

New distributional records of Actiniarian sea anemones from Andaman and Nicobar Islands

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Abstract

Two species of actiniarian sea anemones *Actinodendron arboreum* (Quoy & Gaimard, 1833) and *Diadumene leucolena* (Verrill, 1866) under the families Actinodendronidae and Diadumenidae respectively were recorded as new addition of sea anemone fauna to India from Andaman and Nicobar Islands. Earlier literature indicated that the occurrence of *A. arboreum* from Asia-Pacific region while *D. leucolena* known from east and west coast of North America. The diagnostic features of the presently recorded species along with distributional details are provided.

Keywords: Sea anemone, *Actinodendron arboreum* and *Diadumene leucolena*, New records, Andaman

Introduction

The sea anemones are considered to be a lesser known group in India as only 6.5% of species revealed from Indian water against their global diversity of 1109 species (WoRMS, 2014). Studies on sea anemones was initiated date back the beginning of the 19th century. The first sea anemones were reported from South Africa by Lesson (1830), who described two species from the 'Cape of Good Hope'. In Indian waters, exploration of sea anemones was started in the year 1869 which was attributed by Stolicza. Since 1966 to 1990, Parulekar made a significant contribution on this group and recorded around 40 species of sea anemones from India (Parulekar, 1990). Parulekar (1990) also made first attempt to study the sea anemone in Andaman and Nicobar Islands with the description of a new species *Anthoplerua panikkarii* along with 3 new records: *Metridium senile* (Linnaeus, 1761); *Parabunodactis inflexibilis* Carlgren, 1928 and *Bunodactis nicobarica* Carlgren, 1928. Subsequently, Madhu and Madhu (2007) identified 10 species of sea anemones from these regions. Since 2007 onwards Zoological Survey of India has paid attention towards reporting of sea anemones from the coral reef region of Andaman and Nicobar Islands resulting with a record of 28 species

against 71 species from Indian seas (Raghunathan *et al.*, 2014; Choudhury *et al.*, 2015; Choudhury *et al.*, in press).

The genus *Actinodendron* de Blainville, 1830 representing five species (Fautin, 2015a) is found in littoral to infra littoral and the tropical to subtropical regions of world waters. In India, Raghunathan *et al.* (2014) reported the same genus with a record of *Actinodendron glomeratum* Haddon, 1898 from Andaman and Nicobar Islands. Whereas, the genus *Diadumene* Stephenson, 1920 counts 9 named species globally (Fautin, 2015b) and are predominantly occurred in east and west coast of North America. Among them *Diadumene schilleriana* Stoliczka, 1863 and *Haliplanella lineata* (Verrill, 1870) = *Diadumene lineata* (Verrill, 1873) were reported from Indian waters (Annandale, 1915; Parulekar, 1990; Mitra and Pattanayak, 2013). Furthermore, Carlton (1997) described *Diadumene franciscana* Hand, 1956 may be originated from the southern Pacific or Indian Ocean, rather than from the Atlantic, where the anemone fauna is better known. In this context, the present study provides a description about the newly recorded *Actinodendron arboreum* (Quoy & Gaimard, 1833) and *Diadumene leucolena* (Verrill, 1866) from Andamans with its external morphology, cnidocysts and their geographical distribution.

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Material and Methods

The specimens were collected by hand picking from intertidal to subtidal region of Neil Island, Oliver Island and Chouldari of Andaman (Figure 1) at a maximum depth of 15m during April 2014 to December 2015. SCUBA diving devices were used to collect the specimens. *In situ* pictures of the sea anemones were taken before collecting specimens. Collected specimens were relaxed by adding magnesium chloride crystals with seawater, later fixed with 10% phosphate buffered formalin (PBF) and then preserved in 70% ethyl alcohol following the method of Hausserman (2004).



Figure 1. Map showing area in which new records of sea anemones found in Andaman and Nicobar Islands.

The external characters of specimens was critically observed in *in situ* and also examined under a stereo zoom microscope. The family level taxonomic characters were identified by observing the peculiarity of tentacular structures, arrangement of tentacles and special colour pattern of column. The specimen was identified at the species level consulting the available literatures (Carlgren, 1949; Hand, 1956; Fautin *et al.*, 2009; Fautin 2015c &d.). The histological section was prepared for *D. leucolena*

(Humason, 1967).

