

# Journal of Threatened Taxa

*Building evidence for conservation globally*



*Open Access*

[10.11609/jott.2021.13.12.19675-19886](https://doi.org/10.11609/jott.2021.13.12.19675-19886)

[www.threatenedtaxa.org](http://www.threatenedtaxa.org)

26 October 2021 (Online & Print)

Vol. 13 | No. 12 | Pages: 19675–19886

ISSN 0974-7907 (Online)

ISSN 0974-7893 (Print)



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

Publisher  
**Wildlife Information Liaison Development Society**  
www.wild.zooreach.org

Host  
**Zoo Outreach Organization**  
www.zooreach.org

No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road, Saravanampatti,  
Coimbatore, Tamil Nadu 641035, India  
Ph: +91 9385339863 | [www.threatenedtaxa.org](http://www.threatenedtaxa.org)  
Email: [sanjay@threatenedtaxa.org](mailto:sanjay@threatenedtaxa.org)

#### EDITORS

##### Founder & Chief Editor

**Dr. Sanjay Molur**

Wildlife Information Liaison Development (WILD) Society & Zoo Outreach Organization (ZOO),  
12 Thiruvannamalai Nagar, Saravanampatti, Coimbatore, Tamil Nadu 641035, India

##### Deputy Chief Editor

**Dr. Neelesh Dahanukar**

Noida, Uttar Pradesh, India

##### Managing Editor

**Mr. B. Ravichandran**, WILD/ZOO, Coimbatore, India

##### Associate Editors

**Dr. Mandar Paingankar**, Government Science College Gadchiroli, Maharashtra 442605, India

**Dr. Ulrike Streicher**, Wildlife Veterinarian, Eugene, Oregon, USA

**Ms. Priyanka Iyer**, ZOO/WILD, Coimbatore, Tamil Nadu 641035, India

**Dr. B.A. Daniel**, ZOO/WILD, Coimbatore, Tamil Nadu 641035, India

##### Editorial Board

**Dr. Russel Mittermeier**

Executive Vice Chair, Conservation International, Arlington, Virginia 22202, USA

**Prof. Mewa Singh Ph.D., FASC, FNA, FNASC, FNAPsy**

Ramanna Fellow and Life-Long Distinguished Professor, Biopsychology Laboratory, and  
Institute of Excellence, University of Mysore, Mysuru, Karnataka 570006, India; Honorary  
Professor, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore; and Adjunct  
Professor, National Institute of Advanced Studies, Bangalore

**Stephen D. Nash**

Scientific Illustrator, Conservation International, Dept. of Anatomical Sciences, Health Sciences  
Center, T-8, Room 045, Stony Brook University, Stony Brook, NY 11794-8081, USA

**Dr. Fred Pluthero**

Toronto, Canada

**Dr. Priya Davidar**

Sigur Nature Trust, Chadapatti, Mavinhalla PO, Nilgiris, Tamil Nadu 643223, India

**Dr. Martin Fisher**

Senior Associate Professor, Battcock Centre for Experimental Astrophysics, Cavendish  
Laboratory, JJ Thomson Avenue, Cambridge CB3 0HE, UK

**Dr. John Fellowes**

Honorary Assistant Professor, The Kadoorie Institute, 8/F, T.T. Tsui Building, The University of  
Hong Kong, Pokfulam Road, Hong Kong

**Prof. Dr. Mirco Solé**

Universidade Estadual de Santa Cruz, Departamento de Ciências Biológicas, Vice-coordenador  
do Programa de Pós-Graduação em Zoologia, Rodovia Ilhéus/Itabuna, Km 16 (45662-000)  
Salobrinho, Ilhéus - Bahia - Brasil

**Dr. Rajeev Raghavan**

Professor of Taxonomy, Kerala University of Fisheries & Ocean Studies, Kochi, Kerala, India

##### English Editors

**Mrs. Mira Bhojwani**, Pune, India

**Dr. Fred Pluthero**, Toronto, Canada

**Mr. P. Ilangoan**, Chennai, India

##### Web Maintenance

**Mrs. Latha G. Ravikumar**, ZOO/WILD, Coimbatore, India

##### Typesetting

**Mr. Arul Jagadish**, ZOO, Coimbatore, India

**Mrs. Radhika**, ZOO, Coimbatore, India

**Mrs. Geetha**, ZOO, Coimbatore India

#### Fundraising/Communications

**Mrs. Payal B. Molur**, Coimbatore, India

**Subject Editors 2018–2020**

#### Fungi

Dr. B. Shivaraju, Bengaluru, Karnataka, India

Dr. R.K. Verma, Tropical Forest Research Institute, Jabalpur, India

Dr. Vatsavaya S. Raju, Kakatiya University, Warangal, Andhra Pradesh, India

Dr. M. Krishnappa, Jnana Sahyadri, Kuvempu University, Shimoga, Karnataka, India

Dr. K.R. Sridhar, Mangalore University, Mangalagangothri, Mangalore, Karnataka, India

Dr. Gunjan Biswas, Vidyasagar University, Midnapore, West Bengal, India

#### Plants

Dr. G.P. Sinha, Botanical Survey of India, Allahabad, India

Dr. N.P. Balakrishnan, Ret. Joint Director, BSI, Coimbatore, India

Dr. Shonil Bhagwat, Open University and University of Oxford, UK

Prof. D.J. Bhat, Retd. Professor, Goa University, Goa, India

Dr. Ferdinando Boero, Università del Salento, Lecce, Italy

Dr. Dale R. Calder, Royal Ontario Museum, Toronto, Ontario, Canada

Dr. Cleofas Cervancia, Univ. of Philippines Los Baños College Laguna, Philippines

Dr. F.B. Vincent Florens, University of Mauritius, Mauritius

Dr. Merlin Franco, Curtin University, Malaysia

Dr. V. Irudayaraj, St. Xavier's College, Palayamkottai, Tamil Nadu, India

Dr. B.S. Kholia, Botanical Survey of India, Gangtok, Sikkim, India

Dr. Pankaj Kumar, Kadoorie Farm and Botanic Garden Corporation, Hong Kong S.A.R., China

Dr. V. Sampath Kumar, Botanical Survey of India, Howrah, West Bengal, India

Dr. A.J. Solomon Raju, Andhra University, Visakhapatnam, India

Dr. Vijayasankar Raman, University of Mississippi, USA

Dr. B. Ravi Prasad Rao, Sri Krishnadevaraya University, Anantpur, India

Dr. K. Ravikumar, FRLHT, Bengaluru, Karnataka, India

Dr. Aparna Watve, Pune, Maharashtra, India

Dr. Qiang Liu, Xishuangbanna Tropical Botanical Garden, Yunnan, China

Dr. Noor Azhar Mohamed Shazili, Universiti Malaysia Terengganu, Kuala Terengganu, Malaysia

Dr. M.K. Vasudeva Rao, Shiv Ranjani Housing Society, Pune, Maharashtra, India

Prof. A.J. Solomon Raju, Andhra University, Visakhapatnam, India

Dr. Mandar Datar, Agharkar Research Institute, Pune, Maharashtra, India

Dr. M.K. Janarthanam, Goa University, Goa, India

Dr. K. Karthigeyan, Botanical Survey of India, India

Dr. Errol Vela, University of Montpellier, Montpellier, France

Dr. P. Lakshminarasimhan, Botanical Survey of India, Howrah, India

Dr. Larry R. Noblick, Montgomery Botanical Center, Miami, USA

Dr. K. Haridasan, Pallavur, Palakkad District, Kerala, India

Dr. Analinda Manila-Fajard, University of the Philippines Los Baños, Laguna, Philippines

Dr. P.A. Sinu, Central University of Kerala, Kasaragod, Kerala, India

Dr. Afroz Alam, Banasthali Vidyapith (accredited A grade by NAAC), Rajasthan, India

Dr. K.P. Rajesh, Zamorin's Guruvayurappan College, GA College PO, Kozhikode, Kerala, India

Dr. David E. Boufford, Harvard University Herbaria, Cambridge, MA 02138-2020, USA

Dr. Ritesh Kumar Choudhary, Agharkar Research Institute, Pune, Maharashtra, India

Dr. Navendu Page, Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand, India

#### Invertebrates

Dr. R.K. Avasthi, Rohtak University, Haryana, India

Dr. D.B. Bastawade, Maharashtra, India

Dr. Partha Pratim Bhattacharjee, Tripura University, Suryamaninagar, India

Dr. Kailash Chandra, Zoological Survey of India, Jabalpur, Madhya Pradesh, India

Dr. Ansie Dippenaar-Schoeman, University of Pretoria, Queenswood, South Africa

Dr. Rory Dow, National Museum of Natural History Naturalis, The Netherlands

Dr. Brian Fisher, California Academy of Sciences, USA

Dr. Richard Gallon, Ilandudno, North Wales, LL30 1UP

Dr. Hemant V. Ghate, Modern College, Pune, India

Dr. M. Monwar Hossain, Jahangirnagar University, Dhaka, Bangladesh

Mr. Jatishwor Singh Irungbam, Biology Centre CAS, Branišovská, Czech Republic.

