Occurrence of marine sponge *Chelonaplysilla delicata* Pulitzer-Finali & Pronzato, 1999 (Porifera: Demospongiae: Darwinellidae) from the Andaman Islands and the Indian Ocean: An indication of unexplored sessile habitat on mesophotic shipwrecks

Rocktim Ramen Das[1,3]*, Titus Immanuel[1], Raj Kiran Lakra[1], Karan Baath[1] and Ganesh Thiruchitrambalam[1]

[1]Department of Ocean Studies and Marine Biology, Pondicherry University, Brookshabad, Andaman Islands, India; [2]Infinity Scuba Andaman's, Chidiyatapu, Andaman Islands, India; [3]Graduate School of Engineering and Science, University of the Ryukyus, Nishihara, Okinawa, Japan.

Corresponding author: Rocktim Ramen Das; Email: k188604@cs.u-ryukyu.ac.jp

Titus Immanuel: titusimmanuel@gmail.com

Raj Kiran Lakra: rajkiranlakra@gmail.com

Karan Baath: karan123divewithme@gmail.com

T. Ganesh: tganesh.es@gmail.com

Occurrence of marine sponge *Chelonaplysilla delicata* Pulitzer-Finali & Pronzato, 1999 (Porifera: Demospongiae: Darwinellidae) from the Andaman Islands and the Indian Ocean: An indication of unexplored sessile habitat on mesophotic shipwrecks

Rocktim Ramen Das[1,3]*, Titus Immanuel[1], Raj Kiran Lakra[1], Karan Baath[1] and Ganesh Thiruchitrambalam[1]

[1]Department of Ocean Studies and Marine Biology, Pondicherry University, Brookshabad, Andaman Islands, India; [2]Infinity Scuba Andaman's, Chidiyatapu, Andaman Islands, India; [3]Graduate School of Engineering and Science, University of the Ryukyus, Nishihara, Okinawa, Japan.

Corresponding author: Rocktim Ramen Das; Email: k188604@cs.u-ryukyu.ac.jp

Abstract

During a biodiversity assessment on an upper mesophotic artificial reef of Andaman and Nicobar Islands (Shipwreck: HMIS Sophie Marie/HMIS SM), a single specimen of sponge *Chelonaplysilla delicata* was recorded. Our finding confirms the species taxonomy and highlights the current observation as a first report from the Andaman and Nicobar Islands and the Indian Ocean. Further indicating the significance of old sunken structures surrounding the islands.

Keywords: *Chelonaplysilla delicata*, Indian Ocean, Biodiversity, Porifera, Andaman and Nicobar Islands

Introduction

The Andaman and Nicobar Islands (ANI) (Figure 1) is an archipelago that lies in the eastern side of Bay of Bengal, bounded by the Andaman Sea on the west[1]. These islands support a diverse

coral reef ecosystem that harbours a plethora of marine organisms[2]. Most faunal groups that have been studied extensively in these waters are large-sized, conspicuous and are of economic importance[3] however, areas in the mesophotic depths remain poorly explored. The study of sponge distribution in the islands, though have existed since the early 19th century[4-11], numerous recent works have revealed many undocumented and new species[12-19] indicating its high diversity.

The coastal and offshore waters of ANI consist of a number of shipwrecks both in the shallow and mesophotic zones. These sunken structures act as an artificial reef providing space for growth and establishment of various sessile marine communities creating a habitat intricacy[20-22]. Being a dominant group in shipwreck driven ecosystem, poriferans are capable of colonizing in a relatively short period[20, 23-27]. Although globally numerous studies have been conducted on these environments, shipwrecks remain less studied in the mesophotic zones (F. Sinniger pers comm). However, recent attempts to explore shallow wrecks has revealed interesting results[22, 28-31].

Our findings document the presence of the marine sponge *Chelonaplysilla delicata* from the Andaman and Nicobar Islands and the Indian Ocean and highlights the need to explore the rich unexplored fauna of mesophotic shipwrecks.

Materials and Methods

The sponge *C.delicata* (Figure 2), collected from the shipwreck HMIS SM (Figure 2, 3) during a survey conducted for documenting epifaunal diversity from February to March 2014. The shipwreck is a 70m long Royal Indian navy minesweeper that sank in the year of 1942 (Figure 3). At a depth of ≈33 meters, the wreck lies at the edge of the Macpherson strait near Chidiyatapu (11º28’38.02”N 92º42’12.20”E), the southernmost tip of South Andaman Island (Fig. 1). Water transparency and temperature were recorded with Secchi disc and dive calculator. Within 2 hours after

collection, the specimen was preserved in 100% ethanol. A surface peel of the easily separable cortex of the specimen was removed and placed in xylene for 24 hours after which a permanent slide of the peel was mounted with DPX. A single fibre with its base and branches intact was removed from the sponge for species-level identification under a stereo microscope. (Figure 2B - D). The specimen was identified following Finali and Pronzato[32]. The preserved specimen is deposited in the National Zoological Collections (NZC) of the Andaman and Nicobar Regional Centre (ANRC), Zoological Survey of India (ZSI), Port Blair. Study maps were created using QGis.

