out-spacing of the native species[19]. The entire process depends on various environmental factors, including the favourable condition of the alien species to proliferate, which vary with different geographical locations. In Hawaii, *C. riisei* has been reported[8–10] to dominate the black coral (*Antipathes* sp. and *Myriopathes* sp.) community at a depth of 70 m. In Columbia, it was reported to outcompete other soft coral species[7], indicating the invasive potential of *C. riisei*.

The distribution of *C. riisei* has been reported in India only in recent years, and the studies do not establish its state of dominance, out-spacing any native species or rapidity of change or its impact on the reef ecosystem. Padmakumar *et al.*[12] reported that 2.16% of the reef area of Poovarasanpatti Island in the Gulf of Mannar is covered by *C. riisei*. The study reports the occurrence of the species in Grande Island as a new locational record and could not assess the impact on the reef due to lack of baseline data on the reef health.

It is desirable to undertake coordinated and concerted research to monitor the reef health in all sites where the occurrence of *C. riisei* has been reported, in order to conserve the fragile reef ecosystem of the country, already challenged with large-scale climatological and environmental changes. Though the present study does not contest the invasive potential of *C. riisei*, as reported from various parts of the world, it calls for a systematic genetic profiling of the said species in order to scientifically prove its evolutionary origin and nativity, so as to put to rest the claims on biological invasion of Indian reefs by this ‘alien coral species’.

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SHESDEV PATRO
P. KRISHNAN
M. GOPI
S. RAJA
C. R. SREERAJ
PURVAJA RAMACHANDRAN
R. RAMESH*

National Centre for Sustainable Coastal Management,
Ministry of Environment, Forest and Climate Change,
Koodal Building,
Anna University Campus,
Chennai 600 025, India
**For correspondence.*
e-mail: rramesh_au@yahoo.com

Intrusion of coral-killing sponge (*Terpios hoshinota*) on the reef of Palk Bay

Coral disease, epizootics, bleaching and bioinvasions are threatening the persistence of coral reefs world over, including India[1-4]. Now sponge overgrowth on corals has also been included in the list of serious threats at various geographical locations[5]. The first encrusting cyanobacteria sponge *Terpios hoshinota* outbreak was reported from Guam[6], which is expanding its range and causing mortality ranging from 30% to 80% in coral reefs of various geographical locations. Recently invaded reefs include the Great Barrier Reef (Australia), some reefs in Philippines, America, Taiwan, Japan and Maldives[7–11]. As a result, *T. hoshinota* is now well recognized as a potential threat to the survival of corals and other associated organisms, consequently creating serious concerns about its unchecked geographical expansion.

In August 2014, assessment was carried out in Palk Bay (09°20′052″N, 79°17.468″E) up to a maximum depth of 5 m and at an average depth of 3 m between. After *T. hoshinota* growth was noticed, five sites were randomly selected to quantify sponge overgrowth signs in coral colonies. Five 20 × 4 m line

Figure 1. ***a***, Numerous *Terpios* spicules associated with black coloured mat. ***b***, Spicules of *T. hoshinota* showing lobed head of tylostyle spicules. ***c***, Close-up view of lobed head tylostyle and sharp pin view of the spicules.

