Journal of Threatened Taxa

Building evidence for conservation globally

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

SHORT COMMUNICATION

INCURSION OF THE KILLER SPONGE *TERPIOS HOSHINOTA* RÜTZLER & MUZIK, 1993 ON THE CORAL REEFS OF THE LAKSHADWEEP ARCHIPELAGO, ARABIAN SEA

Rocktim Ramen Das, Chemmencheri Ramakrishnan Sreeraj, Gopi Mohan, Kottarathil Rajendran Abhilash, Vijay Kumar Deepak Samuel, Purvaja Ramachandran & Ramesh Ramachandran

26 October 2020 | Vol. 12 | No. 14 | Pages: 17009–17013
DOI: 10.11609/jott.5790.12.14.17009-17013

For Focus, Scope, Aims, Policies, and Guidelines visit https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-0
For Article Submission Guidelines, visit https://threatenedtaxa.org/index.php/JoTT/about/submissions#onlineSubmissions
For Policies against Scientific Misconduct, visit https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-2
For reprints, contact <ravi@threatenedtaxa.org>

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 October 2020 | 12(14): 17009–17013
ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)
DOI: https://doi.org/10.11609/jott.5790.12.14.17009-17013
#5790 | Received 19 February 2020 | Final received 03 October 2020 | Finally accepted 07 October 2020

SHORT COMMUNICATION

Incursion of the killer sponge *Terpios hoshinota* Rützler & Muzik, 1993 on the coral reefs of the Lakshadweep archipelago, Arabian Sea

Rocktim Ramen Das [1], Chemmencheri Ramakrishnan Sreeraj [2], Gopi Mohan [3], Kottarathil Rajendran Abhilash [4], Vijay Kumar Deepak Samuel [5], Purvaja Ramachandran [6] & Ramesh Ramachandran [7]

[1–7] National Centre for Sustainable Coastal Management, Ministry of Environment, Forest and Climate Change, Chennai, Tamil Nadu 600025, India.
[1] Graduate School of Engineering and Science, University of the Ryukyus, Nishihara 903-0213, Okinawa, Japan.
[1] k188604@cs.u-ryukyu.ac.jp, [2] crsreeraj@gmail.com, [3] gpsakthi@gmail.com, [4] abhilaashkr@gmail.com, [5] deepakocean@gmail.com (corresponding author), [6] purvaja.ramachandran@gmail.com, [7] rramesh_au@yahoo.com

Abstract: Our study documents the outbreak of a coral-killing sponge *Terpios hoshinota* in the coral reefs of Lakshadweep archipelago and highlights that it has further extended its territory into the isolated atolls of Arabian Sea and maybe a growing threat to the existing coral reefs in the region.

Keywords: Atoll, Black disease, Indian Ocean.

Abbreviations: GOM—Gulf of Mannar | PB—Palk Bay | QGIS—Quantum Geographic Information System.
*The terms Black disease and Killer sponge are used synonymously.

Coral killing sponges have the potential to overgrow live corals, eventually killing the coral polyps, and thus leading to an epidemic (Bryan 1973). The cyanobacterio sponge *Terpios hoshinota* Rützler & Muzik, 1993 also known as the black disease* (Liao et al. 2007) first reported from Guam (Bryan 1973) and later described from the coral reefs of the Ryukyu archipelago (Japan) (Rützler & Muzik 1993) 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 Reef (Fujii et al. 2011), Papua New Guinea (Ekins et al. 2017), Taiwan (Liao et al. 2007), Philippines (Plucer-Rosario 1987), Indonesia (De Voogd et al. 2013), South China Sea (Shi et al. 2012; Hoeksema et al. 2014; Yang et al. 2018) , Thailand (Plucer-Rosario 1987), Palk Bay (PB)/Gulf of Mannar (GOM) (India) (Thinesh et al. 2015, 2017; Raj et al. 2018a), Maldives

Editor: M. Nithyanandan, Kuwait Institute for Scientific Research (KISR), Salmiya, Kuwait. **Date of publication:** 26 October 2020 (online & print)

Citation: Das, R.R., C.R. Sreeraj, G. Mohan, K.R. Abhilash, V.K.D. Samuel, P. Ramachandran & R. Ramachandran (2020). Incursion of the killer sponge *Terpios hoshinota* Rützler & Muzik, 1993 on the coral reefs of the Lakshadweep archipelago, Arabian Sea. *Journal of Threatened Taxa* 12(14): 17009–17013. https://doi.org/10.11609/jott.5790.12.14.17009-17013

Funding: Ministry of Environment, Forests and Climate Change, Govt. of India, and The World Bank.