Results

Taxonomy and Description

Phylum: Porifera

Class: Demospongiae

Subclass: Keratosa

Order: Dendroceratida

Family: Darwinellidae

Genus: *Chelonaplysilla*

Species: *C. delicata* Pulitzer-Finali & Pronzato, 1999

Materials Examined: 1 ex (Paratype)., ZSI/ANRC – 14321, India: Andaman Island: South Andaman: Chidiyatapu (11º28’38.02”N 92º42’12.20”E). Coll. RRD, 2014

Description: *C.delicata* predominantly thickly encrusting (< 10 mm) but has erect lobes that are about 4 - 5 cm high. The sponge surface is conulose, and the acute conules separated from each other by 2 - 5 mm. Oscules 1 - 3 mm in diameter, flush with the surface and unevenly distributed all over on sponge surface. The texture is soft collapsible and feeble. The fresh specimen was dark violet or purple in colour and retained its colour even in the preserved condition. Sponge surface covered by structured regular reticulation of sand and spicule detritus, which forms regular roundish or oval meshes of 90 - 155 µm. This reticulation is typical of the genus. Regular rounded fibrous pores, inhalant in nature are enclosed within these rounded meshes (Figure 2D). The skeleton is dendritic, made up of pigmented fibres fragile in nature with repeated branching that originate from a basal spongin plate (Fig. 4B and 4C) and extends towards the boundary. The primary fibre measured to be around 0.4 mm at its thickest. Spicules are absent.

Distribution: India: ANI (South Andman, Present study). Elsewhere: Bismark Sea (Papua New Guinea)[32], Indonesia (Sulawesi)[33], Palau[34], French Polynesia[35].

Similar Species: *C.delicata* is very similar to *C.erecta*[36]; however, the latter has fibres anastomosing in nature whereas the thickness of fibres in *C.delicata* fades in diameter. Our specimen was initially identified as *C.erecta*[29].

Remarks: The specimen mentioned in Finali and Pronzato[32] is gray whereas our specimen in dark maroon in live condition.

Comments: The family Darwinellidae possesses sponging fibres with proper skeleton and fibrous spicules[37,38]. It consists of four recognized genus and forty-seven accepted species (one under "nomen nudum" status). *Chelonaplysilla* is the only genus, which is devoid of spicules but consists of a fibrous dendritic skeleton that possesses distinct laminated bark surrounding a central pith region. A

103 structured and separable cortex that is reinforced by a delicate reticulation of sand grains[38]
104 distinguishes this genus.

105 Wreck Biodiversity: The surface of the wreck surveyed consisted of various sessile
106 communities[31], revised identification of which revealed the presence of encrusting Sponges, Tunicates,
107 Bryozoans, and Hydroids. Ahermatypic corals of family Dendrophylliidae (*Tubastrea*) were common
108 and easily visible (Figure 3). Solitary corals (*Heterocyathus*) were scattered in few vertical areas. Reef-
109 building corals were relatively less in abundance. The observed corals include *Favia*, *Symphyllia*,
110 *Podabacia crustacea*, and *Leptoseris*. A Gastropod (*Chicoreus* sp.) and few Crinoids were also present.
111 Poriferan families which were identified during the survey include Ircinidae (*Ircinia*), Chalinidae
112 (*Haliclona* (*Reniera*)); Thorectidae (*Hyrtios*), Iotrochotidae (*Iotrochota baculifera*), Thorectidae
113 (*Dactylospongia*). Tunicates comprised of Didemnidae (*Didemnum*), Perophoridae (*Perophora*) and
114 other unidentified sp. Macroalgae were absent however areas covered with a mix of turf algae and
115 encrusting crustose algae (ECA). The mean temperature in the area was 26.5º C.