The cnidocysts derived from various parts of *A. arboreum* and *D. leucolena* such as tentacles, vesicles, actinopharynx, acontia and mesenterial filaments (Carlgren, 1945 and 1949; Fautin *et al.*, 2009; Fautin 2015a &b) were examined. Identification of the cnidocysts was done based on the keys of Carlgren (1949) and Mariscal (1974).

Results

Systematics

Phylum CNIDARIA Verrill, 1865

Class ANTHOZOA Ehrenberg, 1884

Subclass HEXACORALLIA Haeckel, 1896

Order ACTINIARIA Hertwig, 1882

Family ACTINODENDRIDAE Haddon, 1898

Genus *Actinodendron* de Blainville, 1830

Actinodendron arboreum (Quoy & Gaimard, 1833), Figure 2.

Synonyms

Actinia arborea Quoy & Gaimard, 1833 (Original description)

Acremodactyla ambonensis Kwietniewski, 1897

Actinodendron ambonense (Kwietniewski, 1897)

Actinodendron ambonensis (Kwietniewski, 1897)

Actinodendron arborea Quoy & Gaimard, 1833

Actinodendrum arboreum de Blainville, 1830

Material Examined: One specimen collected from Neil Island (Lat. 11°50.939'N; Long: 93°01.207'E), at the depth of 10 m on 18.VIII.2015. Registration No. ZSI/ANRC-14114.

Description: The pedal disc is well developed with 7.5 mm diameter. Column is smooth. When fully expanded, the oral disc is spread with long tentacles (11.73 mm in length and 2 mm in width), about 12-36 number with complexly branched (Figure 2a). The specimen resembles like a bush or broccoli (Figure 2a). The tentacles are hexamerously arranged in three cycles (6+12+18=36) (Figure 2a). The branching tentacles are more erect and also covered with numerous acrosphers (0.85 mm in length) (Figure 2b &c). The oral disc diameter is about same length as extended tentacles. The acrosphers and tip of the tentacles are dense with long Basitrich forming nematocyst batteries. The column is buried in the substrate surface leaving only the crown of tentacles branching. Longitudinal muscles of

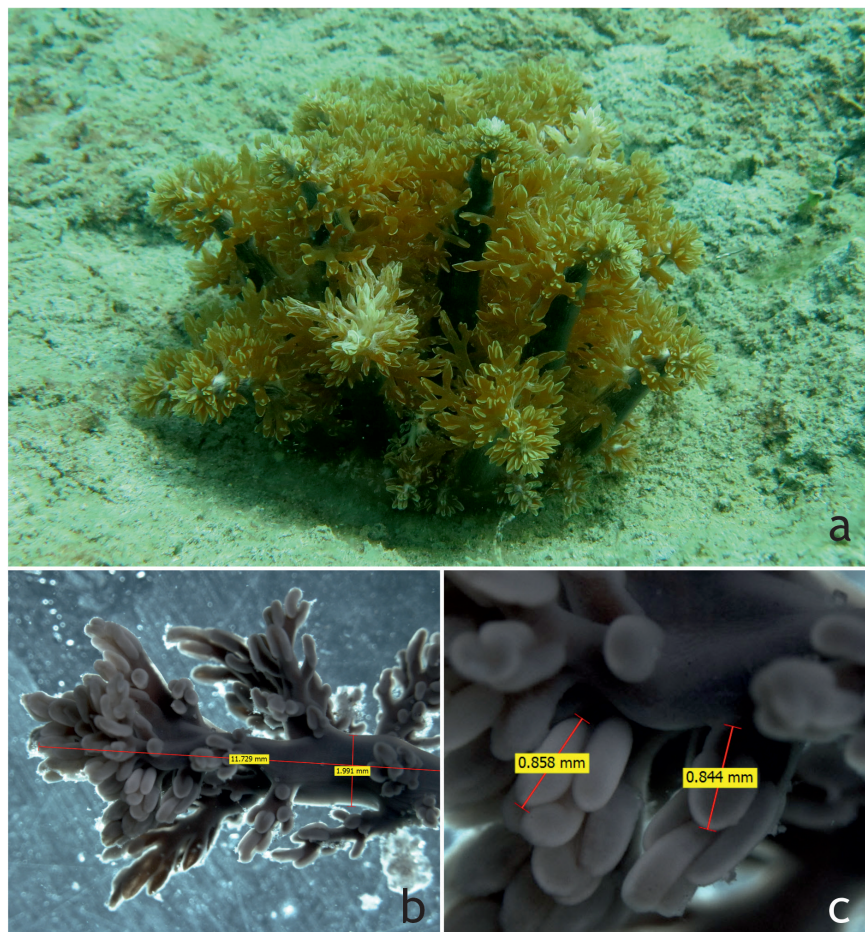


Figure 2. *Actinodendron arboreum* [a. *Actinodendron arboreum* in sandy bottom; b. Branched tentacle of *A. arboreum*; c. Acrospheres].