Competing interests: The authors declare no competing interests. A preprint of this manuscript was posted on bioRxiv Preprint server on April 29, 2019.

Acknowledgements: This study was undertaken as part of the grant-in-aid project of "Mapping of Ecologically Sensitive Areas (ESAs) and Critically Vulnerable Coastal Areas (CVCAs) along the Coast of India", "[F.No. 22-29/2008-WBICZM-IA-III; 19 June 2014]". The authors acknowledge the financial and technical support provided by MoEF&CC, Government of India, and the World Bank under the India ICZM Project. The authors are grateful to Dr. S.L Liu (Tunghai University, Taiwan) for comments, to Dr. S.L. Tang (Biodiversity Research Center, Academia Sinica, Taiwan) and to Dr. S.Y. Yang (Shimoda Marine Research Center, University of Tsukuba, Japan) for important literature and information on the killer sponge outbreak in the South China Sea. The authors acknowledge the section editor for further improving the manuscript.

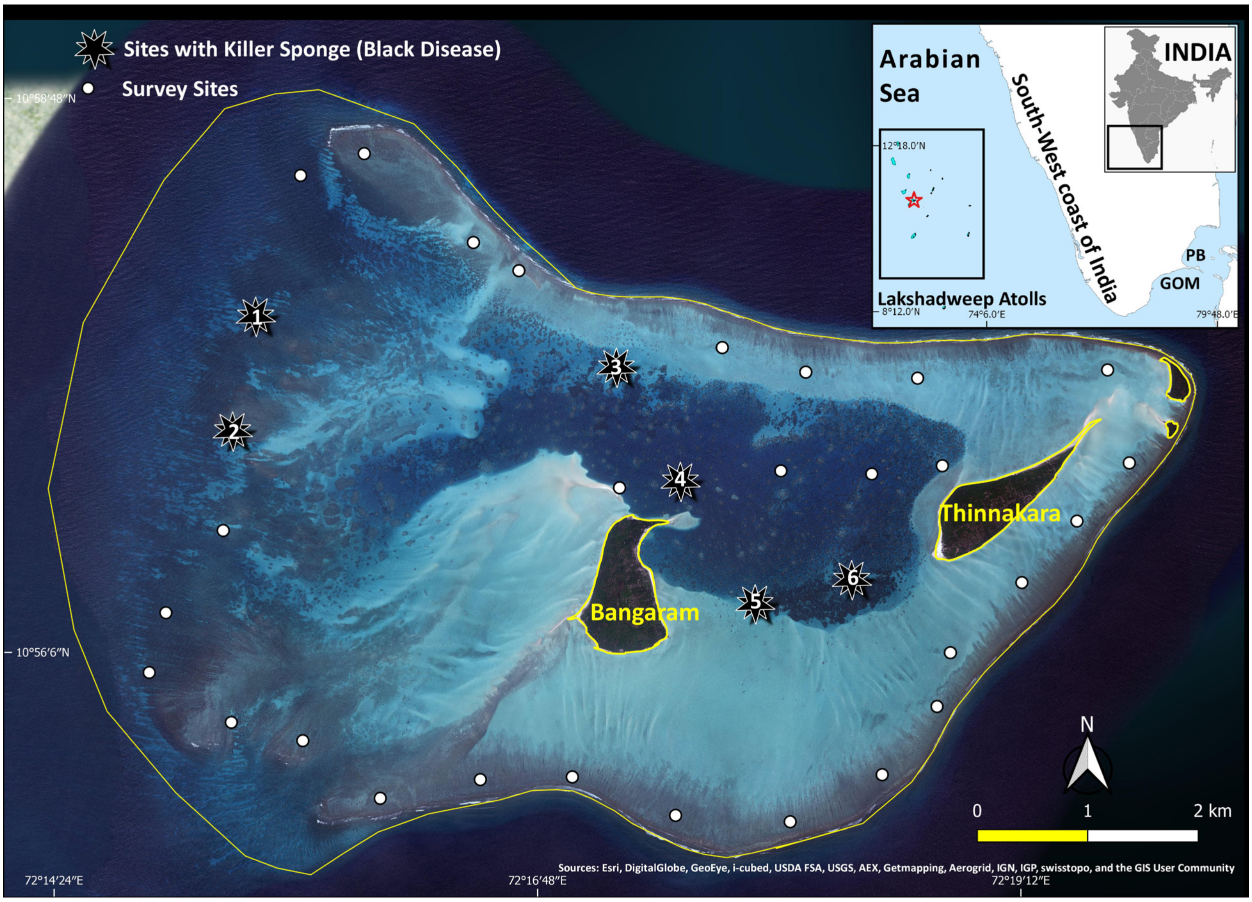

Image 1. Bangaram & Thinnakara atoll (Inset - red star) (QGIS 3.6).

(Montano et al. 2015), Mauritius (Elliott et al. 2016) and our present observation, confirms that the species has further extended its habitat into the pristine atolls of Lakshadweep (Image 1) (Arabian Sea) and requires urgent attention.

During the coral reef surveys conducted at Lakshadweep in November 2016, *T. hoshinota* was observed overgrowing on several colonies of *Acropora muricata, Isopora palifera, Cyphastrea* sp., *Dipsastraea lizardensis* and *Porites lutea* (Image 2 and 3) in the atoll encircling Bangaram and Thinnakara Islands. Out of 34 sites surveyed, six exhibited the presence of *T. hoshinota* (Image 1). The coral colonies in atoll were patchy and the depth of the atoll varied between 2 and 12 meters. As depth increased, (i.e., >5m) large boulder corals were observed whereas the shallow regions (<5m) 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 of canals, was clearly visible and the thickness of the mat was less than 1mm (Image 2). It was observed that the encrusting sponges were propagating laterally and infecting the other live coral colonies. Other associated communities such as ascidians and clams remain unaffected but interestingly the calcareous serpulid tubes, though overgrown by the *Terpios*, the animal was unharmed (Elliott et al. 2016) (Image 2d). Further, in some colonies along with *T. hoshinota*, algal presence was noted (Image 3a) but the sponge was absent in the colonies which were completely covered with turf algae (Image 3b). Environmental parameters assessed with a multiparameter water quality probe (YSI optic probe no. 15K100034) 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.