116 ## Discussion

117 The Faunal organisms that thrives in Artificial Reefs (Shipwrecks) is an important part of the
118 marine community[27,39]. With increasing anthropogenic impacts on natural coral reef habitats, artificial
119 reefs are regarded as a successful alternative[25]. As a result, it becomes important to understand the
120 biological communities growing on these habitats[26]. Since a stable structural feature can lead a
121 centennial shipwreck to mimic a natural coral reef ecosystem[39,40], the necessity to investigate pre-
122 existing shipwrecks in a mesophotic zone can provide insights on these complex ecosystems. The
123 faunal assemblages in shipwrecks vary with horizontal and vertical orientation[39]. Such assemblages
124 enhance food resources for fishes, increasing its abundance thus improving diversity[20]. Sponges which
125 naturally occupy shipwrecks are one of the dominant organisms in such habitat, as evidenced by many

126 studies[20,21,26,27,41,42]. Their presence in large numbers also signifies advance stages of community
127 succession[20,43]. Sponges are known to play an important role in ecological recycling, habitat formation
128 for other organisms, acting as functional connecters between the benthic community and ocean
129 productivity and are also known to replace corals[44,45].

130 Environmental parameters like depth and light penetration play an important role in the
131 distribution and presence of communities in a shipwreck[20,39]. Lower light intensity in the study area can
132 contribute towards the abundance of poriferans and ahermatypic corals (*Tubastrea* sp.) (Figure 1), by
133 limiting macroalgal growth[31,39]. Yogesh-Kumar et al.[30] reported high sponge cover when studying
134 other wrecks in the region; however, the live coral coverage remains contrasting, indicating the role of
135 regional stressors and geolocation. Sponges that inhabit mesophotic areas mainly rely on plankton
136 feeding rather than photosymbionts and have higher growth rates due to the limited light intensity[45,46].
137 In the Caribbean's, sponge density seems to be directly proportional to depth[44]. Moreover, the
138 difference in current velocities affects the growth and development of filter feeders like sponges
139 present in the shipwrecks[39]. Higher current velocities through the Macpherson strait (Figure 1) can
140 effectively determine the faunal assemblage of HMIS SM but a long-term monitoring is necessary in
141 this regard.

142 The occurrence of a sponge from the deepest (Upper mesophotic region) and oldest wreck
143 (WWII) studied in the area sheds light on the vast and rich biodiversity that thrives on such habitats
144 and awaits much-needed attention from the scientific community. Technical gaps have always been a
145 hurdle to study mesophotic ecosystems but with the advancement of time, technologies like automated
146 underwater vehicle (AUV), remotely operated underwater vehicle (ROV), submersible's etc. can be
147 well utilized for the exploration of shipwrecks in such depths. It should be noted that the recent use of
148 ROV in ANI (see. Ramesh et al.[47]) and the documentation of Mesophotic reefs off Puducherry coast[48]

is an important step that will further lead towards the exploration of deeper ecosystems in the region. Further, as only certain areas of the wreck were assessed, long-term repeated sampling, taking structural heterogeny, hydrodynamics, and other environmental parameters into account will possibly give a detailed picture of the faunal assemblages.

Acknowledgements

The authors thank Dr. P.M Mohan Former HOD, DOSMB, Pondicherry University, Mr. G. Sakthivel for providing information on HMIS SM. RRD acknowledges critical comments by Dr. K. Wangkulangkul (PSU, Thailand) on the initial draft, to Dr. F. Sinniger (University of the Ryukyus, Japan) for providing valuable insights on the mesophotic ecosystem.

References

1. Ubare, V.U. and Mohan, P.M., New Records and Range Extensions of Some Marine Sponges (Porifera: Demospongiae and Homoscleromorpha) from the Andaman Islands, India; Part of the Indo-Burma Biodiversity Hotspot. *Zool. Stud.*, 2018, DOI:10.6620/ZS.2018.57-03
2. Venkataraman K, *et al.*, 2012. Scleractinia of Andaman and Nicobar Islands. Kolkata: Zoological Survey of India.
3. Venkataraman, K. and Wafar, M., Coastal and Marine Biodiversity of India. *Indian J. Geomarine Sci.*, 2005, **34**(1): 57-75.
4. Schulze FE. 1902. An account of the Indian Triaxonia collected from the Royal Indian marine survey ship “Investigator” translated into English by R. von Lendenfeld. Trustees of the Indian museum, Calcutta, pp. 1-113
5. Schulze FE. 1904. Hexactinellida. Vol. 4 of the Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer" Valdivia" 1898-1899.