tentacles and radial muscles of oral disc are ectodermal. Two broad siphonglyphs are present. Retractor muscles are very strong. Hence, in case of predator, may disappear in fractions of a second retreating completely into the substrate through a strong contraction. The colour of the specimen is tan or light brown. The vesicles are light brown in colour while, the stalk of tentacles are light green or grey in colour.

Cnidocysts

Cnidocysts contain spirocysts and nematocysts which include microbasic p-mastigophores, basitrichs which were derived from various organs of *A. arboreum* (Table 1) and all are illustrated in Figure 3.

Table 1. Morphometric measurement of cnidocysts in different body organs of *A. arboreum*

Organ	Type of Cnidocysts	Length (µm)	Width (µm)	n	N	Frequency	State
Tentacle	Spirocysts(G) (Figure 3a)	12.8 - 21.6	2.3 - 3.8	26	3	C	Unfired
	Basitrich (Figure 3b)	37.5 - 61.8	2.3 - 4.1	74	3	A	Unfired
Vesicles	Basitrich (Figure 2c)	39.0 - 64.3	2.3 - 4.1	68	3	A	Unfired
	MPM (Figure 3d)	18.5 - 20.3	3.0 - 4.3	12	3	R	Unfired
	Spirocysts (G) (Figure 3e)	11.3 - 22.5	2.6 - 4.1	34	3	C	Unfired
Column	Basitrich (Figure 3f)	33.8 - 69.5	1.5 - 3.8	41	1	A	Unfired
	Spirocysts(G) (Figure 3g)	13.5 - 21.0	2.3 - 3.8	20	1	C	Unfired

n= Number of nematocyst measured; N = Number of individuals; Frequency indicated by A= abundant C= common, R= rare, MPM= Micro basic p-mastigophores; Spirocyst (G) = gracile spirocyst

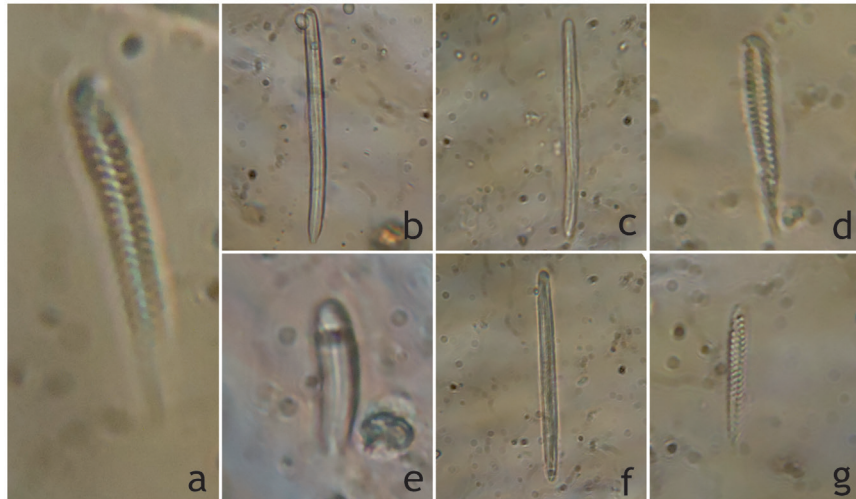


Figure 3. Cnidocysts of *A. arboretum* [a. Spirocyst (G) from tentacle; b. Long basitrich from tentacle; c. Basitrich from acrospheres d. Spirocysts from acrospheres; e. Microbasic *p-mastigophore* from acrospheres; f. Basitrich from column; g. Spirocyst from column].

Habitat: This species mainly lives singly in sandy and rubbles covered bottoms on coral reef (Fautin *et al.*, 2009). The specimen reported from Neil Island was found in sandy area and subsequently it was observed from Oliver Island (Lat. 12°59.731' N; Long. 092°59.918' E) in the same substratum.