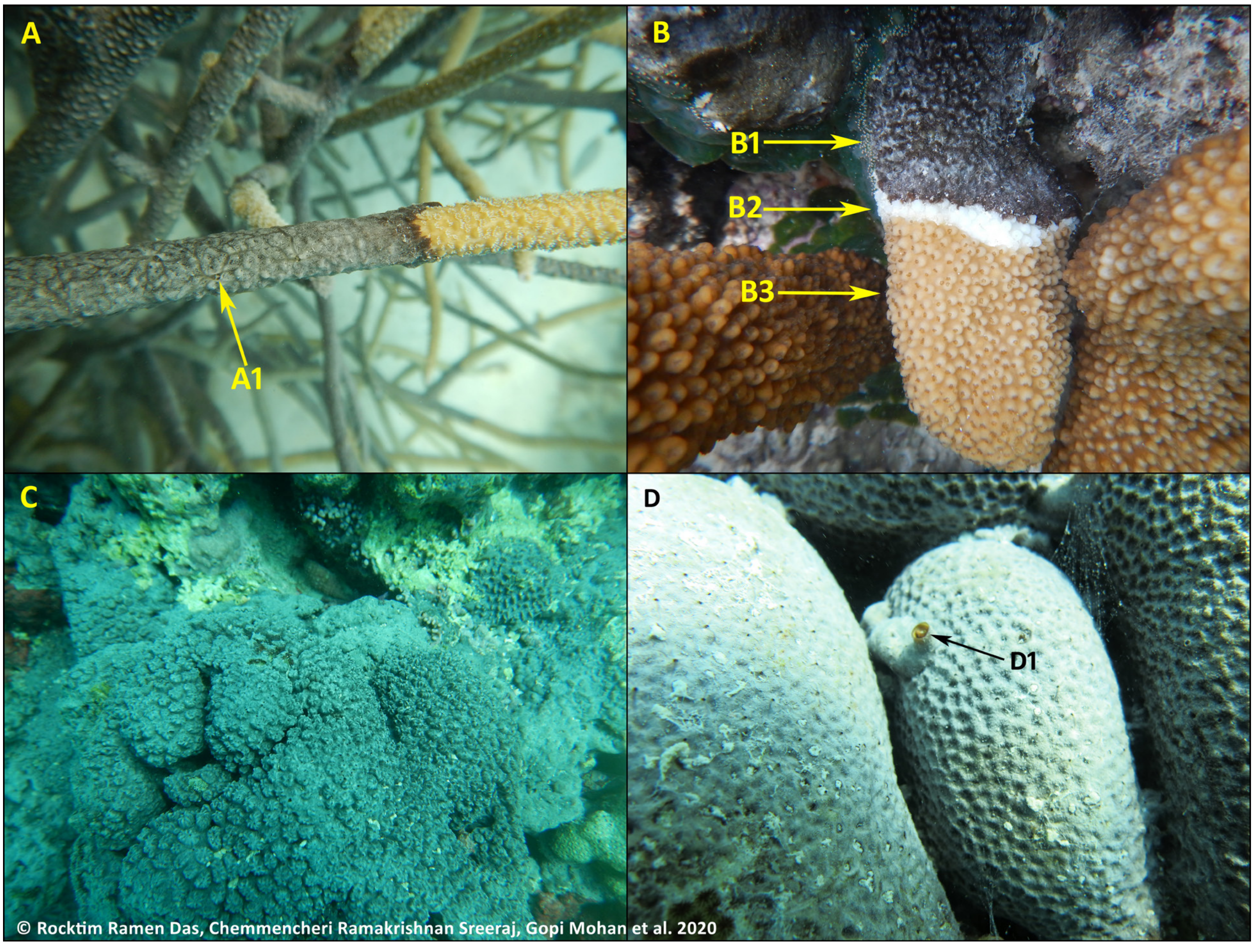

Image 2. A—Incrustations of *T. hoshinota* on *A. muricata*, A1. *T. hoshinota* exhibiting osculum with radiating networks | B—Incrustation on *I. palifera*, B1. *T. hoshinota* mat, B2. Bleached ring, B3. Live coral | C—*T. hoshinota* taking shape of a Coral (*Cyphastrea* sp.) | D—*T. hoshinota* overgrowing calcareous serpulid tubes, D1. animal unaffected.

Previous studies (Rützler & Muzik 1993; Thinesh et al. 2015) suspected that the outbreak of *T. hoshinota* is related to increased water turbidity or due to high anthropogenic stress/pollution its close proximity to mainland, as reported in the south eastern reefs of India (~800km from Lakshadweep) (Thinesh et al. 2015, 2017; Raj et al. 2018a), Guam (Plucer-Rosario 1987; Rützler & Muzik 1993) and in Green island (Chen et al. 2009). A similar conclusion, however, cannot be applied in the case of Lakshadweep because of its isolated geography (Arthur et al. 2005) 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. (2012) who observed *T. hoshinota* outbreak in unpolluted areas of Yongxing Island (South China Sea), highlighting the difficulty in establishing a negative co-relationship between water quality and black disease outbreak (Sung-Yin Yang pers comm. 2020). In terms of host selectivity, the killer sponge has affected several coral species in different parts of the world (Bryan 1973; Thinesh et al. 2015; Elliott et al. 2016; Raj et al. 2018a) and in the reefs of Palk Bay (PB), it has affected all genus surveyed (Thinesh et al. 2015). In Vaan Island (GOM) the dominant genus *Montipora* was the most susceptible (Raj et al. 2018a). Our observation though could not reveal any specific host coral selectivity, we can speculate that the dense branching *Acropora* coral beds (ACB) in site 3, 5 and 6 were more easily overgrown because the killer sponge prefers branching corals as reported from Mauritius (Elliott et al. 2016). We would further conclude that the coral composition in any specific location may play an important role in determining its host.

T. hoshinota is a belligerent contender for space (Plucer-Rosario 1987) and is known to overgrow corals from its base where it interacts with turf algae (Elliott et al. 2016). Branching *Acropora* beds in site 3, 5 and 6 (Image 3a) consisted both algae (e.g., *Dictyota* sp.)