Dr. Ian J. Kitching, Natural History Museum, Cromwell Road, UK

Dr. George Mathew, Kerala Forest Research Institute, Peechi, India

Dr. John Noyes, Natural History Museum, London, UK

For Focus, Scope, Aims, and Policies, visit [https://threatenedtaxa.org/index.php/JoTT/aims\\_scope](https://threatenedtaxa.org/index.php/JoTT/aims_scope)

For Article Submission Guidelines, visit <https://threatenedtaxa.org/index.php/JoTT/about/submissions>

For Policies against Scientific Misconduct, visit [https://threatenedtaxa.org/index.php/JoTT/policies\\_various](https://threatenedtaxa.org/index.php/JoTT/policies_various)

continued on the back inside cover

Caption: Stripe-backed Weasel *Mustela strigidorsa*. Medium—digital, Software—procreate, Device—iPad + Apple pencil © Dhanush Shetty.



## New records of cheilostome Bryozoa from the eastern coast of India encrusting on the exoskeleton of live horseshoe crabs of Indian Sundarbans

Swati Das<sup>1</sup> , Maria Susan Sanjay<sup>2</sup> , Basudev Tripathy<sup>3</sup> , C. Venkatraman<sup>4</sup>  & K.A. Subramanian<sup>5</sup> 

<sup>1-4</sup>Zoological Survey of India, M- Block, New Alipore, Kolkata, West Bengal 700053, India.

<sup>1,2</sup>Department of Zoology, University of Madras, Chennai, Tamil Nadu 600025, India.

<sup>5</sup>Zoological Survey of India, Southern Regional Centre, 130, Santhome High Road, Chennai, Tamil Nadu 600028, India.

<sup>1</sup>swtds4788@gmail.com (corresponding author), <sup>2</sup>mariasanjay257@gmail.com, <sup>3</sup>tripathyb@gmail.com, <sup>4</sup>cvrmanmbs@gmail.com, <sup>5</sup>subbuka.zsi@gmail.com

**Abstract:** Bryozoans are common commensal on hard surfaces and cover slow-moving animals like molluscs, sea turtles, brachyuran crabs, and horseshoe crabs. A total of six species of bryozoans belonging to four genus under three families of order Cheilostatida were recorded encrusting on the carapaces of horseshoe crabs collected from Indian Sundarbans along the east coast of India and two among them, viz., *Biflustra savartii* (Audouin, 1826) and *Sinoflustra arabianensis* (Menon & Nair, 1975) are reported for the first time. Additionally, *Jellyella tuberculata* (Bosc, 1802) is reported for the first time from West Bengal coastal waters, previously known only from the Odisha coast of India. Both male and female horseshoe crabs were found to have been encrusted with bryozoan mats, although adequately not known about the life stages of their encrustation.

**Keywords:** Bryozoa, *Carcinoscorpius rotundicauda*, East coast, Epibionts, Indian Sundarbans, *Tachypleus gigas*, Xiphosura.

**Editor:** A. Biju Kumar, University of Kerala, Thiruvananthapuram, India.

**Date of publication:** 26 October 2021 (online & print)

**Citation:** Das, S., M.S. Sanjay, B. Tripathy, C. Venkatraman & K.A. Subramanian (2021). New records of cheilostome Bryozoa from the eastern coast of India encrusting on the exoskeleton of live horseshoe crabs of Indian Sundarbans. *Journal of Threatened Taxa* 13(12): 19773–19780. <https://doi.org/10.11609/jott.6046.13.12.19773-19780>

**Copyright:** © Das et al. 2021. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use, reproduction, and distribution of this article in any medium by providing adequate credit to the author(s) and the source of publication.

**Funding:** The present work was funded through research fellowship from Zoological Survey of India and MoEFCC (Ministry of Environment, Forest and Climate Change).

**Competing interests:** The authors declare no competing interests.

**Author details:** Swati Das is currently working as a research fellow and pursuing her PhD from Madras University, Chennai. Her research topic is on the ecology of Indian Horseshoe Crabs. Her research interests include ornithology, herpetology, wildlife biology, conservation biology, and wildlife photography. Maria Susan Sanjay is a research fellow working on taxonomy of marine bryozoans and also has research interest in ecological conservation and environmental studies. Dr. Basudev Tripathy is a senior scientist having more than 20 years of research experience in zoological research, especially on marine biology and wildlife conservation. He has published more than 100 peer reviewed scientific papers and books as well as book chapters. He has research projects both on the east and west coast of India. Dr. C. Venkatraman is a senior scientist who conducts regular field surveys in coastal habitats of eastern and western coasts of India. He is also an expert in mammals and birds in different habitats. Dr. K.A. Subramanian specializes in aquatic insect diversity and freshwater biodiversity conservation.

**Author contributions:** SD, BT and KAS designed the survey, SD conducted field survey and collected specimens, MSS examined and identified the specimens, SD and MSS compiled the information, illustration, and prepared the first draft of the manuscript, KAS and BT did manuscript correction, and all authors contributed to drafting the manuscript.

**Acknowledgements:** The present piece of work is part of the doctoral thesis of Swati Das. Our sincere thanks to the director, Zoological Survey of India for providing all necessary permission to carry out the field work. SD and MSS were supported through research fellowship from ZSI. We are grateful to all field staff and forest department for logistics. Special thanks to Poonam Chandel, WTI for helping first author with creating the study area map.



## INTRODUCTION

Bryozoa is considered a minor phylum placed in between phylum Mollusca and Echinodermata and are ancient, microscopic, sessile, and colonial coelomates inhabiting both marine & freshwater ecosystem (Soja 2006). They can erect or encrust on all types of hard, permanent or ephemeral substrates (Canu & Bassler 1920; Harmer 1926; Osburn 1940; Cook 1968; Ziko & Hamza 1987; Xi-Xing 1992; Key et al. 1996). Although mostly found in the littoral zone, bryozoans have been reported up to 6,000 m depth in the marine realm. Studies on the Indian bryozoan fauna are scarce except for some notable documentation by Annandale (1912) and Thornely (1907, 1916), and after that by Menon (1967), Menon & Nair (1967), Nair (1973), Pillai (1978, 1981), Raveendran et al. (1990), Swami & Karande (1987, 1994), Geetha (1994), Swami & Udayakumar (2010), Soja (2006), Mankeshwar et al. (2015), Tripathy et al. (2016), and Venkatraman et al. (2018). However, very few scientific publications are available on the bryozoan fauna of the east coast of India (Robertson 1921; Shrinivaasu et al. 2015).

The horseshoe crabs are marine chelicerates that migrate to nearshore waters during lunar cycles for spawning. Represented by only four extant species within Xiphosura, two species of horseshoe crabs, *Tachypleus gigas* (Müller, 1785) and *Carcinoscorpius rotundicauda* (Latreille, 1802) are known to occur along the upper east coast of India, co-occurring mainly along the West Bengal and Odisha Coast (Annandale 1909; Roonwal 1944; Debnath 1992; Tripathy et al. 2018). *C. rotundicauda* is the most abundant of the two species in Indian Sundarbans (Saha 1989; Debnath 1992; Tripathy et al. 2018). Xiphosurans serve as host species for a variety of organisms, viz., bryozoans, barnacles, oysters, tunicates, coelenterates, flatworms, annelids, isopods, diatoms, amphipods, gastropods, polychaetes, and green algae (Humm & Wharton 1942; Roonwal 1944; Rao & Rao 1972; Davis & Fried 1977; Mackenzie 1979; Shuster 1982; Jeffries et al. 1989; Saha 1989; Debnath 1992; Key et al. 1996). However, *T. gigas* and *C. rotundicauda* are found mainly infested by bryozoans, barnacles, mussels, oysters, limpets, and polychaetes (Botton 2009). There are scanty records on the epizoic bryozoans reported from exoskeleton of horseshoe crabs. Notable works have been carried out by Pearse (1947), Butler & Cuffey (1991), Allee (1922), Watts (1957), and Key et al. (1996). In India, Rao & Rao (1972), Debnath (1992) and Patil & Anil (2000) reported an unidentified species of *Membranipora* as epizoic bryozoa on both *T. gigas* and

*C. rotundicauda*. As such, studies on biological studies on horseshoe crabs are limited and commensalism, symbiosis and parasitism on horseshoe crabs, are scantily known from India. The present work attempted documentation of bryozoan species encrusting on the carapaces of horseshoe crabs for the first time from India.

