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FIRST REPORT ON *CARYOPHYLLIA (CARYOPHYLLIA) TRANSVERSALIS* MOSELEY, 1881 FROM INDIAN DEEP-SEA

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AZOOXANTHELLATE CORALS
CARYOPHYLLIIDAE
FIRST REPORT
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ABSTRACT. – The studies on Indian scleractinians have been comprehensively carrying out on the zooxanthellate corals mostly from the shallow reef habitats while the insightful documentation on azooxanthellate corals are scanty till now, though it was initiated before more than a century in 1891. Among the azooxanthellates, most of the species are reported under the family Caryophylliidae in a global context. This present paper deals with the reporting of one species of caryophylliid coral [*Caryophyllia (Caryophyllia) transversalis* Moseley, 1881] from Andaman and Nicobar Islands as the first report to Indian waters. The sample was collected at the depth of 332 m by dredge sampling technique.

INTRODUCTION

Azooxanthellate corals contribute nearly about half of the species content under the order Scleractinia. These faunal communities are widely distributed from intertidal zones to a greater depth up to 6328m of the world's oceans (Keller 1976, Collins & Coates 1999). The wide ranges of vertical distribution are the major constraint for the studies as well as the exploration of these animals across the world. Significant numbers of scleractinian species are usually azooxanthellate with a total of around 725 species, which share nearly half of the genus and species of scleractinians (Cairns 1999, 2016) while the present database reports 1681 valid species of scleractinian corals (Hoeksema & Cairns 2022a). The family Caryophylliidae represents the highest diversity of azooxanthellate corals with more than 300 species (Reyes *et al*. 2009) while the present database suggests a total of 306 valid species (Hoeksema & Cairns 2022b). A total of 532 solitary azooxanthellate species are recorded across the globe till now which is about 73.5 % of the total azooxanthellate corals of the world whereas the rest of the species are colonial (Qurban *et al*. 2014). The studies on azooxanthellate corals in Indian waters are not adequately carried out till now (Mondal *et al*. 2017a). Only nine species of corals under the genus *Caryophyllia* are recorded till now from Indian waters (Alcock 1898, Pillai 1983, Pillai & Jasmine 1995, Venkataraman 2007, Singarayan & Rethnaraj 2016, Mondal *et al*. 2017b) whereas a major contribution was made by Alcock (1898) for the discovery of this group of fauna in Indian waters. Present paper deals with the first reporting of *Caryophyllia (Caryophyllia) transversalis* Moseley, 1881 from Indian waters beyond its previous distributional range.

MATERIAL AND METHODS

Study site: Marine faunal exploration was carried out in Andaman and Nicobar Islands by *FORV Sagar Sampada* during November 2017 (Fig. 1). The sampling of the species was made from off Car Nicobar Island (Lat.: 09°19.090'N; Long.: 92°37.507'E), Andaman and Nicobar Islands, India.

Survey and sampling: A survey was carried out by dredge sampling technique. A total of five specimens was collected during the survey period by *FORV Sagar Sampada*.

Sample processing and cleaning: Collected samples were kept in freshwater for one week and cleaned in running tap water to remove algal parts and unwanted debris or dust materials. Only sunlight is used for drying the samples and kept for seven days.

Sample analysis and identification: The cleaned samples were examined under a stereo-zoom microscope [model Leica M 205 A, DFC 500] for morphometric study. Taxonomical studies of the specimens were carried out with the available literature of Cairns & Zibrowius (1997), Cairns (1998, 2004). The validity of the species is checked in conjunction with Hoeksema & Cairns (2021).

Registration of the sample: The specimens were deposited as National Zoological Collections in Zoological Survey of India, Port Blair after the thorough analysis of morphometric features. These specimens are kept as voucher specimens for future references.