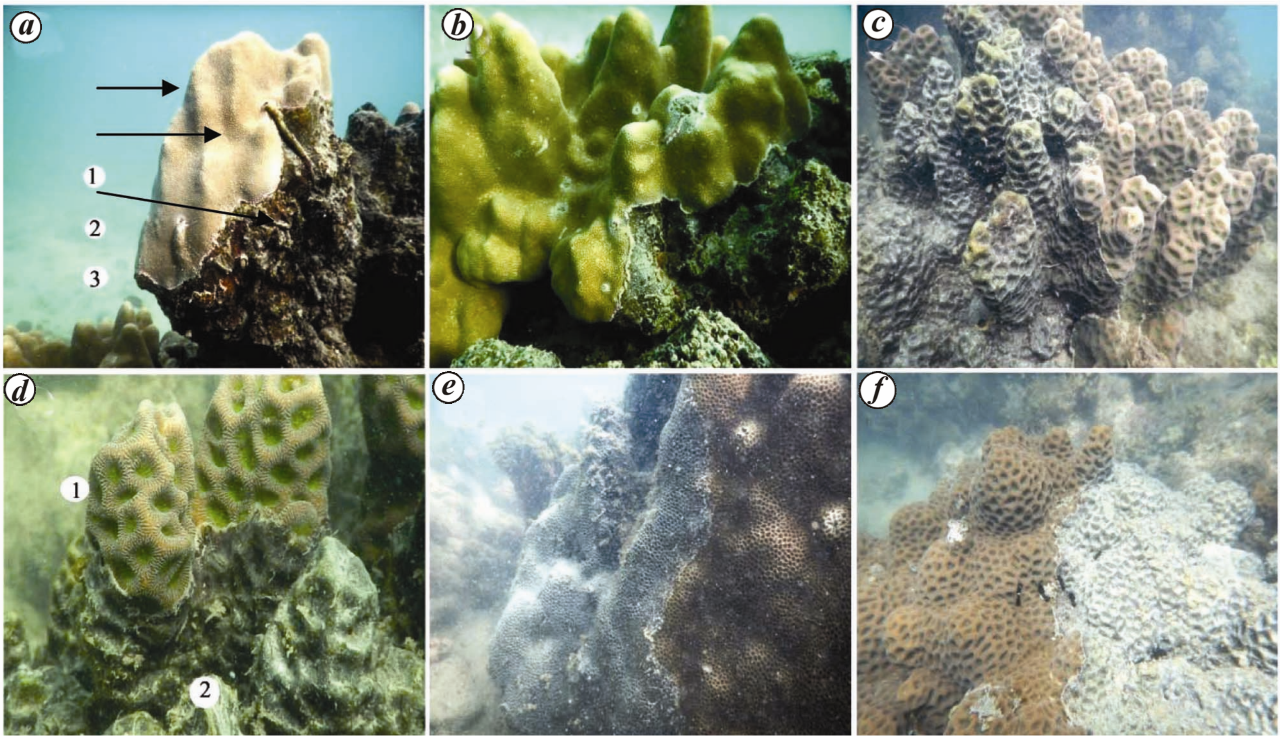

Figure 2. Some *Terpios*-affected coral colonies in the study site. ***a*** and ***b***, Affected *Porites* colonies. (***a***) (1), healthy portion of the coral; (2), portion covered by active *Terpios* and (3) recently dead portion of the coral colony covered by black coloured mat. ***c–f***, Other affected *Favites* colonies. (***d***) (1) Healthy portion of *Favites*; (2) recently dead portion of the coral colony turning pale white.

intercept transects were placed end to end parallel to the reef crest, with a gap of at least 20 m between the transects. Total healthy and sponge-affected colonies were counted to calculate sponge overgrowth percentage (per cent corals with lesions)[12].

Prevalence = Total number of colonies/Number of infected colonies $\times$ 100.

In situ identification of *T. hoshinota* was performed based on morphological characteristics by following the diagnostic characters described by Rutzler and Muzik[7]. For *ex situ* confirmation of identification, a small portion of the mat was peeled-off from the active portion and was placed in sterile 100 ml centrifuge tube at 4°C, transported to laboratory and preserved in 70% ethanol at –20°C until further analysis.

The mat was washed in distilled water twice to remove ethanol and then 30% 1.5 ml sodium hypochlorite solution was added to digest the sample. After 1 h the sample was centrifuged at 3000 rpm for 5 min (Eppendorf). The suspension was used for the microscopic observation to identify the species-specific, distinctive spicules and cyanobacteria[13]. The remaining mat was stored in ethanol to confirm endosymbiotic cyanobacteria[13].

The observed smothering mat was brownish-black in colour, the active band was 1 mm thick and recently dead colonies were pale white in colour. Microscopic observation of blackish smothering mat collected from the study site revealed the presence of many long and slender spicules with typical pin-shaped tylostyle

(Figure 1 *c*). The tylostyle spicule exhibited a lobed head with four knobs perpendicular to each other (Figure 1 *c*). Numerous coccoid (2–4 μm in size) internal symbiotic cyanobacteria were observed and this confirmed that the blackish encrusting mat in the corals of Palk Bay belongs to *T. hoshinota* associated with cyanobacteria.

T. hoshinota colonies were found in all the observed study sites. Out of 340 colonies observed, 108 (31.7%) were found affected by *T. hoshinota*. Irrespective of genus and species, all the observed genera (*Symphylia*, *Porites*, *Acropora*, *Platygyra*, *Favia* and *Favites*) were found to be affected by this sponge overgrowth with varying percentage. Few of the colonies were completely covered by *T. hoshinota* (Figure 2).

The morphology of *T. hoshinota*-affected corals was similar to the black band-like disease described in earlier studies[14]. As those studies were not confirmed by microscopic analysis, there could be a possibility of *T. hoshinota* outbreaks. All the observed genera were invariably affected by this sponge, which reveals its multi-host nature as reported from other locations[7].

No signs of recovery in the affected colonies were noticed in the study site as also reported in previous studies[7]. Overall, *T. hoshinota*-affected percentage of coral colony in the study site was above 31. This is higher than the report from Japan[7]. Pollution, overfishing and turbidity were the main factors responsible for the outbreak of this sponge intrusion[13,14]. *T. hoshinota* outbreaks in Palk Bay are likely to be higher due to anthropogenic activities, including pollution, fishing, harbour activities, trap fishing, anchoring, seaweed culture, its proximal nature to the mainland and more importantly, the area not having been included in the marine protected areas[15,16].

T. hoshinota not only kills the corals, but grows over other benthos, which prevents new coral recruitment in the affected area[7]. Though prevalence is low in the present study area, it can cause huge mortality in the affected area once the conditions become favourable because of its larvae-producing capacity and better immunity than corals[17]. Already Palk Bay reefs are in a serious state of decline because of overfishing, disease and recent emergence of various unknown factors[16,18]. Hence, this intrusion of *T. hoshinota* could cause coral reef mortality in Palk Bay and the nearest marine national park (Gulf of Mannar, dominant number of corals present in the shallow water depths less than 6 m) because of its geographical position and connectivity with Palk Bay through a channel. Therefore, further studies are needed to understand the ecology on local scale at the Palk Bay and Gulf of Mannar on shallow reefs. Simultaneously, experimental research on corals needs to be initiated to understand the factors responsible for *T. hoshinota* overgrowth. These could form baseline data for management plan to save the corals from further *T. hoshinota* spread and prevent the sponges from reshaping the reefs.

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T. THINESH[1,*]
P. ARUL JOSE[2]
SAQIB HASSAN[1]
K. MUTHAMIZH SELVAN[3]
J. SELVIN[1]

[1]*Department of Microbiology, Pondicherry University, Puducherry 605 014, India*
[2]*Department of Molecular Microbiology, Madurai Kamaraj University, Madurai 625 021, India*
[3]*Department of Ecology and Environmental Sciences, Pondicherry University, Puducherry 605 014, India*
**For correspondence.*
e-mail: thina.sathesh@gmail.com