## MATERIALS AND METHODS

### Study area

Field surveys have been conducted in the Sagar Island and Patiboni areas of the Indian Sundarbans. The Sagar Island (21.791°N, 88.131°E) is situated at the western part of Indian Sundarbans and is the largest island of the Sundarban deltaic complex (Figure 1). Hoogly river borders north and west with Muriganga River in the east and Bay of Bengal in the south. It is a tidal dominated island and characterized by tidal creeks, mud flats/salt marshes, mangroves and sandy beaches/dunes. The Patiboni in Frezerganj (21.578°N, 88.246°E) is well known for its fishing activities, located eastward to the Sagar Island and having a more sandy substrate at the intertidal zones (Figure 1). The estuarine area of the Sagar Island (Tripathy et al. 2018) and Patiboni area of Frezerganj are considered as potential habitats for both species of horseshoe crabs.

### METHODS

The present study was conducted from March to December 2019 as part of the first authors doctoral research. Sampling was done during the end of high tide and the beginning of low tide, keeping a gap of two hours during the full moon/new moon period to avail the maximum exposed intertidal zone. *C. rotundicauda* and *T. gigas* were observed carefully on the mudflats and wherever encountered on horseshoe crabs, the bryozoan colonies were scraped off from the exoskeleton (Cephalothorax, telson, appendages, gills, and eyes) using a scalpel blade (Tan et al. 2011). The bryozoan specimens were preserved using 70% ethanol in a glass/plastic container and labelled properly in the field itself. The specimens were brought to the base camp and washed thoroughly with freshwater for automatic removal of any debris. In the base camp laboratory, collected bryozoan specimens were soaked with sodium hypochlorite (0.5%) for eight hours to remove the organic tissue and later soaked in distilled water for four hours (Shrinivaasu et al. 2015) and then dried for identification and thereafter photographed with Nikon

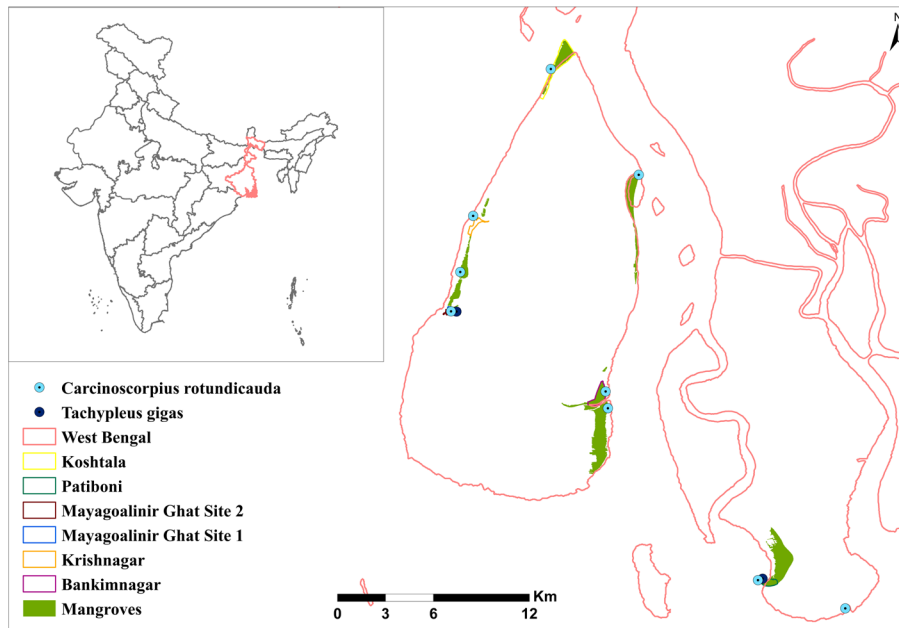


Figure 1. Study area map showing sampling sites of horseshoe crabs.

D7000 with 105 mm VR lens, post-processing with Adobe Photoshop CS6. The specimen was brought to ZSI HQ, Kolkata, for comparing with other museum specimens of the same families and genus, present in the Zoological Survey of India, which is part of the National Zoological Collections. In the field, fouled horseshoe crabs were counted, sexed and measured. After data collection and sampling of bryozoan specimens, horseshoe crabs were released back to the sea. The bryozoan colonies were observed under a stereomicroscope (Leica EZ4), for which the identified colonies were given a gold-palladium coating under vacuum condition and scanning electron micrographs were prepared with a Zeiss Evo 18 special edition SEM, using the “Smart SEM version 5.09” image processing software.

## RESULTS

A total of 58 *Carcinoscorpius rotundicauda* (Image 2) and six *Tachypleus gigas* were observed for bryozoan encrustation examination during the study period. Out of 58, 11 *C. rotundicauda* (six male and five female) and five *T. gigas* (four male and one female) were found encrusted with bryozoan mat. A total of six bryozoan species belonging to five genera under three families of order Cheilostomatida were documented encrusting on the exoskeleton of horseshoe crabs from the Indian Sundarbans. The study further confirmed the presence

of two bryozoan species, viz., *Biflustra savartii* (Audouin, 1826) and *Sinoflustra arabianensis* (Menon & Nair, 1975), on the carapaces of horseshoe crabs, reported to be recorded for the first time from the Bay of Bengal, previously known from the Arabian sea (Menon & Menon 2006). *Jellyella tuberculata* (Bosc, 1802), previously known only from the Odisha coast of India (Menon & Menon 2006), was reported for the first time from the West Bengal coast during this study.

## Systematic Account

Kingdom: Animalia  
 Phylum: Bryozoa  
 Class: Gymnolaemata  
 Order: Cheilostomatida  
 Suborder: Membraniporina  
 Superfamily: Membraniporoidea  
 Family: Membraniporidae  
 Genus *Biflustra* d’Orbigny, 1852

### 1. *Biflustra savartii* (Audouin, 1826)

Image 1A

**Location:** Bankimnagar, Sagar Island, Sundarbans

**Substratum:** Encrusted on prosoma of *Carcinoscorpius rotundicauda* (A female without telson).

**Description:** Colony encrusting, forming a unilaminar sheet on the substratum arranged in longitudinal rows. Zooids sub-rectangular or sub-hexagonal, curved and raised distally and angular at the two proximal corners, separated by a raised ridge with a distinct mural rim.

Opesia occupying most of the frontal area, deep and oval, slightly smaller than the frontal membrane, nearly occupying two-thirds of the frontal area.

**Distribution:** It is a very common species worldwide in the tropical and sub-tropical seas reported from Indonesia and all along the Pacific coast. Earlier, it was reported from Cape Comorin (Menon 1967) and the Mangalore coast (Thornely 1907) in India.

### 2. *Biflustra hugliensis* (Robertson, 1921)

Image 1B

**Location:** Patiboni (Frezerganj), Bankimnagar (Sagar Island)

**Substratum:** Encrusted on prosoma of male *Tachypleus gigas* and female *Carcinoscorpius rotundicauda*.

**Description:** Colony encrusting, zooecia elongated, aperture occupying three fourths of the front, separated by a delicate calcareous mural rim. Distal portion of the zooid overarching the pre-seeding zooid. Operculum semi-circular, straight at its proximal border, much wider than long. Cryptocyst marginally developed, granular on its surface, serrated coarsely on its inner margin. Ovicells and avicularia are wanting.

**Remarks:** Earlier, a colony of encrusting *Biflustra hugliensis* was identified from the posterior of the carapace of *Lepidochelys olivacea* (Olive Ridley Sea Turtle) from the Gulf of Kachchh, Gujarat (Frazier et al. 1992).

**Distribution:** Although a species of tropical and subtropical seas, this species was first identified from the mouth of the Hugli River, Bay of Bengal (Robertson 1921) and subsequently reported from the Gulf of Kachchh, Gujarat (Frazier et al. 1992). Except for these two records, there is no report of this species from anywhere else in India.

Genus: *Jellyella* Taylor & Monks, 1997

### 3. *Jellyella tuberculata* (Bosc, 1802)

Image 1C

**Location:** Bankimnagar (Sagar Island) and Patiboni (Frezerganj)

**Substratum:** Encrusted on ventral side of prosoma of a male *Tachypleus gigas* as well as encrusted on the shell of a mollusc found on the right prosoma of a female *Carcinoscorpius rotundicauda*.

**Diagnosis:** Colony encrusting, multi-serial. Zooids rectangular to sub-rectangular, quincuncially arrangement, opesia elongate-oval, bordered by a very narrow cryptocystal rim laterally and a cryptocystal shelf proximally; cryptocyst sparsely tubercular. Gymnocyst

proximally, starting at the corners of the zooid, then as a thin continuous proximal rim, the gymnocyst arches forward, forming small pockets beneath, especially at the corners; in fully calcified zooids the gymnocystal tubercles can be stoutly developed, completely concealing the proximal cryptocyst.

**Distribution:** A widely distributed species of the major oceans, this species is reported from North Carolina to Brazil along the Atlantic coast, California to Peru along the Pacific coast. Among the Indian Ocean countries, it is reported from Japan and Bangladesh and in India, it has been earlier reported from the coast of Odisha (Menon & Menon 2006).