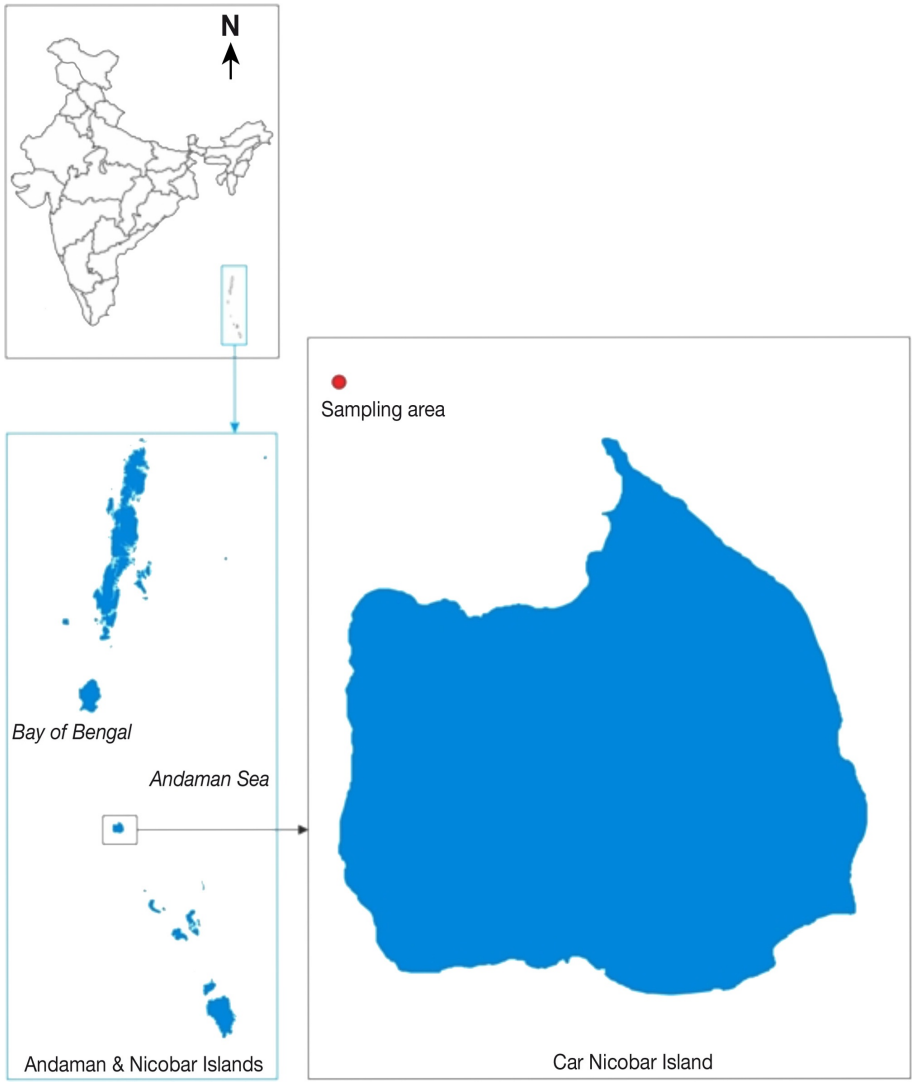

Fig. 1. – Study area in Andaman and Nicobar Islands.

RESULTS

One species of deep-sea caryophylliid coral was recorded from Andaman and Nicobar Islands, India. The detailed taxonomical features of the species are represented below.

Systematics

Phylum CNIDARIA Verrill, 1865
Class ANTHOZOA Ehrenberg, 1834
Subclass HEXACORALLIA Haeckel, 1896
Order SCLERACTINIA Bourne, 1900
Superfamily CARYOPHYLLIOIDEA Dana, 1846
Family CARYOPHYLLIIDAE Dana, 1846
Genus *Caryophyllia* Lamarck, 1816
Subgenus *Caryophyllia (Caryophyllia)* Lamarck, 1816
Caryophyllia (Caryophyllia) transversalis Moseley, 1881

Material examined

Five specimens (Reg. No.: ZSI/ANRC-19149; 22499; 25254; 25371; 25611); *Location of collection*: Off Car Nicobar Island (Lat.: 09°19.090'N; Long.: 92°37.507'E) (Fig. 1), Andaman and Nicobar Islands, India; *Date of collection*: 17.xi.2017; *Depth*: 332 m; *Sampling method*: Dredge sampling.

Description

Corallum is solitary, straight, and trochoid shaped (Fig. 2A, B). The edge angle is 60°. The pedicel is gradually narrowed down and represents a basal disc attachment. The present sample was attached to a small rubble. Pedicel diameter (PD) is 2.66 mm (Fig. 2B). The length of greater calicular diameter (GCD) is 23.89 mm and the lower calicular diameter (LCD) is 18.57 mm (Fig. 2A). The height (H) of the specimen is 19.40 mm (Fig. 2B). The ratio of pedicel diameter and greater calicular diam-