6. Dendy A. 1905. Report on the sponges collected by Professor Herdman at Ceylon in 1902. Ceylon Pearl Oyster Fisheries, Supplementary reports Royal Society London **XVIII**: 57-246.
7. Annandale, N., Indian Boring Sponges of the Family Clionidae. *Rec. Indian Museum*, 1915, **11**: 1-24.
8. Dendy A, Burton M. 1926. Report on Some Deep-Sea Sponges from the Indian Museum Collected by the R.I.M.S. 'Investigator'. Part I. Hexactinellida and Tetractinellida (PARS.). *Rec Indian Museum* **28**(4): 225-248.
9. Burton, M. and Rao, H.S., Report on the Shallow-Water Marine Sponges in the Collection of the Indian Museum. Part I. *Rec. Indian Museum*, 1932, **XXXXIV**: 299-358.
10. Burton M. 1937. Supplement to The Littoral Fauna of Krusadai Island in the Gulf of Manaar: Porifera. 2 vols. Calcutta: Government Press.
11. Rao H. S. 1941. Indian and Ceylon Sponges in the Naturalistoriska Riksmuseet, Stockholm, collected by K. Fistedt. *Rec Indian Museum* **XLIII**: 417–496.
12. Pattanayak JG. 2006. Marine Sponges of Andaman and Nicobar Islands, India. *Rec Zool Surv India* **255**: 1–152.
13. Vinod K, *et al.*, 2007. An Account of Hexactinellid Sponge, *Hyalonema* (*Cyliconema*) *apertum apertum* Collected from Andaman Waters. *JMBAI* **49**(2): 219-225.
14. Vinod K, *et al.*, 2012. *Semperella megaloxea* sp. nov. (Family: Pheronematidae): A new hexactinellid sponge from Andaman waters, India. *Indian J Fish* **59**: 33-36
15. Immanuel T, Raghunathan C. 2011. First Record of the Sponge *Damiria toxifera* (Poecilosclerida: Acarnidae) from the Andaman Sea, Andaman and Nicobar Islands. *Mar Biodivers Rec* **4**: e32.

16. Immanuel T, *et al.,* 2014. An Updated Report on the Diversity of Marine Sponges of the Andaman and Nicobar Islands. *In*: Venkataraman K, Sivaperuman C. (eds.) Marine Faunal Diversity in India: Taxonomy, Ecology and Conservation, Elseiver, pp. 3-13.
17. Immanuel T, *et al.,* 2016. New Records of *Chondrilla australiensis* and *Chondrilla grandistellata* (Demospongiae: Chondrosida: Chondrillidae) from Havelock Island, South Andaman, India. *J Threat Taxa* **7**(14): 8167-8172.
18. Ubare VU, Mohan PM. 2016. A New Species of Genus *Plakortis* Schulze 1880 (Porifera: Homoscleromorpha) from Badabalu, Andaman and Nicobar Islands, India. *Zool Stud* **55**(2): doi:10.6620/ZS.2016.55-02
19. Periera P, Raghunathan C. 2018. Diversity of sponges in Marine protected areas of North Andaman, India. *Thalassas*. https://doi.org/10.1007/s41208-018-0073-2
20. Walker SJ, *et al.,* 2007. Spatial Heterogeneity of Epibenthos on Artificial Reefs: Fouling Communities in the Early Stages of Colonization on an East Australian Shipwreck. *Marine Ecology* **28**: 435-445.
21. Lira SMA, *et al.,* 2010. Sessile and Sedentary Macrofauna from the Pirapama Shipwreck, Pernambuco, Brazil. *Biota Neotrop **10**(9): 155-165.*
22. Mondal T, Raghunathan C. 2017. Shipwrecks in Andaman and Nicobar Islands: An Artificial Habitat for Corals. *JMBAI* **59**(2): 92-101.
23. Aseltine-Neilson DA, *et al.*, 1999. Comparisons of Turf Communities from Pendleton Artificial Reef, Torrey Pines Artificial Reef, and a Natural Reef using Multivariate Techniques. *Bull Mar Sci* **65**(1): 37-57.
24. Clark S, Edwards AJ. 1999. An Evaluation of Artificial Reef Structures as Tools for Marine Habitat Rehabilitation in the Maldives. *Aquat Conserv* **9**(1): 5-21.

25. Perkol-Finkel S, Benayahu Y. 2005. Recruitment of Benthic Organisms onto a Planned Artificial Reef: Shifts in Community Structure One Decade Post Deployment. *Mar Environ Res* **59**(2): 79–99.

26. Thanner SE, *et al.,* 2006. Development of Benthic and Fish Assemblages on Artificial Reef Materials Compared to Adjacent Natural Reef Assemblages in Miami-Dade County, Florida. *Bull Mar Sci* **78**(1): 57-70.

27. Amaral FMD, *et al.,* . 2009/2010. Benthic Macrofauna Inventory of Two Shipwrecks from Pernambuco Coast, Northeastern of Brazil. *Revista Nordestina de Zoologia-Recife* **4**(1): 24-41.

28. Hema M. 2013. Fish Assemblage on Artificial Reef and Natural Reef (A Comparative Study). MSc Dissertation, Department of Ocean Studies and Marine Biology, Pondicherry University.

29. Das RR. 2014. An Inventory of Benthic Macrofauna from Two Shipwrecks along the Coast of South Andaman. MSc Dissertation, Department of Ocean Studies and Marine Biology, Pondicherry University.