Family: Electridae

Genus: *Conopeum* Gray, 1848

### 4. *Conopeum reticulum* (Linnaeus, 1767)

Image 1D

**Location:** Patiboni (Frezerganj)

**Substratum:** Encrusted on ventral side of prosoma of a male *Tachypleus gigas*.

**Description:** Encrusting, colonies appear as whitish patches with uneven growing margin. Zooecia quincuncially arranged, chitinous outline distinct. Shape of zooecia variable, but generally longer than wide, very much elongated in certain cases. Cryptocyst tuberculated, developed all-round the opesia with tubercles projecting into the opesia. The tubercles are more or less of the same length, small tubercles are present in the proximal region of the cryptocyst. In certain Zooids the proximal region of the opesia is broader than the distal region.

**Remarks:** This species is known to be found on fouling organisms which have been previously identified from the carapace and appendages of the *Neptunus pelagicus* (Swimming Crab) caught in a trawl net in Cochin (Menon 1967).

**Distribution:** *Conopeum reticulum* is a warm water Indo-Pacific species. This is recorded from Tortugas Island, Florida (Osburn 1950); Indonesia (Harmer 1926); Java, Sumatra, and Myanmar (Marcus 1937). In India, it has been reported from the Arabian Sea along with the Lakshadweep Islands and the Cochin coast (Menon 1967) as well as the Bay of Bengal from Chilka Lake (Annandale 1915).

Family: Sinoflustridae

Genus: *Sinoflustra* Liu & Yang, 1995

### 5. *Sinoflustra amoyensis* (Robertson, 1921)

Image 1E

**Location:** Patiboni (Frezerganj) and Bankimnagar

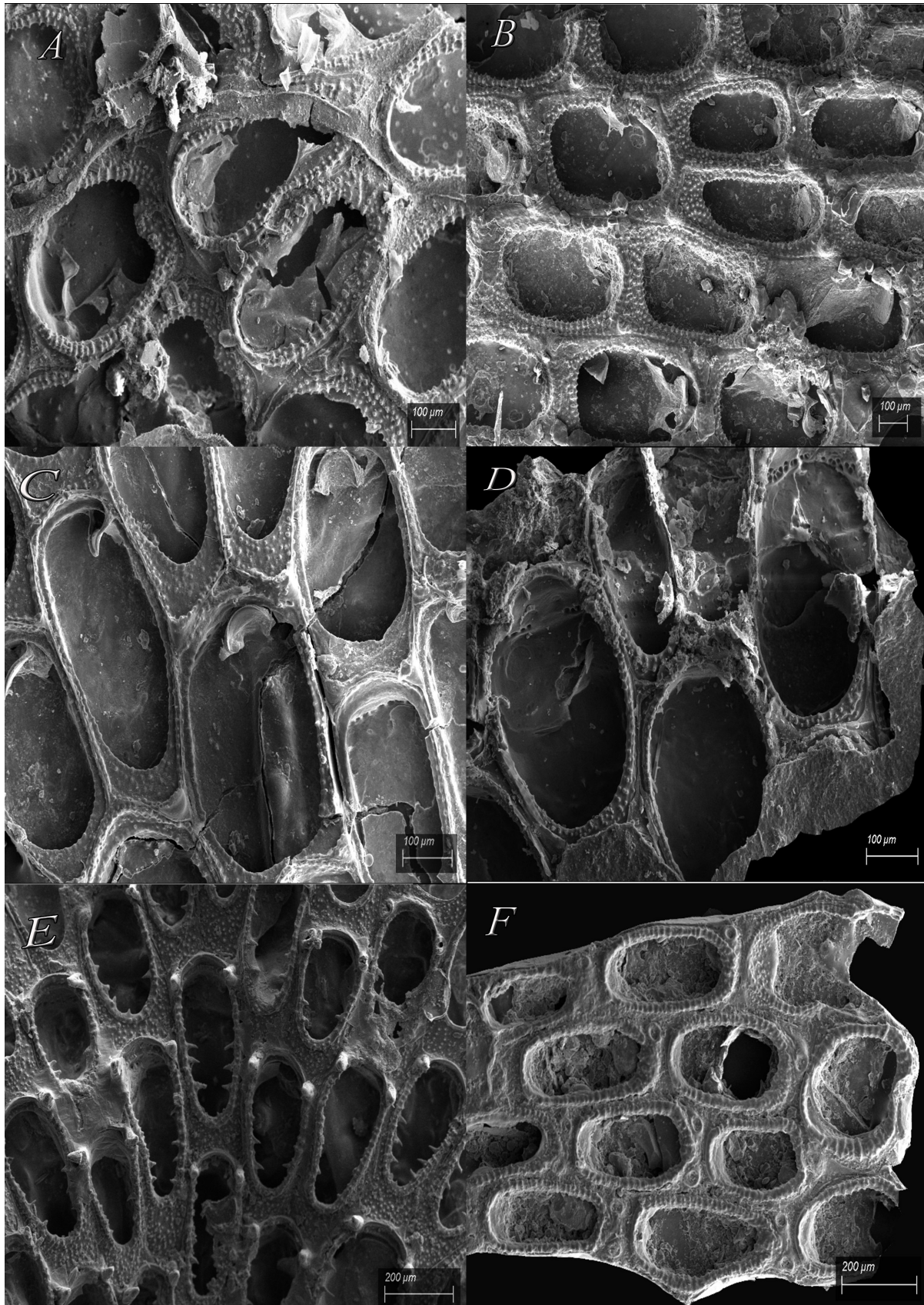


Image 1. A—*Biflustra savartii* (Audouin 1826) | B—*Biflustra hugliensis* (Robertson, 1921) | C—*Jellyella tuberculata* (Bosc, 1802) | D—*Conopeum reticulum* (Linnaeus, 1767) | E—*Sinoflustra amoyensis* (Robertson, 1921) | F—*Sinoflustra arabianensis* (Menon & Nair, 1975).

(Sagar Island)

**Substratum:** Encrusted on prosoma of a male *Carcinoscorpius rotundicauda* and also found encrusted on hardened sediments found on the right side of the prosoma of a female *Carcinoscorpius rotundicauda*.

**Description:** Colony encrusting, white. The zooecia are moderate in size and very delicate and chalk like, zooids elongated rectangular, arranged in quincuncial series, and separated by a distinct fine groove. The mural rim is thin, raised and smooth on its edge. No gymnocyst. Frontal membrane large, occupying the whole of the frontal area. Cryptocyst marginal, narrowest distal to the opesia, developed laterally and proximally, smooth and granular in younger colonies, and granular on its surface in older colonies, with strong cryptocystal spinules. It contains six strong cryptocystal spinules on each side equidistant from each other, on its inner border proximal to the orifice. Opesia elongate and reduced by the cryptocystal spinules. A strong conical spine is present on each distal corner of every zooid.

**Distribution:** This species has been reported to have its presence since the Pliocene era and distribution range in the Indo-Pacific region. It has been originally collected from Amoy of China; in India, this species has the report of its presence in the Holocene rocks of the west coast of Maharashtra, Ernakulam channel from Cochin, and also from the coast of West Bengal (Menon & Menon 2006).

#### 6. *Sinoflustra arabianensis* (Menon & Nair, 1975)

Image 1F

**Location:** Patiboni (Frezeranj)

**Substratum:** Encrusted on the dorsal side of prosoma of a male *Tachypleus gigas*.

**Description:** Colony encrusting. Grows flat, disk-like structures in the absence of any hindrance. Zooecia elongated, quadrangular the distal portion of the preceding zooecium slightly over arch the proximal portion of the succeeding zooid. Opesia occupying three-fourths of the front, being narrowed distally. Gymnocyst present, slightly extensive proximally. Cryptocyst with spinules, the size of the spinules decrease at the distal portion of the cryptocyst. Ancestrula possesses a pair of branched spines.

**Distribution:** It has been reported only from Cochin along the coast of the Arabian Sea (Menon 1967). This is the first report from the Bay of Bengal and also from the Indian Sundarbans region.