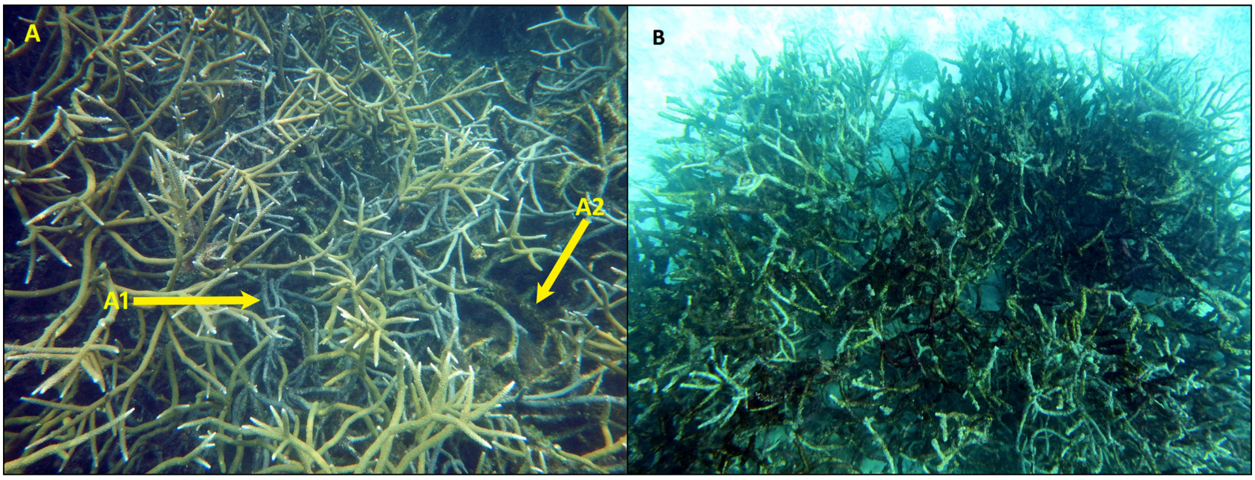

Image 3. *Acropora* colonies (Site 3): A—A1. *T. hoshinota* A2. Algae | B—*Acropora* colonies (Site 5) completely over grown by turf algae, killer sponge/black disease absent.

and the killer sponge. Additionally, a massive turf algae covered area of ~0.35km in *T. hoshinota* occurrence site (5, 6) highlights a complex ecological scenario (Image 3b). Such complexity between sponges, corals and algae can be only understood through long term monitoring. González-Rivero et al. (2011) 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 hypothesize site 5/6 scenario 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 (Image 3a, b). Moreover, reports of turf algae being a dominant component in the atolls (Arthur et al. 2005) might indicate a faster transition. Globally Elevated SST is a major threat to coral reefs (Hughes et al. 2018), and the reefs of India (Edward et al. 2018; Krishnan et al. 2018; Raj et al. 2018b) including the atolls (Vinoth et al. 2012) are no different. With reports indicating that elevated SST has already depleted the coral ecosystem of Lakshadweep, which was evident during 1998 (Arthur et al. 2005), 2010 (Vinoth et al. 2012), and 2016 (Hughes et al. 2018) mass bleaching events, it can provide an opportunity for sponges to invade (Bell et al. 2013). The dynamics of waterflow (Arthur et al. 2005) may also play a crucial role in this regard.

Our findings confirm that the infestation of *T. hoshinota* on the coral colonies of Lakshadweep is currently limited to only Bangaram and Thinnakara as it was not observed in the other atolls surveyed. Although there is a possibility that the killer sponge could invade nearby atolls as seen in other regions (Bryan 1973; Reimer et al. 2011), large-scale damage cannot be concluded at this stage. This is in fact the first documentation of *T. hoshinota* on the reefs of Lakshadweep and can be regarded as a baseline for subsequent studies. Further, to protect the reefs of Lakshadweep, a long term coral health monitoring program is required which will allow us to understand the nature of occurrence, distribution, the impact and the causative factors of the killer sponge and to understand it's larger threat to the reefs. Black disease along with other coral associated diseases needs enlarged emphasis according to which various coral reef management plans can be initiated.