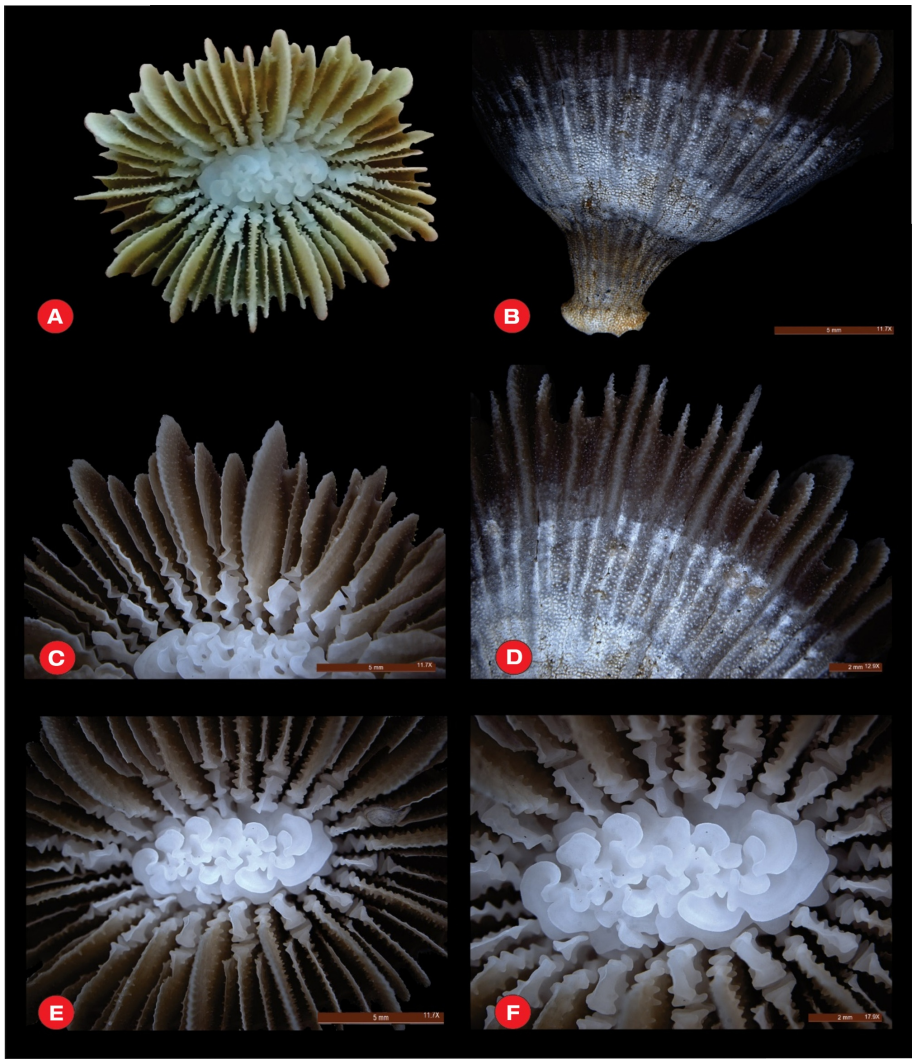

Fig. 2. – **A**: *Caryophyllia (Caryophyllia) transversalis* Moseley, 1881, oral view; **B**: *C. (C.) transversalis* Moseley, 1881, side view showing pedicel; **C**: Septal margins; **D**: Costae with thin and shallow striae; **E**: Septal arrangement; **F**: Fossa with twisted lamellae.

eter (PD: GCD) is 0.11. The ratio of greater calicular diameter and lower calicular diameter (GCD: LCD) is 1.28 and represented elliptical calice. Costae are usually flat but some portion is convex in appearance (Fig. 2B, D). Costae are visible and arranged with 1 mm wide, thin, and shallow striae (Fig. 2D). Rounded granules cover the costae. Septa not pigmented and theca longitudinal with costae always. Septa are arranged decatetrameral (14 primary septa) (Fig. 2A, C, E). All the septa are highly exserted viz., primary septa> secondary septa> tertiary septa. Calice margin is serrated (Fig. 2A, C). A total of 56 septa are present. 14 pali are recorded in this present specimen (Fig. 2E, F). Fossa represents columella, which is ornamented with 12 closely arranged twisted lamellae (Fig. 2E, F) (adapted from Cairns & Zibrowius 1997; Cairns 1998, 2004).

Type specimen

Type locality: Kai Island (Lat.: 05°42'N; Long.: 132°25'E), Banda Sea; depth 235 m; Syntypes-BM 1880.11.25.23 (Cairns & Zibrowius 1997, Cairns 2004).

Global distribution

Indonesia: Banda Sea, Arafura Sea, Bali Sea (depth: 210-397 m) (Cairns & Zibrowius 1997, Cairns 1998); *Western Australia*: Bhagwan, Rowley Shoals to Brown Island (depth: 100-450 m) (Cairns 1998, 2004).

Remarks

The species is identified as new distributional record to Indian waters from Andaman and Nicobar Islands.