## DISCUSSION AND CONCLUSION

Bryozoans are important macro fouling community in the coastal waters of India. So far, very little is known on the bryozoan species diversity and their association with horseshoe crabs and other organisms with hard surfaces and substratum. In India, the upper eastern coast is a preferred breeding and spawning ground for two species of horseshoe crabs: *Tachypleus gigas* and *Carcinoscorpius rotundicauda*. Both the species are in the data deficient category of the IUCN Red List; however, placed in the Schedule IV category of the Indian Wildlife Protection Act, 1972. The Mangrove Horseshoe Crab *Carcinoscorpius rotundicauda* (Latreille, 1802) is more common on the mudflats of the Indian Sundarbans than the Indian Horseshoe Crab *Tachypleus gigas* (Müller, 1785) although occurring in a sympatric habitat. In the present study, it was observed that adult male and female horseshoe crabs are host for bryozoan mats and the reason could be multiple. As most marine organisms compete for substrate space (Paine 1974; Jackson 1977; Connell & Keough 1985) to attach with suitable host species for their dispersal and gene flow (Wahl 1989), unoccupied and clean, bare exoskeletons of horseshoe crabs may act as an ideal surface for colonization of bryozoan species and probably help them to expand their range of distribution. Currents generated by the movement of hosts, respiration and feeding of the host (Bowers 1968; Wahl 1989; Gili et al. 1993) may help in capture of suspended food particles to the bryozoans. Additionally, host species may also protect bryozoan species from predators like amphipods, annelids, echinoids, isopods, nudibranchs, pycnogonids, and gastropods and in return, bryozoans help the host species via camouflage (Key et al. 1996, 2000; Patil & Anil 2000). As studies elsewhere (Renouf 1932; Cadee 1991) suggest bryozoan encrustation can reduce the effectiveness of the host's organs, hence, it can be inferred that epizoic bryozoans may impair the sight of horseshoe crabs as bryozoan mats were found encrusting on the compound eyes of horseshoe crabs during the present study, although bryozoan growth was also found on the mouth, gills, legs and telson of horseshoe crabs. Therefore, these aspects need further investigation to study the occurrence of any parasitic organisms of Bryozoa, which may impair the movement/function of organs of horseshoe crabs. Overall, the interaction between a horseshoe crab and epizoic bryozoan is found non-symbiotic and facultative (Key et al. 1996) and as epizoic bryozoans have a less negative impact on horseshoe crabs, both co-exist.





**Image 2.** Field image of bryozoa (pale brown coloured mat) encrusting on the carapace of *Carcinoscorpius rotundicauda*.

Reporting of two species of Bryozoa for the first time from the east coast of India and one new report from the West Bengal coast clearly indicates that further intense surveys will bring more details on Bryozoa and their relationship with horseshoe crabs. Investigations are also required documenting ecological factors that regulate the epizoid bryozoan distribution on horseshoe crabs.

## REFERENCES

- Allee, W.C. (1922).** Studies in marine ecology II. An annotated catalog of the distribution of common invertebrates of the Woods Hole littoral. Marine Biological Laboratory, Woods Hole, 123 pp.
- Annandale, N. (1909).** The habits of Indian king crabs. *Records of the Indian Museum* 3: 294–295.
- Annandale, N. (1915).** The genus *Austrellella* and some allied species of phylactolaematous polyzoa. *Records of the Indian Museum* 11: 163–169.
- Botton, M.L. (2009).** The ecological importance of horseshoe crabs in estuarine and coastal communities: a review and speculative summary, pp. 45–63. In: Tanacredi, J.T., M.L. Botton & D. Smith (eds.). *Biology and Conservation of Horseshoe Crabs*. Springer, USA.
- Bowers, R.L. (1968).** Observations on the orientation and feeding behavior of barnacles associated with lobsters. *Journal of Experimental Marine Biology and Ecology* 2: 105–112.
- Butler, G.M. & R.J. Cuffey (1991).** Bryozoans as estuarine indicators-paleoecologic implications from the modern fauna of Delaware Bay. *Abstracts with programs - Geological Society of America* 23: 14.
- Cadee, G.C. (1991).** Carapaces of the shore crab *Carcinus maenas* as a substrate for encrusting organisms, pp. 71–79. In: Bigey, F.P. (ed.). *Bryozoa: Living and Fossil*. Societe des Sciences Naturales de l'Ouest de la France, Memoire hors serie, Nantes, France.
- Canu, F. & R.S. Bassler (1920).** North American early Tertiary Bryozoa. *Bulletin of the United States National Museum* 106(879): 1–162.
- Connell, J.H. & M.J. Keough (1985).** Disturbance and patch dynamics of subtidal marine animals on hard substrata, pp. 125–151. In: Pickett, S.T.A & P.S. White (eds.). *The Ecology of Natural Disturbance and Patch Dynamics*. Academic Press, San Diego.
- Cook, P.L. (1968).** Polyzoa from west Africa. The Malacostega, Part I. *Bulletin of the British Museum (Natural History). Zoology* 16: 116–160.
- Davis, R.E. & B. Fried (1977).** Histological and histochemical observations on *Bdelloura candida* (Turbellaria) maintained in vitro. *Transactions of the American Microscopical Society* 96: 258–263.
- Debnath, R. (1992).** Studies on Indian Horseshoe Crabs (Merostomata: Xiphosura) with special reference to its feeding behaviour. PhD Thesis. Department of Marine Science, University of Calcutta, vi+115 pp.
- Frazier, J.G., J.E. Winston & C.A. Ruckdeschel (1992).** Epizoan communities on marine turtles. III. Bryozoa. *Bulletin of Marine Science* 51(1): 1–8.
- Geetha, P. (1994).** Indian and Antarctic bryozoans taxonomy and observation on toxicology. PhD Thesis. Department of Marine Biology, Microbiology and Biochemistry, Cochin University of Science and Technology, Cochi, 234 pp.
- Harmer, S.F. (1926).** The Polyzoa of the Siboga expedition; II,