Distribution: This species is found in Singapore (Ardelean, 2003); Marshall Islands, New Caledonia, Australia, Solomon Islands, New Guinea, Indonesia,

Okinawa, Philippines (Fautin, 2008; Fautin *et al.*, 2009), Japan (Uchida and Soyama, 2001).

India: Neil Island, South Andaman and Oliver Island, North Andaman.

Remark: New record to Indian waters

Family DIADUMENIDAE Stephenson, 1920

Genus *Diadumene* Stephenson, 1920

Diadumene leucolena (Verrill, 1866), Figure 4

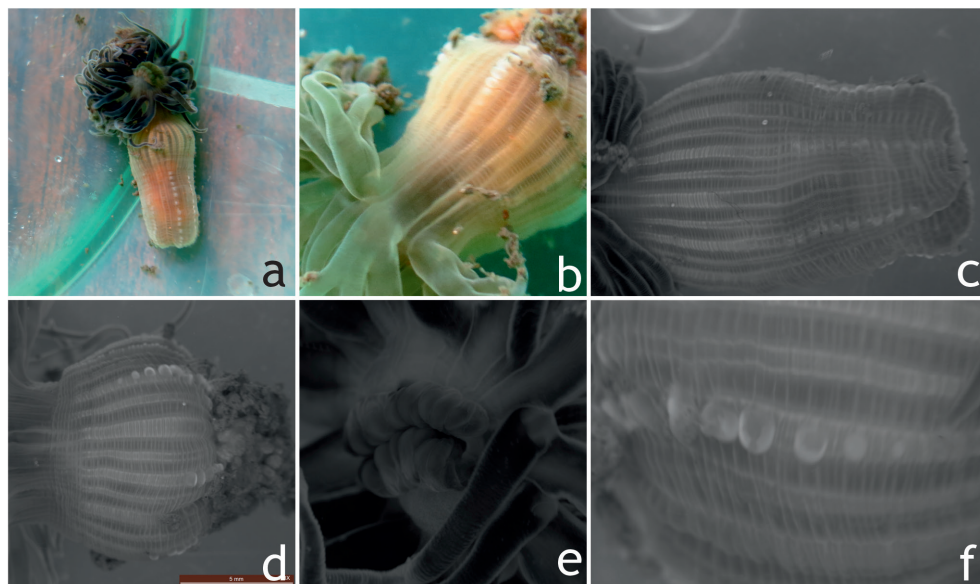


Figure 4. *Diadumene leucolena* [a. *Diadumene leucolena* in live condition; b. Capitulum and scapus in live condition; c. Specimen in preserved condition; d. Capitulum and scapus in preserved condition; e. Mouth; f. Cincloids].

Synonyms

Sagartia leucolena Verrill, 1866 (Original description)

Cylistia leuconela (Verrill, 1866)

Sagartia (Thoe) leucolena Verrill, 1866

Diadumene kameruniensis (Carlgren, 1927)

Material Examined: Five specimens were collected from the intertidal regions of Chouldari (Lat. 11°37.224'N; Long. 92°40.285'E), South Andaman on 9.I.2015. Registration No. ZSI/ANRC -13005.

Description: The pedal disc is well developed with 5.94 mm in diameter (Figure 4a). Column is 15 mm length which is divisible into scapus and capitulum (Figure 4b & d). The column appears smooth from a distance, but is studded with small dark bumps when looked at closely. The double stripes are prominently seen on the column (Figure 4a & c). Mouth is present with prominent lips (Figure 4e). The capitulum is smooth. The scapus is with cinclides (Figure 4f). The tentacles are about 66 number, hexamerously arranged in four cycles (12+12+18+24 =

66) (Figure 4a). The tentacles are long, tapered, numerous, more regularly arranged, which are not retractile (Figure 4a). All of the inner tentacles are typically thicker than the outer tentacles (Figure 4a). Acontia is well developed. The retractor muscles are observed (Figure 6a). Gametogenic tissues are well observed (Figure 6a & b). Parietobasilar and basilar muscles are weak (Figure 6c).

The columns of the individuals observed in the field were slightly pinkish or salmon or orange in colour (Figure 4a) and transparent with a tinge of green near the upper part of the column. The mesenteries were visible as 24 white double stripes on the column. The colour of tentacles are off white (Figure 4a).