A total of ten species under the genus *Caryophyllia* is reported from Indian waters including present study (Table I). Except two species such as *Caryophyllia (Caryophyllia) ambrosia* Alcock, 1898 and *C. (C.) para-*

Table I. – Distribution of species under the genus *Caryophyllia* in Indian waters.

Sl. No.	Valid name	Synonyms/ reported names	Distribution in Indian waters	Depth range
	Family CARYOPHYLLIIDAE Dana, 1846			
	Genus *Caryophyllia* Lamarck, 1801			
1.	*Caryophyllia (Acanthocyathus) grayi* (Milne Edwards & Haime, 1848)	*Acanthocyathus grayi* Milne Edwards & Haime, 1848); *Caryophyllia grayi* (Milne Edwards & Haime, 1848)	A&N Islands (Alcock 1898, Pillai 1972)	37-360 m
2.	*Caryophyllia (Caryophyllia) ambrosia* Alcock, 1898	*Caryophyllia (Caryophyllia) scillaeomorpha* Alcock, 1894; *Caryophyllia ambrosia* Alcock, 1898	Tamil Nadu (Alcock 1898)	183-1646 m
3.	*Caryophyllia (Caryophyllia) cintinculata* (Alcock, 1898)	*Caryophyllia cintinculata* (Alcock, 1898); *Thecocyathus cinticulatus* Alcock, 1898	A&N Islands (Horst 1931)	384 m
4.	*Caryophyllia (Caryophyllia) ephyala* Alcock, 1891	*Caryophyllia ephyala* Alcock, 1891; *Caryophyllia scyllaeomorpha* Alcock, 1898	A&N Islands (Wood-Mason & Alcock 1891) & Lakshadweep (Alcock 1898)	420 m
5.	*Caryophyllia (Caryophyllia) grandis* Gardiner & Waugh, 1938	*Caryophyllia grandis* Gardiner & Waugh, 1938	A&N Islands & Lakshadweep (Venkataraman 2007)	183-596 m
6.	*Caryophyllia (Caryophyllia) inornata* (Duncan, 1878)	*Caryophyllia inornata* (Duncan, 1878); *Coenocyathus dohrni* Döderlein, 1913; *Coenocyathus giesbrechti* Döderlein, 1913; *Paracyathus inornatus* Duncan, 1878	A&N Islands (Mohan & Dhivya 2010) (doubtful identification)	0-100 m
7.	*Caryophyllia (Caryophyllia) paradoxus* Alcock, 1898	*Caryophyllia paradoxus* Alcock, 1898	Kerala (Alcock 1898, Pillai 1972)	786 m
8.	*Caryophyllia (Caryophyllia) smithii* Stokes & Broderip, 1828	*Caryophyllia clavus* Scacchi, 1835; *Caryophyllia communis* (Seguenza, 1863); *Caryophyllia borealis* (Fleming, 1828); *Caryophyllia sessilis* Bellamy, 1839	A&N Islands, Kerala & Lakshadweep (Alcock 1898, Pillai 1972)	40-400 m
9.	*Caryophyllia (Caryophyllia) transversalis* Moseley, 1881		**Present report**	210-397 m
10.	*Caryophyllia arcuata* (Milne Edwards & Haime, 1848)		A&N Islands (Venkataraman 2006), Karnataka & Kerala (Pillai & Jasmine 1995), Tamil Nadu & Lakshadweep (Pillai 1972, Pillai & Jasmine 1995)	40-100 m

doxus Alcock, 1898, all the other species are reported from Andaman and Nicobar Islands (including this present report) followed by four species viz. such as *C. (C.) ephyala* Alcock, 1891, *C. (C.) grandis* Gardiner & Waugh, 1938, *C. (C.) smithii* Stokes & Broderip, 1828, and *C. arcuata* (Milne Edwards & Haime, 1848) from Lakshadweep (including previously known the Laccadive Sea), three species viz. *C. (C.) paradoxus* Alcock, 1891, *C. (C.) smithii* Stokes & Broderip, 1828, and *C. arcuata* (Milne Edwards & Haime, 1848) from the coastal areas of Kerala and two species viz. *C. (C.) ambrosia* Alcock, 1898, and *C. arcuata* (Milne Edwards & Haime, 1848) from off Madras coast of Tamil Nadu and one from *i.e.*, *C. arcuata* (Milne Edwards & Haime, 1848) off Mangalore coast of Karnataka. All the reported ten species are distributed within the depth limit of a maximum of 1646 m and mostly are considered as deep-sea (≥ 200 m) representatives. A checklist belonging to the genus *Caryophyllia* reported in Indian waters is summarized here (Table I) along with their regional occurrence and depth range to understand the distributional pattern. The said list is prepared based on the available literature of Wood-Mason & Alcock (1891), Alcock (1898), Horst (1931), Pillai (1972), Pillai & Jasmine (1995), Venkataraman (2006, 2007), and Mohan & Divya (pers comm and submitted sample, Reg. No.: ZSI/ANRC-5152 on 05.x.2010). The identification of *C. (C.) inornata* (Duncan, 1878) is required to check thoroughly for the confirmation of species. Validity of the extant species is checked with the help of online portal www.marinespecies.org (Hoeksema & Cairns 2022c).