- Cheilostomata Anasca. Siboga Expedition Reports 28b: 181–501.
- Humm, H.J. & G.W. Wharton (1942). Ecology of sand beaches at Beaufort, North Carolina. *Ecological Monographs* 12: 135–190.
- Jackson, J.B.C. (1977). Competition on marine hard substrata: the adaptive significance of solitary and colonial strategies. *The American Naturalist* 111: 743–767.
- Jeffries, W.B., H.K. Voris & C.M. Yang (1989). Observations on the incidence of the pedunculate barnacle, *Octolasmis warwickii* (Gray, 1825) on horseshoe crabs (Xiphosura) in the seas adjacent to Singapore. *Raffles Bulletin of Zoology* 37(1–2): 58–62.
- Key, Jr. M.M., W.B. Jeffries, H.K. Voris, C.M. Yang & J.B.C. Jackson (2000). Bryozoan fouling pattern on the horseshoe crab *Tachypleus gigas* (Müller) from Singapore, pp. 265–271. In *Proceedings of the 11th International Bryozoology Association Conference*. Balboa: Smithsonian Tropical Research Institute.
- Key, Jr. M.M., W.B. Jeffries, H.K. Voris & C.M. Yang (1996). Epizoid bryozoans, horseshoe crabs, and other mobile benthic substrates. *Bulletin of Marine Science* 58(2): 368–384.
- Key, Jr. M.M., W.B. Jeffries, H.K. Voris & C.M. Yang (2000). Bryozoan fouling pattern on the horseshoe crab *Tachypleus gigas* (Müller) from Singapore, pp. 265–271. In *Proceedings of the 11th International Bryozoology Association Conference*.
- MacKenzie, C.L., Jr. (1979). Transportation of the oyster drill by horseshoe “crabs.” *Science* 137: 36–37.
- Mankeshwar, M., A. Kulkarni & D. Apte (2015). Diversity of Bryozoans of India with New Records from Maharashtra, pp. 95–106. In: Venkatraman, K. & C. Sivaperuman (eds.). *Marine Faunal Diversity in India Taxonomy, Ecology and Conservation*. Elsevier, USA. <https://doi.org/10.1016/B978-0-12-801948-1.00007-0>
- Marcos, E. (1937). Briozoários marinhos brasileiros I. Boletim da Faculdade de Filosofia, Ciências e Letras, Universidade de São Paulo. *Zoologia* 1: 3–224.
- Menon, N.R. & N.N. Menon (2006). Taxonomy of Bryozoa from the Indian EEZ. A monograph. Ocean Science and Technology Cell on Marine Benthos, Kochi and Centre for Marine Living Resources and Ecology, Kochi, 263 pp.
- Menon, N.R. & N.B. Nair (1967). The ectoproctous bryozoans of the Indian waters. *Journal of the Marine Biological Association India* 9(2): 12–17.
- Menon, N.R. (1967). Studies on the Polyzoa of the south west coast of India. PhD Thesis. University of Kerala, 548 pp.
- Osburn, R.C. (1950). Bryozoa of the Pacific Coast of America. part 2, Cheilostomata-Ascophora. *Allan Hancock Pacific Expeditions* 14: 1–269.
- Patil, J.S. & A.C. Anil (2000). Epibiotic community of the horseshoe crab *Tachypleus gigas*. *Marine Biology* 136: 699–713.
- Patil, J.S. & A.C. Anil (2000). Epibiotic community of the horseshoe crab *Tachypleus gigas*. *Marine Biology* 136(4): 699–713. <https://doi.org/10.1007/s002270050730>
- Pearse, A.S. (1947). On the occurrence of ectoconsorters on marine animals at Beaufort, NC. *Journal of Parasitic Diseases* 33: 453–458.
- Pillai, S.R.M. (1978). A new species of *Hippoporina* (Ectoprocta, Ascophora) from Bombay waters. *Current Science* 47: 61–63.
- Pillai, S.R.M. (1981). A further report on taxonomy of fouling bryozoans from Bombay harbor and vicinity. *Journal of the Bombay Natural History Society* 78: 317–329.
- Rao, K.V.R. & K.V.S. Rao (1972). Studies on Indian King crabs (Arachnida: Xiphosura). *Proceedings of Indian National Science Academy* 38(3/4): 206–211.
- Raveendran, T.V., A.P. DeSouza & A.B. Waugh (1990). Fouling Polyzoans of Bombay off shore waters. *Mahasagar* 23(2): 69–178.
- Renouf, L.P.W. (1932). *Xantho inciscus* Leach and *Cancer pagurus* L., infested with *Sacculina carcini* Thompson, on the south coast of Co. Cork. *Annals and Magazine of Natural History* 10: 132–133.
- Robertson, A. (1921). Report on a collection of Bryozoa from the Bay of Bengal and other eastern seas. *Records of the Indian Museum* 22: 33–65.
- Roonwal, M.L. (1944). Some observations on the breeding biology, and on the swelling, weight, water content and embryonic movements in the developing, eggs, of the Moluccan King-crab, *Tachypleus gigas* (Müller) (Arthropoda: Xiphosura). *Proceedings of the Indian Academy of Sciences-Section B* 20(4): 115–129.
- Saha, D. (1989). Status survey, breeding biology and some aspects of morphology by SEM study of Xiphosurid Arthropods in Indian coastal waters. PhD Thesis. Department of Zoology, University of Calcutta, viii+106 pp.
- Shrinivaasu, S., C. Venkatraman, R. Rajkumar & K. Venkataraman (2015). Marine Bryozoans of India, pp. 321–337. In: Venkataraman, K., C. Raghunathan, T. Mondal & R. Raghuraman (eds.). *Lesser Known Marine Animals of India*. Zoological Survey of India, Kolkata, 1–550 pp.
- Shuster, C.N., Jr. (1982). A pictorial view of the natural history and ecology of the horseshoe crab *Limulus polyphemus*, with references to other Limulidae, pp. 1–52. In: Bonaventura, J., C. Bonaventura & S. Tesh (eds.). *Physiology and biology of the horseshoe crabs: Studies on normal and environmentally stressed animals*. Alan R. Liss, New York.
- Soja, L. (2006). Taxonomy, bionomics and biofouling of bryozoans from the coast of India and the Antarctic waters. PhD Thesis. Cochin University of Science and Technology, viii+336 pp.
- Stoliczka, F. (1868). On the anatomy of *Sagartia schilleriana* and *Membranipora bengalensis*, a new coral and a Bryozoa living in brackish water at Port Canning. *Journal of The Asiatic Society of Bengal* 38: 28–63.
- Swami, B.S. & A.A. Karande (1987). Encrusting bryozoans in coastal waters of Bombay. *Mahasagar. Bulletin of the National Institute of Oceanography* 20(4): 225–236.
- Swami, B.S. & A.A. Karande (1994). Encrusting bryozoans in Karwar waters, central west coast of India. *Indian Journal of Marine Sciences* 23(3): 170–172.
- Swami, B.S. & M. Udhayakumar (2010). Seasonal influence on settlement, distribution and diversity of organisms at Mumbai harbour. *Indian Journal of Marine Sciences* 39(1): 57–67.
- Tan, A.N., A. Christianus & M.A. Satar (2011). Epibiont infestation on horseshoe crab *Tachypleus gigas* (Müller) at Pantai Balok in Peninsular Malaysia. *Our Nature* 9(1): 9–15.
- Thornely, L.R. (1907). Report on the marine Polyzoa in the collection of the Indian Museum. *Records of the Indian Museum*, Kolkata 1: 179–196.
- Tripathy, B., A. Mohapatra & A.K. Mukhopadhyay (2016). An assessment of taxonomic status, conservation and sustainable utilization of the horseshoe crab resources along the east coast of India. Final technical report. Zoological Survey of India, Kolkata, 121 pp.
- Tripathy, B., A. Mohapatra & A.K. Mukhopadhyay (2018). Status survey of Horseshoe Crabs along the East Coast of India. Status Survey Report. Zoological Survey India, Kolkata, 13: 109 pp.
- Tripathy, S.K., S. Resmi & A. Lahiri (2016). Comparative study of bryozoans from inner shelf of Andaman and Nicobar Islands. *Indian Journal of Geosciences* 70(1): 79–90.
- Nair, N.U. (1973). Observations on the fouling characteristics of four bryozoans in Cochin harbour. *Fishery Technology* 1(1): 61–65.
- Venkataraman, C., P. Padmanaban, S. Louis & S. Shrinivaasu (2018). Marine bryozoans of Gujarat and Maharashtra. *Records of the Zoological Survey of India* 118(4): 389–404. <https://doi.org/10.26515/rzsi/v118/i4/2018/122918>
- Watts, E. (1957). A Survey of the Bryozoa in the Southwest Portion of Delaware Bay, with Special Reference to those Species on the Blue Crab, *Callinectes sapidus*. *Delaware Mar Lab* 57(7): 1–19.
- Xi-Xing, L. (1992). On the genus *Membranipora* (Anasca: Cheilostomata: Bryozoa) from south Chinese seas. *Raffles Bulletin of Zoology* 40: 103–144.
- Ziko, A. & F. Hamza (1987). Bryozoan fauna from a post-Pliocene outcrop north of the Giza Pyramids Plateau, Egypt, pp. 301–308. In: Ross, J.R.P. (ed.). *Bryozoa: Present and Past*. Western Washington University, Bellingham, Washington.

Dr. Albert G. Orr, Griffith University, Nathan, Australia  
Dr. Sameer Padhye, Katholieke Universiteit Leuven, Belgium  
Dr. Nancy van der Poorten, Toronto, Canada  
Dr. Kareen Schnabel, NIWA, Wellington, New Zealand  
Dr. R.M. Sharma, (Retd.) Scientist, Zoological Survey of India, Pune, India  
Dr. Manju Siliwal, WILD, Coimbatore, Tamil Nadu, India  
Dr. G.P. Sinha, Botanical Survey of India, Allahabad, India  
Dr. K.A. Subramanian, Zoological Survey of India, New Alipore, Kolkata, India  
Dr. P.M. Sureshan, Zoological Survey of India, Kozhikode, Kerala, India  
Dr. R. Varatharajan, Manipur University, Imphal, Manipur, India  
Dr. Eduard Vives, Museu de Ciències Naturals de Barcelona, Terrassa, Spain  
Dr. James Young, Hong Kong Lepidopterists' Society, Hong Kong  
Dr. R. Sundararaj, Institute of Wood Science & Technology, Bengaluru, India  
Dr. M. Nithyanandan, Environmental Department, La La Al Kuwait Real Estate. Co. K.S.C., Kuwait  
Dr. Himender Bharti, Punjabi University, Punjab, India  
Mr. Purnendu Roy, London, UK  
Dr. Saito Motoki, The Butterfly Society of Japan, Tokyo, Japan  
Dr. Sanjay Sondhi, TITLI TRUST, Kalpvriksh, Dehradun, India  
Dr. Nguyen Thi Phuong Lien, Vietnam Academy of Science and Technology, Hanoi, Vietnam  
Dr. Nitin Kulkarni, Tropical Research Institute, Jabalpur, India  
Dr. Robin Wen Jiang Ngiam, National Parks Board, Singapore  
Dr. Lionel Monod, Natural History Museum of Geneva, Genève, Switzerland.  
Dr. Asheesh Shivam, Nehru Gram Bharti University, Allahabad, India  
Dr. Rosana Moreira da Rocha, Universidade Federal do Paraná, Curitiba, Brasil  
Dr. Kurt R. Arnold, North Dakota State University, Saxony, Germany  
Dr. James M. Carpenter, American Museum of Natural History, New York, USA  
Dr. David M. Claborn, Missouri State University, Springfield, USA  
Dr. Kareen Schnabel, Marine Biologist, Wellington, New Zealand  
Dr. Amazonas Chagas Júnior, Universidade Federal de Mato Grosso, Cuiabá, Brasil  
Mr. Monsoon Jyoti Gogoi, Assam University, Silchar, Assam, India  
Dr. Heo Chong Chin, Universiti Teknologi MARA (UiTM), Selangor, Malaysia  
Dr. R.J. Shiel, University of Adelaide, SA 5005, Australia  
Dr. Siddharth Kulkarni, The George Washington University, Washington, USA  
Dr. Priyadarsanan Dharma Rajan, ATREE, Bengaluru, India  
Dr. Phil Alderslade, CSIRO Marine And Atmospheric Research, Hobart, Australia  
Dr. John E.N. Veron, Coral Reef Research, Townsville, Australia  
Dr. Daniel Whitmore, State Museum of Natural History Stuttgart, Rosenstein, Germany.  
Dr. Yu-Feng Hsu, National Taiwan Normal University, Taipei City, Taiwan  
Dr. Keith V. Wolfe, Antioch, California, USA  
Dr. Siddharth Kulkarni, The Hormiga Lab, The George Washington University, Washington, D.C., USA  
Dr. Tomas Ditrich, Faculty of Education, University of South Bohemia in Ceske Budejovice, Czech Republic  
Dr. Mihaly Foldvari, Natural History Museum, University of Oslo, Norway  
Dr. V.P. Niyal, Wildlife Institute of India, Dehradun, Uttarakhand 248001, India  
Dr. John T.D. Caleb, Zoological Survey of India, Kolkata, West Bengal, India  
Dr. Priyadarsanan Dharma Rajan, Ashoka Trust for Research in Ecology and the Environment (ATREE), Royal Enclave, Bangalore, Karnataka, India