References

Arthur, R., T.J. Done & H. Marsh (2005). Benthic recovery four years after an El Nino-induced coral mass mortality in the Lakshadweep atolls. *Current Science* 89(4): 694–699.

Bell, J.J., S.K. Davy, T. Jones, M.W. Taylor & N.S. Webster (2013). Could some coral reefs become sponge reefs as our climate changes? *Global Change Biology* 19: 2613–2624. https://doi.org/10.1111/gcb.12212

Bryan, P. (1973). Growth rate, toxicity, and distribution of the encrusting sponge *Terpios* sp. (Hadromerida: Suberitidae) in Guam, Mariana Islands. *Micronesica* 9(2): 237–242.

Chen, S.L., C.Y. Kuo & C.A. Chen (2009). Spatial distribution and temporal variation of the cyanobacteriosponge, *Terpios hoshinota*, and benthos composition on the coral reefs of Green Island. *Journal of National Park* 19: 33–45.

De Voogd, N.J., F. Dekker & D.F.R. Cleary (2013). The coral-killing sponge *Terpios hoshinota* invades Indonesia. *Coral Reefs* 32: 755. https://doi.org/10.1007/s00338-013-1030-4

Edward, J.K.P., G. Mathews, K.D. Raj, R.L. Laju, M.S. Bharath, A. Arasamuthu, P.D. Kumar, D.S. Bilgi & H. Malleshappa (2018). Coral mortality in the Gulf of Mannar, southeastern India, due to bleaching caused by elevated sea temperature in 2016. *Current Science* 114(9): 1967–1972. https://doi.org/10.18520/cs/v114/i09/1967-1972

Ekins, M., B. Willis, T. Bridge, M. Srinivasan, S. Rowley & J. Hooper (2017). The coral killing sponge *Terpios hoshinota* in Kimbe Bay, Papua New Guinea. *Memoirs of the Queensland Museum* 60: 174–175. https://doi.org/10.1082/j.2204-1478.60.2017.2017-02

Elliott, J., M. Patterson, N. Summers, C. Miternique, E. Montocchio & E. Vitry (2016). How does the proliferation of the coral-killing sponge *Terpios hoshinota* affect benthic community structure on coral reefs? *Coral Reefs* 1–13. https://doi.org/10.1007/s00338-016-1434-z

Fujii, T., E. Hirose, S. Keshavmurthy, C.A. Chen, W. Zhou & J.D. Reimer (2011). Coral-killing cyanobacteriosponge (*Terpios hoshinota*) on the Great Barrier Reef. *Coral Reefs* 30: 483. https://doi.org/10.1007/s00338-011-0734-6

González-Rivero, M., L. Yakob & P.J. Mumby (2011). The role of sponge competition on coral reef alternative steady states. *Ecological Modelling* 222: 1847–1853. https://doi.org/10.1016/j.ecolmodel.2011.03.020

Hoeksema, B.W., Z. Waheed & N.J. De Voogd (2014). Partial mortality in corals overgrowth by the sponge *Terpios hoshinota* at Tioman Island, Peninsular Malaysia (South China Sea). *Bulletin of Marine Science* 90(4): 989–990. https://doi.org/10.5343/bms.2014.1047

Hughes, T.P., K.D. Anderson, S.R. Connolly, S.F. Heron, J.T. Kerry, J.M. Lough, A.H. Baird, J.K. Baum, M.L. Berumen, T.C. Bridge, D.C. Claar, C.M. Eakin, J.P. Gilmour, N.A.J. Graham, H. Harrison, J.P.A. Hobbs, A.S. Hoey, M. Hoogenboom, R.J. Lowe, M.T. McCulloch, J.M. Pandolfi, M. Prachett, V. Schoepf, G. Torda & S.K. Wilson (2018). Spatial and temporal patterns of mass bleaching of corals in the Anthropocene. *Science* 359: 80–83. https://doi.org/10.1126/science.aan8048

Krishnan, P., R. Purvaja, C.R. Sreeraj, R. Raghuraman, R.S. Robin, K.R. Abhilash, R.S. Mahendra, A. Anand, M. Gopi, P.C. Mohanty, K. Venkataraman & R. Ramesh (2018). Differential bleaching patterns in corals of Palk Bay and the Gulf of Mannar. *Current Science* 114(3): 679–685. https://doi.org/10.18520/cs/v114/i03/679-685

Liao, M.H., S.L. Tang, C.M. Hsu, K.C. Wen, H. Wu, W.M. Chen, J.T. Wang, P.J. Meng, W.H. Twan, C.K. Lu, C.F. Dai, K. Soong & C.A. Chen (2007). The "Black Disease" of reef-building corals at Green Island, Taiwan – Outbreak of a cyanobacteriosponge, *Terpios hoshinota* (Suberitidae; Hadromerida). *Zoological Studies* 46(4): 520.