DISCUSSION

The studies on deep-sea corals in Indian waters have been carried out on a minimal scale due to a lack of expertise and facilities. Among the deep-sea scleractinian corals, the family Caryophylliidae represents a maximum

number of species in comparison with other families under the Order Scleractinia. Out of the 44 valid genera under this family, genus *Caryophyllia* represents a total of 82 valid and extant species whereas eight species are considered as *taxon inquirendum* (Hoeksema & Cairns 2022c). The studies on Indian deep-sea corals or azooxanthellate corals especially on this said genus was initiated by Wood-Mason & Alcock (1891) and Alcock (1898) with the description and recording of *Caryophyllia ephyala, C. grayi*, *C. ambrosia, C. scillaeomorpha*, *C. communis, C. paradoxus* and *C. clavus* whereas recently *C. scillaeomorpha* is accepted as the synonym of *C. (C.) ambrosia* whereas *C. communis* and *C. clavus* is presently accepted as *C. (C.) smithii* (Hoeksema & Cairns, 2021). Later on, Horst (1931) reported *C. (C.) cintinculata* from Indian waters while some documentation on the reporting of species under this same genus from Indian waters were made by Pillai (1972), Pillai & Jasmine (1995), and Venkataraman (2006, 2007) based on the ground level studies, observation, and analysis of museum specimens and published literature. The thorough literature review suggested the presence of a total of nine species belonging to the genus *Caryophyllia* including seven species such as *C. (Acanthocyathus) grayi* (Milne Edwards & Haime, 1848), *C. (Caryophyllia) cintinculata* (Alcock, 1898), *C. (C.) ephyala* Alcock, 1891, *C. (C.) grandis* Gardiner & Waugh, 1938, *C. (C.) inornata* (Duncan, 1878), *C. (C.) smithii* Stokes & Broderip, 1828, and *C. arcuata* (Milne Edwards & Haime, 1848) from Andaman & Nicobar Islands, four species such as *C. (C.) ephyala* Alcock, 1891, *C. (C.) grandis* Gardiner & Waugh, 1938, *C. (C.) smithii* Stokes & Broderip, 1828, and *C. arcuata* (Milne Edwards & Haime, 1848) from Lakshadweep, three species viz. *C. (C.) paradoxus* Alcock, 1891, *C. (C.) smithii* Stokes & Broderip, 1828, and *C. arcuata* (Milne Edwards & Haime, 1848) from Kerala, two species such as *C. (C.) ambrosia* Alcock, 1898, and *C. arcuata* (Milne Edwards & Haime, 1848) from Tamil Nadu, and only one species *i.e.*, *C. arcuata* (Milne Edwards & Haime, 1848) from Karnataka off coastal regions of Indian waters. All the species reported previously from Indian waters are collected during the dredge sampling and none of them are reported from the shallow reef habitats. During the present study, one species of caryophyllid coral *i.e.*, *Caryophyllia (Caryophyllia) transversalis* Moseley, 1881 was sampled by dredge sampling from Andaman and Nicobar Islands at the depth of 332 m which is falling under the previously reported depth range of this species is *i.e.*, 210 to 397 m (Hoeksema & Cairns 2021). This is the first report of this species from Indian waters beyond its geographical distributions in Indonesia and Australia. This reporting of azooxanthellate coral contributes significantly to the enhancement of species database under the genus *Caryophyllia* up to 10 valid species along with the augmentation of scleractinian database and zoogeographical distribution in Indian waters. The bathymetrical distributional pattern in greater depth region and lack of exploration methods are the prime constraints for the reporting of species during the recent time under the genus *Caryophylli* from Indian waters as most of the reporting was made more than a century ago. The biogenic habitat of Indian waters is providing a substantial niche for the survival and development of these azooxanthellate groups of corals since the initial time of scleractinian exploration in Indian as well as South-Asian countries. Comprehensive studies by employing dredge-sampling technique in greater depth region are much required in this hour to explore more species from Indian waters, which may bring some new finding to the science also from this Indo-Pacific marine zoogeographical realm.

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