30. Yogesh Kumar JS, *et al.,* 2015. An Assessment of Faunal Diversity and its conservation of shipwrecks in Indian seas. *In*: Venkataraman K, Sivaperuman C (eds.) Marine Faunal Diversity in India: Taxonomy, Ecology and Conservation, 441-450 USA: Elseiver, pp. 441-450.

31. Das RR, *et al.,* 2016. A preliminary macrobenthic study of world war two era wrecks along the coast of South Andaman. *In*: Bijukumar A, Pradeep NS, Ajit Kumar KG, Rajendran PG. (eds.) Perspectives on Biodiversity of India, Centre for Innovation in Science & Social Action (CISSA), pp. 83-92.

32. Pulitzer-Finali G, Pronzato R. 1999. Horny Sponges from the North-Eastern Coast of Papua New Guinea, Bismark Sea. *J Mar Biol Assoc U.K.* **79**(4): 593-607.

33. GBIF 2000

34. Ridley CP, *et al.*, 2005. Speciation and Biosynthetic variation in four dictyoceratid sponges and their cyanobacterial symbiont, *Oscillatoria spongeliae*. *Chemistry and Biology* **12**: 397-406.

35. *Hall KA, et al., 2017. Sponges of Polynesia. Papeete (PYF): IRD. pp. 827.*

36. Tsurnamal M. 1967. *Chelonaplysilla erecta* n. sp. (Demospongiae, Keratosa) from Mediterranean Coast of Israel. *Isr J Zool* **16**(2): 96-100.

37. Van Soest RWM. 1978. Marine Sponges from Curaçao and Other Caribbean localities Part I. Keratosa. Studies on the Fauna of Curaçao and Other Caribbean Islands **56**(1): 1-94.

38. Bergquist PR, Cook SC. 2002. Family Darwinellidae Merejkowsky, 1879. In: Hooper JNA, Van-Soest RWM. (eds.) Systema Porifera: A guide to the classification of Sponges, New York: Springer, pp. 1068-1071.

39. Zintzen V, *et al.*, 2006. Epifaunal inventory of two shipwrecks from the Belgian Continental Shelf. *Hydrobiologia* **555**(1): 207-219.

40. Perkol-Finkel S, *et al.*, 2006. Can Artificial Reefs Mimic Natural Reef Communities? The Roles of Structural Features and Age. *Mar Environ Res* **61**(2): 121-135.

41. Diaz MC, Rützler K. 2001. Sponges: An Essential Component of Caribbean Coral Reefs. *Bull Mar Sci* **69**(2): 535-546.

42. Cedro VR, *et al.*, 2007. Demospongiae (Porifera) of the shallow coral reefs of Maceió, Alagoas State, Brazil. *In*: Custódio MR, Lôbo- Hajdu G, Muricy G. (eds.) Porifera research biodiversity, innovation and sustainability, Rio de Janeiro: Museu Nacional, pp. 233-237.

43. Roberts DE, *et al.*, 2006. Structure and Dynamics of Sponge-Dominated Assemblages on Exposed and Sheltered Temperate Reefs. *Mar Ecol Prog Ser* **321**: 19–30.

44. Lesser MP, Slattery M. 2013. Ecology of Caribbean Sponges: are Top-Down or Bottom-Up Processes more Important?. *PloS one* **8**(11): e79799.

45. Sinniger F, *et al.*, 2016. Biodiversity of mesophotic coral ecosystems. *In*: Baker EK, Puglise KA, Harris PT. (eds.) Mesophotic coral ecosystems A lifeboat for coral reefs.?, Arendal and Nairobi: UNEP and GRID, pp. 50-58.

46. Baker E, *et al.*, 2016. What are mesophotic coral ecosystems.? *In*: Baker EK, Puglise KA, Harris PT (eds.) Mesophotic coral ecosystems A lifeboat for coral reefs.?, Arendal and Nairobi: UNEP and GRID, pp. 11-19.

47. Ramesh S, *et al.*, 2017. Application of Indigenously developed Remotely Operated Vehicle for the study of Driving Parameters of Coral Reef Habitat of South Andaman Islands, India. *Curr Sci* doi: 10.18520/cs/v113/i12/2353-2359.

48. Laxmilatha P, Jasmine S, Sreeram MP, Rengaiyan P. 2019. Benthic communities of mesophotic coral ecosystem off Puducherry east coat of India. *Curr Sci* doi: 10.18520/cs/v116/i6/982-987.