Montano, S., W.H. Chou, C.A. Chen, P. Galli & J.D. Reimer (2015). First record of the coral-killing sponge *Terpios hoshinota* in the Maldives and Indian Ocean. *Bulletin of Marine Science* 91(1): 97–98. https://doi.org/10.5343/bms.2014.1054

Plucer-Rosario, G. (1987). The effect of substratum on the growth of *Terpios,* an encrusting sponge which kills corals. *Coral Reefs* 5(4): 197–200.

Raj, K.D., M.S. Bharath, G. Mathews, G.S. Aeby & J.K.P. Edward (2018a). Coral-killing sponge *Terpios hoshinota* invades the corals of Gulf of Mannar, Southeast India. *Current Science* 114(5): 1117–1119. https://doi.org/10.18520/cs/v114/i05/1117-1119

Raj, K.D., G. Mathews, M.S. Bharath, R.D. Sawant, V. Bhave, D. Apte, N. Vasudevan & J.K.P. Edward (2018b). Climate change-induced coral bleaching in Malvan marine sanctuary, Maharashtra, India. *Current Science* 114(2): 384–387. https://doi.org/10.18520/cs/v114/i02/384-387

Reimer, J.D., M. Mizuyama, M. Nakano, T. Fujii & E. Hirose (2011). Current status of the distribution of the coral-encrusting cyanobacteriosponge *Terpios hoshinota* in southern Japan. *Galaxea, Journal of Coral Reef Studies* 13: 35–44.

Rützler, K. & K. Muzik (1993). *Terpios hoshinota*, a new cyanobacteriosponge threatening Pacific reefs. *Scientia Marina* 57(4): 395-403.

Shi, Q., G.H. Liu, H.Q. Yan & H.L. Zhang (2012). Black disease (*Terpios hoshinota*): A probable cause for the rapid coral mortality at the northern reef of Yongxing Island in the South China Sea. *AMBIO* 41(5): 446–455. https://doi.org/10.1007/s13280-011-0245-2

Thinesh, T., P.A. Jose, S. Hassan, K.M. Selvan & J. Selvin (2015). Intrusion of coral-killing sponge (*Terpios hoshinota*) on the reef of Palk Bay. *Current Science* 109(6): 1030–1032.

Thinesh, T., G. Mathews, K.D. Raj & J.K.P. Edward (2017). Outbreaks of *Acropora* white syndrome and *Terpios* sponge overgrowth combined with coral mortality in Palk Bay, southeast coast of India. *Diseases of Aquatic Organisms* 126: 63–70. https://doi.org/10.3354/dao03155

Vinoth, R., M. Gopi, T.T.A. Kumar, T. Thangaradjou & T. Balasubramanian (2011). Coral reef bleaching at Agatti Island of Lakshadweep Atolls, India. *Journal of Ocean University China* 11(1): 105-110. https://doi.org/10.1007/s11802-012-1822-0

Yang, S.Y., H.J. Chen, M.J. Ho, Y.J. Chen, Y.Y. Huang, W.S. Chow, S.L. Tang, M.S. Jeng & C.A. Chen (2018). Outbreak of coral-killing cyanobacteriosponge, *Terpios hoshinota*, in Taiping Island (Itu Aba), Spratlys, South China Sea. *Bulletin of Marine Science* 94(4): 1543–1544. https://doi.org/10.5343/bms.2018.0023

PLATINUM OPEN ACCESS

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

October 2020 | Vol. 12 | No. 14 | Pages: 16927–17062
Date of Publication: 26 October 2020 (Online & Print)
DOI: 10.11609/jott.2020.12.14.16927-17062

Article

Communications

Short Communications

Notes

Addendum

Member

Publisher & Host

Threatened Taxa