#### Fishes

Dr. Neelesh Dahanukar, IISER, Pune, Maharashtra, India  
Dr. Topiltzin Contreras MacBeath, Universidad Autónoma del estado de Morelos, México  
Dr. Heok Hee Ng, National University of Singapore, Science Drive, Singapore  
Dr. Rajeev Raghavan, St. Albert's College, Kochi, Kerala, India  
Dr. Robert D. Sluka, Chiltern Gateway Project, A Rocha UK, Southall, Middlesex, UK  
Dr. E. Vivekanandan, Central Marine Fisheries Research Institute, Chennai, India  
Dr. Davor Zanella, University of Zagreb, Zagreb, Croatia  
Dr. A. Biju Kumar, University of Kerala, Thiruvananthapuram, Kerala, India  
Dr. Akhilesh K.V., ICAR-Central Marine Fisheries Research Institute, Mumbai Research Centre, Mumbai, Maharashtra, India  
Dr. J.A. Johnson, Wildlife Institute of India, Dehradun, Uttarakhand, India

#### Amphibians

Dr. Sushil K. Dutta, Indian Institute of Science, Bengaluru, Karnataka, India  
Dr. Annemarie Ohler, Muséum national d'Histoire naturelle, Paris, France

#### Reptiles

Dr. Gernot Vogel, Heidelberg, Germany  
Dr. Raju Vyas, Vadodara, Gujarat, India  
Dr. Pritpal S. Soorae, Environment Agency, Abu Dhabi, UAE.  
Prof. Dr. Wayne J. Fuller, Near East University, Mersin, Turkey  
Prof. Chandrashekhler U. Rivonker, Goa University, Taleigao Plateau, Goa, India  
Dr. S.R. Ganesh, Chennai Snake Park, Chennai, Tamil Nadu, India  
Dr. Himansu Sekhar Das, Terrestrial & Marine Biodiversity, Abu Dhabi, UAE

#### Birds

Dr. Hem Sagar Baral, Charles Sturt University, NSW Australia  
Dr. Chris Bowden, Royal Society for the Protection of Birds, Sandy, UK  
Dr. Priya Davidar, Pondicherry University, Kalapet, Puducherry, India  
Dr. J.W. Duckworth, IUCN SSC, Bath, UK  
Dr. Rajah Jayapal, SACON, Coimbatore, Tamil Nadu, India  
Dr. Rajiv S. Kalsi, M.L.N. College, Yamuna Nagar, Haryana, India  
Dr. V. Santharam, Rishi Valley Education Centre, Chittoor Dt., Andhra Pradesh, India  
Dr. S. Balachandran, Bombay Natural History Society, Mumbai, India  
Mr. J. Praveen, Bengaluru, India  
Dr. C. Srinivasulu, Osmania University, Hyderabad, India  
Dr. K.S. Gopi Sundar, International Crane Foundation, Baraboo, USA  
Dr. Gombobaatar Sunde, Professor of Ornithology, Ulaanbaatar, Mongolia  
Prof. Reuven Yosef, International Birding & Research Centre, Eilat, Israel  
Dr. Taej Mundkur, Wetlands International, Wageningen, The Netherlands  
Dr. Carol Inskipp, Bishop Auckland Co., Durham, UK  
Dr. Tim Inskipp, Bishop Auckland Co., Durham, UK  
Dr. V. Gokula, National College, Tiruchirappalli, Tamil Nadu, India  
Dr. Arkady Lelej, Russian Academy of Sciences, Vladivostok, Russia  
Dr. Simon Dowell, Science Director, Chester Zoo, UK  
Dr. Mário Gabriel Santiago dos Santos, Universidade de Trás-os-Montes e Alto Douro, Quinta de Prados, Vila Real, Portugal  
Dr. Grant Connette, Smithsonian Institution, Royal, VA, USA  
Dr. M. Zafar-ul Islam, Prince Saud Al Faisal Wildlife Research Center, Taif, Saudi Arabia

#### Mammals

Dr. Giovanni Amori, CNR - Institute of Ecosystem Studies, Rome, Italy  
Dr. Anwaruddin Chowdhury, Guwahati, India  
Dr. David Mallon, Zoological Society of London, UK  
Dr. Shomita Mukherjee, SACON, Coimbatore, Tamil Nadu, India  
Dr. Angie Appel, Wild Cat Network, Germany  
Dr. P.O. Nameer, Kerala Agricultural University, Thrissur, Kerala, India  
Dr. Ian Redmond, UNEP Convention on Migratory Species, Lansdown, UK  
Dr. Heidi S. Riddle, Riddle's Elephant and Wildlife Sanctuary, Arkansas, USA  
Dr. Karin Schwartz, George Mason University, Fairfax, Virginia.  
Dr. Lala A.K. Singh, Bhubaneswar, Orissa, India  
Dr. Mewa Singh, Mysore University, Mysore, India  
Dr. Paul Racey, University of Exeter, Devon, UK  
Dr. Honnavalli N. Kumara, SACON, Anaikatty P.O., Coimbatore, Tamil Nadu, India  
Dr. Nishith Dharaiya, HNG University, Patan, Gujarat, India  
Dr. Spartaco Gippoliti, Socio Onorario Società Italiana per la Storia della Fauna "Giuseppe Altobello", Rome, Italy  
Dr. Justus Joshua, Green Future Foundation, Tiruchirappalli, Tamil Nadu, India  
Dr. H. Raghuram, The American College, Madurai, Tamil Nadu, India  
Dr. Paul Bates, Harison Institute, Kent, UK  
Dr. Jim Sanderson, Small Wild Cat Conservation Foundation, Hartford, USA  
Dr. Dan Challenger, University of Kent, Canterbury, UK  
Dr. David Mallon, Manchester Metropolitan University, Derbyshire, UK  
Dr. Brian L. Cypher, California State University-Stanislaus, Bakersfield, CA  
Dr. S.S. Talmale, Zoological Survey of India, Pune, Maharashtra, India  
Prof. Karan Bahadur Shah, Budhanilakantha Municipality, Kathmandu, Nepal  
Dr. Susan Cheyne, Borneo Nature Foundation International, Palangkaraja, Indonesia  
Dr. Hemanta Kafley, Wildlife Sciences, Tarleton State University, Texas, USA

#### Other Disciplines

Dr. Aniruddha Belsare, Columbia MO 65203, USA (Veterinary)  
Dr. Mandar S. Paingankar, University of Pune, Pune, Maharashtra, India (Molecular)  
Dr. Jack Tordoff, Critical Ecosystem Partnership Fund, Arlington, USA (Communities)  
Dr. Ulrike Streicher, University of Oregon, Eugene, USA (Veterinary)  
Dr. Hari Balasubramanian, EcoAdvisors, Nova Scotia, Canada (Communities)  
Dr. Rayanna Hellem Santos Bezerra, Universidade Federal de Sergipe, São Cristóvão, Brazil  
Dr. Jamie R. Wood, Landcare Research, Canterbury, New Zealand  
Dr. Wendy Collinson-Jonker, Endangered Wildlife Trust, Gauteng, South Africa  
Dr. Rajeshkumar G. Jani, Anand Agricultural University, Anand, Gujarat, India  
Dr. O.N. Tiwari, Senior Scientist, ICAR-Indian Agricultural Research Institute (IARI), New Delhi, India  
Dr. L.D. Singla, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India  
Dr. Rupika S. Rajakaruna, University of Peradeniya, Peradeniya, Sri Lanka  
Dr. Bahar Baviskar, Wild-CER, Nagpur, Maharashtra 440013, India

#### Reviewers 2018–2020

Due to paucity of space, the list of reviewers for 2018–2020 is available online.

The opinions expressed by the authors do not reflect the views of the Journal of Threatened Taxa, Wildlife Information Liaison Development Society, Zoo Outreach Organization, or any of the partners. The journal, the publisher, the host, and the partners are not responsible for the accuracy of the political boundaries shown in the maps by the authors.