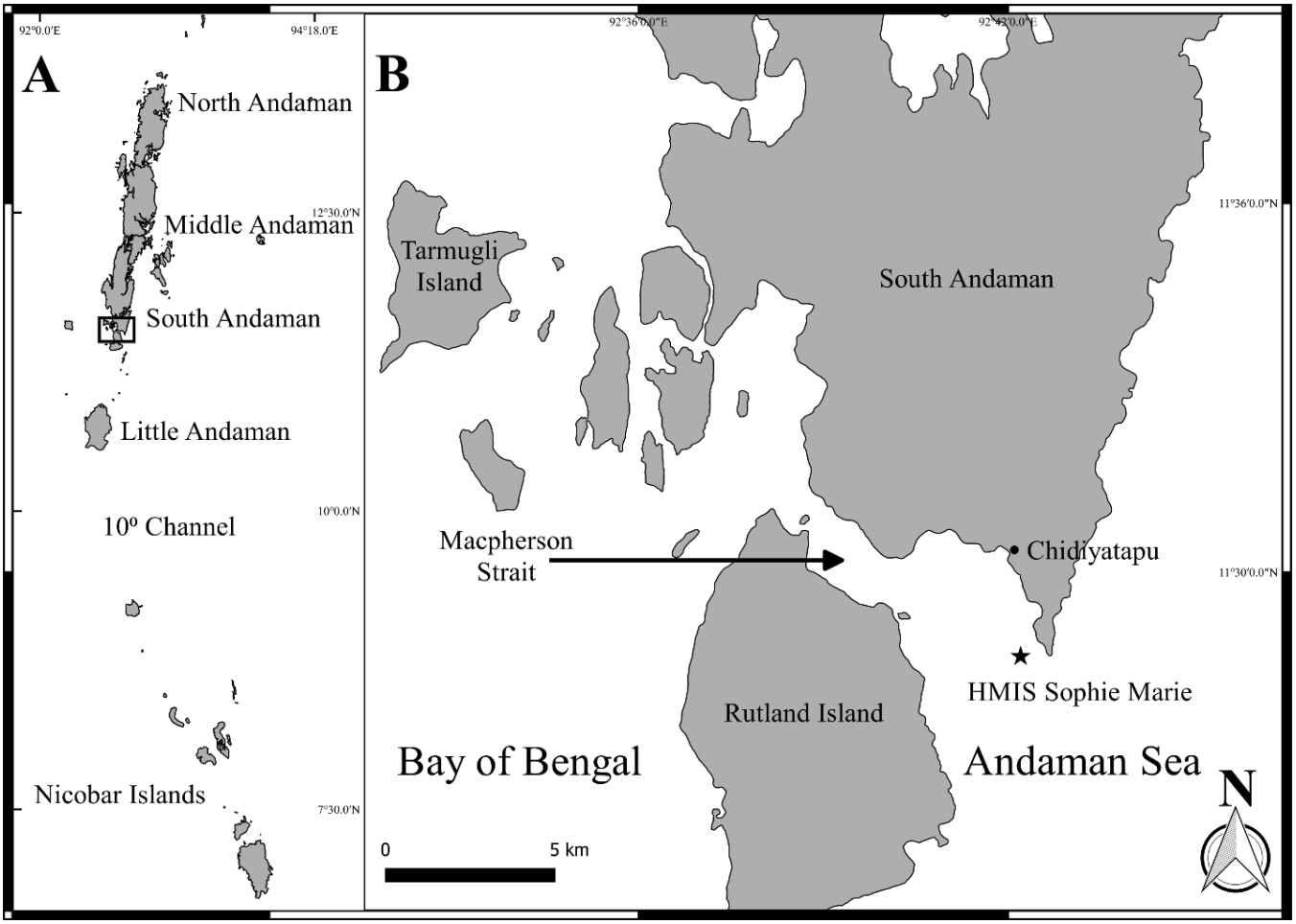


Figure 1. Location of the study area (HMIS SM). (**A)** ANI, (**B)** South Andaman

