of turf algae being a dominant
component in the atolls\(^{18}\) might indicate towards a faster transition. Globally Elevated SST is a major
threat to coral reefs\(^{20}\), and the reefs of India\(^{21,22,23}\) including the atolls\(^{24}\) are no different. With reports
indicating that elevated SST has already depleted the coral ecosystem of Lakshadweep, which was
evident during 1998\textsuperscript{18}, 2010\textsuperscript{24} and 2016\textsuperscript{20} mass bleaching events, it can provide an opportunity for
sponges to invade\textsuperscript{25}. Dynamics of water flow\textsuperscript{18} may also play a crucial role in this regard.

**Conclusion**

Our findings confirm that the infestation of *T.hoshinota* on the coral colonies of Lakshadweep is
currently limited to only Bangaram and Thinnakara atoll as it was not observed in other islands surveyed.
There is although a possibility that the killer sponge could invade nearby atolls as seen in other
regions\textsuperscript{126}. Our observation is indeed the first documentation of *T.hoshinota* on the reefs of Lakshadweep
and can be regarded as a baseline for subsequent studies in the islands. Further, to protect the reefs of
Lakshadweep, coral health monitoring is required which will allow us to understand the nature of
occurrence, distribution, the impact and the causative factors of the killer sponge as well as other coral
diseases as per which various coral reef management plans can be initiated.

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**References**

Figure 1. Bangaram & Thinnakara Atoll (Red star); killer sponge infested areas (1-6) (QGIS 3.0.1)
Figure 2. Incrustations of T. hoshinota (A) Acropora formosa, A1. T. hoshinota exhibiting osculum with radiating networks (B) Incrustation on A. palifera, B1. T. hoshinota mat, B2. Bleached ring, B3. Live coral (C) T. hoshinota taking shape of a Coral (Cyphastrea sp.) (D) Terpios hoshinota overgrowing calcareous serpulid tubes, animal unaffected.

Figure 3. Acropora colonies (Station 3) A1. T. hoshinota A2. Algae (B) Acropora colonies (Station 5) completely over grown by turf algae, killer sponge absent.