Cnidocysts

Cnidocysts contain spirocysts and nematocysts such as micro basic p-mastigophores, basitrichs and micro basic amastigophores were derived from various organs of *D. leucolena* (Table 2) and all are illustrated in Figure 5.

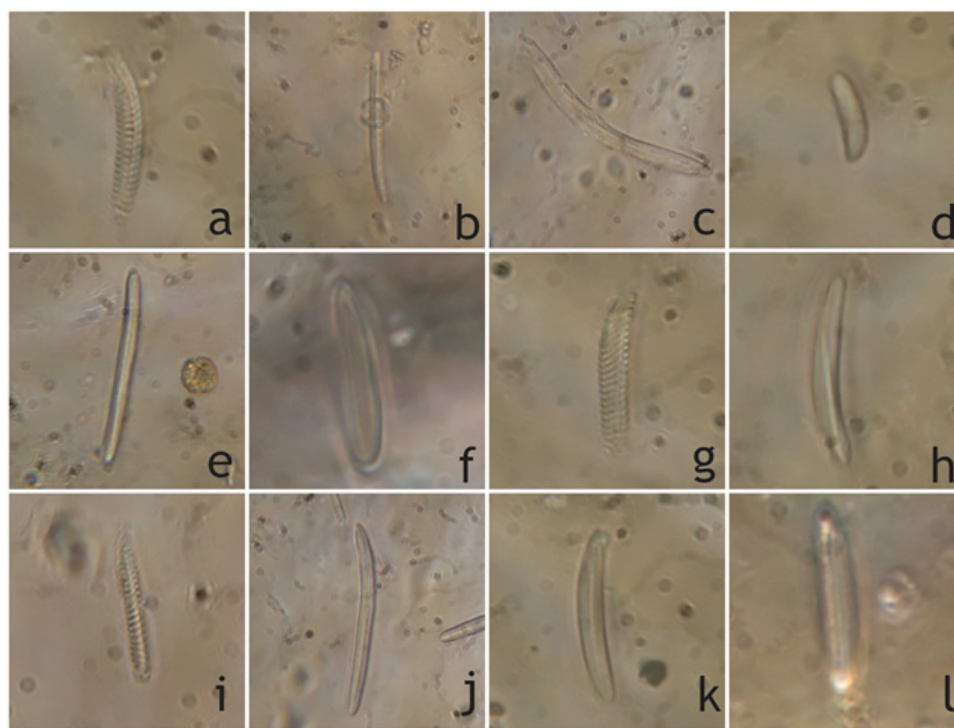


Figure 5. Cnidocysts of *Diadumene leucolena* [a. Spirocyst (G) from tentacle; b. Large basitrich from tentacle; c. Microbasic amastigophores from tentacles; d. Small basitrich from Mesenterial filaments; e. Large basitrich from Mesenterial filaments; f. Microbasic p- mastigophore from Mesenterial filaments; g. Spirocyst (G) from Mesenterial filaments; h. Basitrich from Actinopharynx; i. Spirocysts (G) from Actinopharynx; j. Microbasic amastigophores from Actinopharynx; k. Basitrich from Acontia; l. Microbasic p- mastigophore from Acontia].

Table 2. Morphometric measurement of cnidocyst in different body organs of *D. leucolena*

Organ	Type of Cnidocysts	Length (μm)	Width (μm)	n	N	Frequency	State
Tentacle	Spirocysts(G) (Figure 5a)	10.1 - 29.9	2.2 - 4.0	43	3	A	Unfired
	Basitrich (Figure 5b)	14.4 - 23.0	1.44 - 3.6	74	3	A	Unfired
	MIA (Figure 5c)	21.8 - 33.8	3.0 - 4.1	40	3	C	Unfired
MF	Small Basitrich(Figure 5d)	2.5 - 4.3	1.44 - 1.44	8	3	R	Unfired
	Large Basitrich (Figure 5e)	7.9 - 16.6	1.44 - 2.1	65	3	A	Unfired
	MPM (Figure 5f)	8.6 - 28.1	3.6 - 4.7	52	3	C	Unfired
	Spirocysts(G) (Figure 5g)	6.9 - 18.0	1.44 - 2.9	11	3	R	Unfired
Actinopharynx	Basitrich (Figure 5h)	15.8 - 23.8	1.8 - 2.9	70	3	A	Unfired
	Spirocysts(G) (Figure 5i)	6.5 - 15.1	1.44 - 1.8	20	3	R	Unfired
	MIA (Figure 5j)	20.3 - 30.8	3 - 4.1	30	3	C	Unfired
Acontia	Basitrich (Figure 5k)	9.4 - 19.4	1.8 - 2.2	58	3	A	Unfired
	MPM (Figure 5l)	20.9 - 44.0	3.6 - 4.9	39	3	C	Unfired