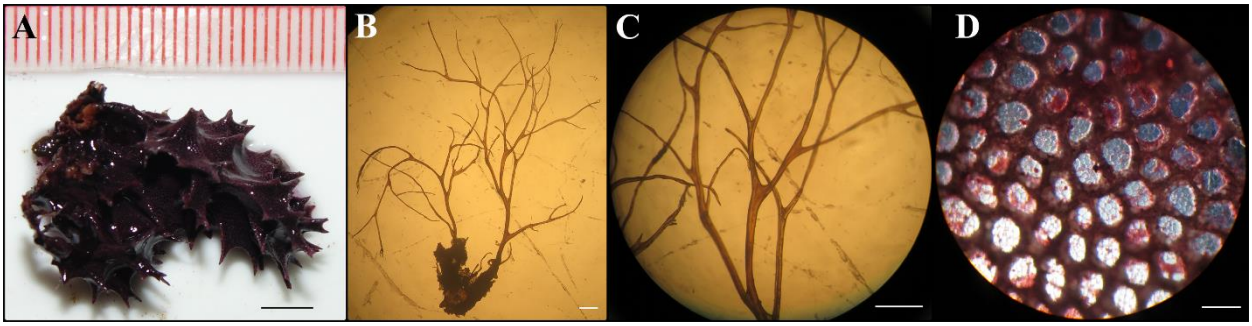
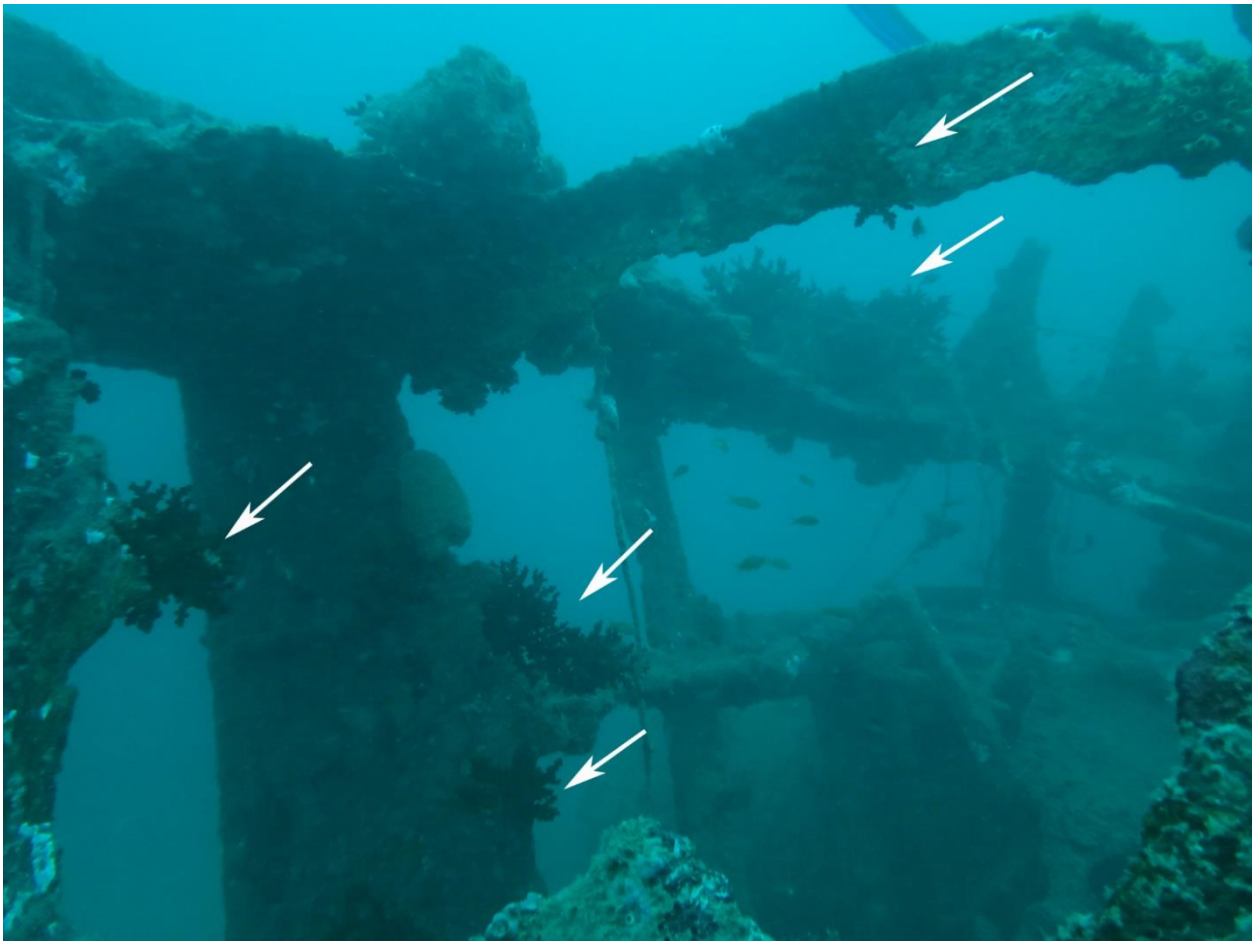