**Journal of Threatened Taxa** is indexed/abstracted in Bibliography of Systematic Mycology, Biological Abstracts, BIOSIS Previews, CAB Abstracts, EBSCO, Google Scholar, Index Copernicus, Index Fungorum, JournalSeek, National Academy of Agricultural Sciences, NewJour, OCLC WorldCat, SCOPUS, Stanford University Libraries, Virtual Library of Biology, Zoological Records.

NAAS rating (India) 5.64

Print copies of the Journal are available at cost. Write to:  
The Managing Editor, JoTT,  
c/o Wildlife Information Liaison Development Society,  
No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road,  
Saravanampatti, Coimbatore, Tamil Nadu 641035, India  
ravi@threatenedtaxa.org



OPEN ACCESS



The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at [www.threatenedtaxa.org](http://www.threatenedtaxa.org). All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

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

October 2021 | Vol. 13 | No. 12 | Pages: 19675–19886

Date of Publication: 26 October 2021 (Online & Print)

DOI: 10.11609/jott.2021.13.12.19675-19886

[www.threatenedtaxa.org](http://www.threatenedtaxa.org)

#### Articles

**Roosting habits and habitats of the Indian Flying Fox *Pteropus medius* Temminck, 1825 in the northern districts of Tamil Nadu, India**  
– M. Pandian & S. Suresh, Pp. 19675–19688

**Diversity and distribution of avifauna at Warathenna-Hakkinda Environmental Protection Area in Kandy, Sri Lanka**  
– Dinelka Thilakarathne, Tithira Lakkana, Gayan Hirimuthugoda, Chaminda Wijesundara & Shalika Kumburegama, Pp. 19689–19701

**Grass species composition in tropical forest of southern India**  
– M. Ashokkumar, S. Swaminathan & R. Nagarajan, Pp. 19702–19713

#### Communications

**Habitat use and conservation threats to Wild Water Buffalo *Bubalus arnee* (Mammalia: Artiodactyla: Bovidae) in Koshi Tappu Wildlife Reserve, Nepal**  
– Reeta Khulal, Bijaya Neupane, Bijaya Dhami, Siddhartha Regmi, Ganesh Prasad Tiwari & Manita Parajuli, Pp. 19714–19724

**Get my head around owls: people perception and knowledge about owls of Andaman Islands**  
– Shanmugavel Sureshmarimuthu, Santhanakrishnan Babu, Nagaraj Rajeshkumar & Honnavalli Nagaraj Kumara, Pp. 19725–19732

**Abundance and diversity of threatened birds in Nangal Wetland, Punjab, India**  
– Rajwinder Kaur & Onkar Singh Braich, Pp. 19733–19742

**Evaluation of fish diversity and abundance in the Kabul River with comparisons between reaches above and below Kabul City, Afghanistan**  
– Ugyen Kelzang, Ahmad Farid Habibi & Ryan J. Thoni, Pp. 19743–19752

**New record of *Myrmarachne melanocephala* MacLeay, 1839 (Araneae: Salticidae) from Jharkhand, India and biogeographical implications of the co-occurrence of its ant model *Tetraponera rufonigra* Jerdon, 1851**  
– Rahul Kumar, Mirtunjay Sharma & Ajay Kumar Sharma, Pp. 19753–19761

**Diversity of spiders (Arachnida: Araneae) and the impact of pruning in Indian sandalwood plantations from Karnataka, India**  
– S. Padma 1 & R. Sundararaj, Pp. 19762–19772

**New records of cheilostome Bryozoa from the eastern coast of India encrusting on the exoskeleton of live horseshoe crabs of Indian Sundarbans**  
– Swati Das, Maria Susan Sanjay, Basudev Tripathy, C. Venkatraman & K.A. Subramanian, Pp. 19773–19780

**On the pteridophytes of Bherjan-Borajan-Padumoni Wildlife Sanctuary, Assam, India**  
– Pranjal Borah & Jayanta Barukial, Pp. 19781–19790

**Population status of *Heritiera fomes* Buch.-Ham., a threatened species from Mahanadi Mangrove Wetland, India**  
– Sudam Charan Sahu, Manas Ranjan Mohanta & N.H. Ravindranath, Pp. 19791–19798

**Additions to the lichenized and lichenicolous fungi of Jammu & Kashmir from Kishtwar High Altitude National Park**  
– Vishal Kumar, Yash Pal Sharma, Siljo Joseph, Roshinikumar Ngangom & Sanjeeva Nayaka, Pp. 19799–19807

#### Short Communications

**Is release of rehabilitated wildlife with embedded lead ammunition advisable? Plumbism in a Jaguar *Panthera onca* (Mammalia: Carnivora: Felidae), survivor of gunshot wounds**  
– Eduardo A. Díaz, Carolina Sáenz, E. Santiago Jiménez, David A. Egas & Kelly Swing, Pp. 19808–19812

**New record of the Sewing Needle Zipper Loach *Paracanthocobitis linypha* Singer & Page, 2015 (Teleostei: Cypriniformes: Nemacheilidae) from the Chindwin drainage of Manipur, India**  
– Yumnam Rameshori, Yengkhom Chinglemba & Waikhom Vishwanath, Pp. 19813–19817

**Field identification characters to diagnose *Microhyla mukhlesuri* from closely related *M. mymensinghensis* (Amphibia: Microhylidae) and range extension of *M. mukhlesuri* up to West Bengal State, India**  
– Suman Pratihar & Kaushik Deuti, Pp. 19818–19823

**First report of *Scipinia horrida* (Stål) (Heteroptera: Reduviidae) from Assam, with comments on related genus *Irantha* Stål**  
– Anjana Singha Naorem, Santana Saikia, Anandita Buragohain, Rubina Azmeera Begum, Swapnil S. Boyane & Hemant V. Ghate, Pp. 19824–19830

**Flesh fly (Diptera: Sarcophagidae): male terminalia, diversity and expanded geographical distribution from India**  
– Kanholi Sreejith, Shuvra Kanti Sinha, Santanu Mahato & Edamana Pushpalatha, Pp. 19831–19836

**Checklist of moths (Heterocera) of Tadong, Sikkim, India**  
– Prayash Chettri, Yuki Matsui, Hideshi Naka & Archana Tiwari, Pp. 19837–19848

**New distribution records of *Begonia* L., *B. murina* Craib and *B. poilanei* Kiew (Begoniaceae: Cucurbitales) for Laos**  
– Phongphayboun Phonepaseuth, Phetlasy Souladeth, Soulivanh Lanorsavanh, Shuichiro Tagane, Thyraphon Vongthavone & Keoudone Souvannakhoummane Pp. 19849–19854

#### Notes

**A recent sighting of the Stripe-backed Weasel *Mustela strigidorsa* (Mammalia: Carnivora: Mustelidae) in Hkakabo Razi Landscape, Myanmar**  
– Sai Sein Lin Oo, Tun Tun, Kyaw Myo Naing & Paul Jeremy James Bates, Pp. 19855–19859

**Are the uplifted reef beds in North Andaman letting nesting Olive Ridley Sea Turtle *Lepidochelys olivacea* stranded?**  
– Nehru Prabakaran, Anoop Raj Singh & Vedagiri Thirumurugan, Pp. 19860–19863

**First record of the orb-weaving spider *Araneus tubabdominus* Zhu & Zhang, 1993 (Araneae: Araneidae) from India**  
– Souvik Sen, John T.D. Caleb & Shelley Acharya, Pp. 19864–19866

**The genus *Catapiestus* Perty, 1831 (Coleoptera: Tenebrionidae: Cnodalonini) from Arunachal Pradesh with one new record to India**  
– V.D. Hegde & Sarita Yadav, Pp. 19867–19869

**Rediscovery and extended distribution of *Indigofera santapau* Sanjappa (Leguminosae: Papilionoideae) from the states of Maharashtra and Gujarat, India**  
– Kumar Vinod Chhotupuri Gosavi, Sanjay Gajanan Auti, Sharad Suresh Kambale & Munivenkatappa Sanjappa, Pp. 19870–19873

**Additional distribution records of *Ceropegia anjanerica*, an endemic and 'Endangered' lantern flower of the northern Western Ghats, India**  
– Samir Shrikant Maity, Ajay Natha Gangurde, Sharad Suresh Kambale, Avinash Ramchandra Gholave, Avinash Asraji Adsul, Ganesh Babaso Pawar & Kumar Vinod Chhotupuri Gosavi, Pp. 19874–19877

**Notes on the extended distribution of *Impatiens megamalayana*, a recently described balsam in Western Ghats, India**  
– Anoop P. Balan & A.J. Robi, Pp. 19878–19883

#### Book Review

**A look over on the scented tree of India (*Santalum album*)**  
– S. Suresh Ramanan & A. Arunachalam, Pp. 19884–19886

Publisher & Host