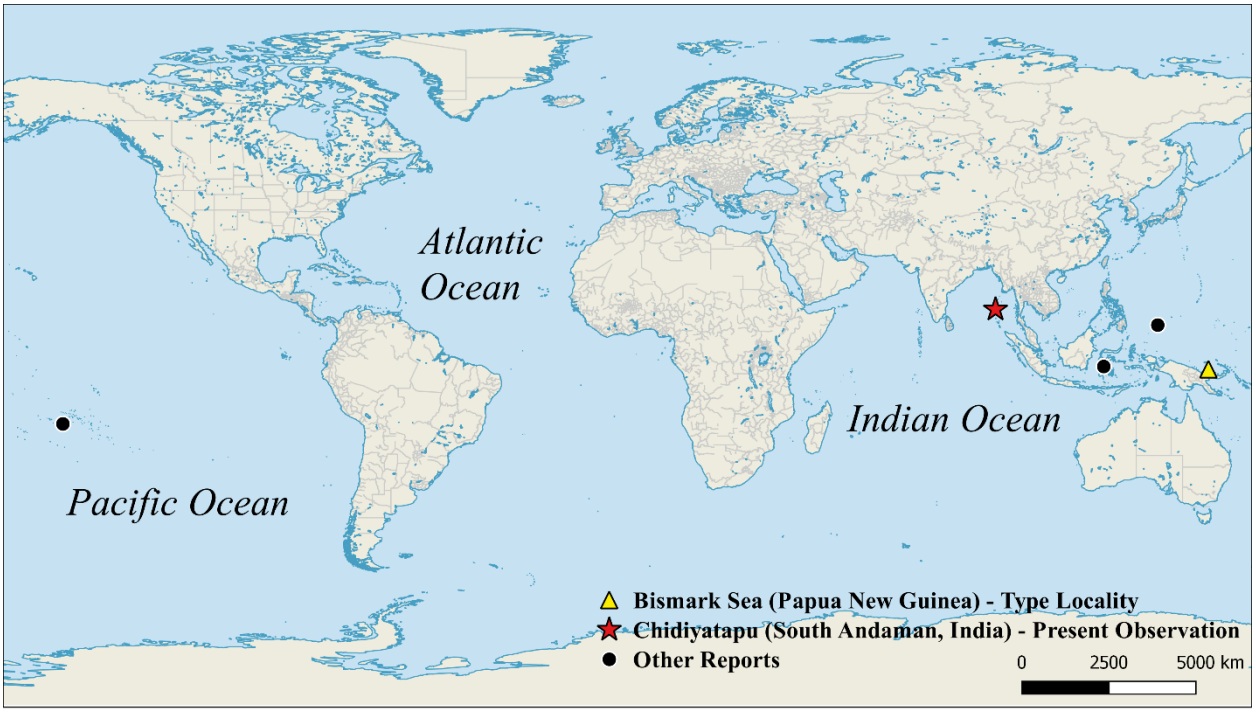
Figure 2. *Chelonaplysilla delicata* [ZSI/ANRC-14321]: (A) Freshly collected specimen, (B) Branching fibres and basal sponging plate, (C) Closer view of pigmented, branching, dendritic spongin fibre, (D) Inhalant pores surrounded by rounded meshes reinforced by sand grains . Scale (A) 5mm (B) 2 mm, (C) 2 mm, (D) 155 µm.



283

284 **Figure 3.** A part of the wreck HMIS SM. (Arrow: high abundance of invasive *Tubastrea* cf.

285 *micranthus*)



286

287 **Figure 4.** Global distribution of *C.delicata* Pulitzer-Finali & Pronzato, 1999

288

289

290 Table 1. Shipwrecks assessed in ANI

Wreck Name	**Co-ordinates**	**Location**	**Date of Sinking**	**Depth (m)**	**Current Activities**	**Reference**
SS Inchkeith	12°00'23.69"N 92°46'08.34"E	Kyd Island (South Andaman)	1955	14	Diving*	28,29,31
HMIS Sophie Marie	**11º28’38.02”N 92º42’12.20”E**	**Chidiyatapu (South Andaman)**	**1942**	**30 - 33**	**Diving***	29,31, **Current Study**
MV Mars	11°55'54.98"N 92°57'24.12"E	Havelock (Ritchie’s Archipelago)	2006	10 - 16	Diving*	31
North Bay Wreck	11°43’00.56“N 92°45’60.60”E	Port Blair (South Andaman)	30 – 40 (yrs)	10	Diving* and Fishing	22,30
Peel Wreck	12°03’84.20“N 92°57’81.10”E	Havelock (Ritchie’s Archipelago)	8 - 10	9 - 12.	Diving*	22,30

Japan Wreck	09°10’88.30“N 92°50’12.30”E	Car Nicobar (Nicobar Islands)	40 - 50	28	Fishing ground	22,30
Sinclair Bay Shipwreck	11°39'873"N 92°45'488"E	Near Ross Island (South Andaman)	-	8		22

*Recreational/Water Tourism