n= Number of nematocyst measured; N = Number of individuals; Frequency indicated by A= abundant C= common, R= rare, MPM= Microbasic *p*-mastigophores; Spirocyst (G) = gracile spirocyst; MIA = microbasic amastigophores

Habitat: It is common to abundant along the bay margin, estuaries and sheltered waters, in fouling communities where it grows on oysters, rocks, seaweeds, pilings, and floats. It can also occur in sheltered tide pools, and is especially tolerant of variable salinities (Carlton 1979; Cohen and Carlton 1995).

The specimen reported here was found in mud flat area of shallow water occurring at depth of 1m.

Distribution: This Atlantic anemone, occurring from at least Cape Cod to South Carolina, was first reported from

the Oakland estuary by Sander (1936), although it may have been present in the Bay since the 19th century (Cohen and Carlton, 1995). Hand (1956) described it in detail from the Bay of central California. It was recorded from Atlantic coast oyster beds (Wells, 1961) as ship fouling or in ballast water. It has also been reported from southern California bays and from Coos Bay, Oregon (Carlton, 1979; Cohen and Carlton, 1995).

India: Chouldari, South Andaman.

Remark: New record to Indian waters

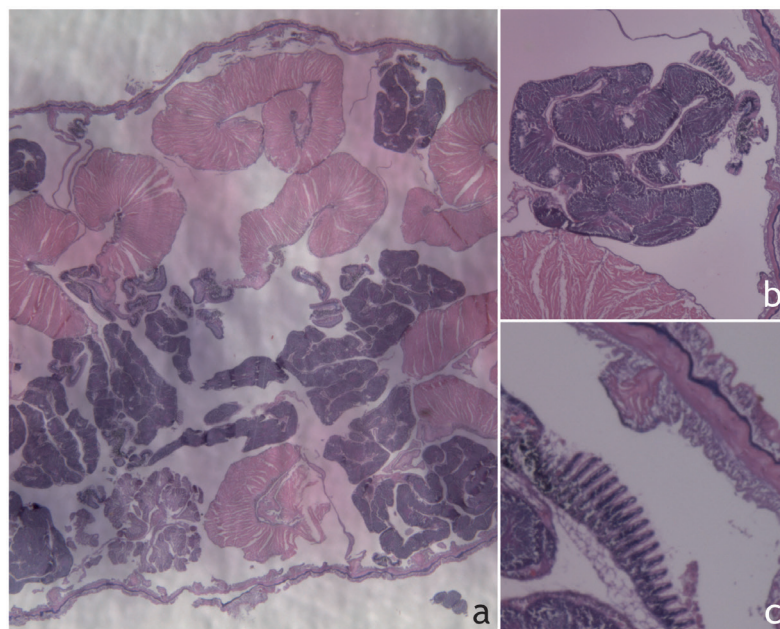


Figure 6. Cross section of *Diadumene leucolena* [a. Middle portion of column showing mesenteries; b. Non-muscular gametogenic region of fertile mesenteries; c. Weak basilar muscles].

Discussion

The family Actinodendronidae consists of five species under the genera *Actinodendron* (Fautin, 2015a), all of which are found only in the tropical waters of the Indo-Pacific. Until now, only one species *Actinodendron glomeratum* Haddon, 1898 was known from India (Raghunathan *et al.*, 2014). The newly recorded species *D. leucolea* is native to the east coast of North America spanning from Georgia, USA to New Brunswick, Canada (Sander, 1936; Hand, 1956). Later, it has been introduced with oyster shipment to Puerto Rico, the Canary Islands, Morocco, Cameroon, the Pacific coast of Panama, the west coast of North America, and Hawaii (Carlton, 1979; Carlton and Eldredge 2009; Ocana and den Hartog, 2002). It is also observed that this species is especially tolerant of variable salinities and it is mesohaline (Cohen and Carlton, 1995). There are no reports of negative impact of this species in its introduced range. The occurrence of this species in Andaman Sea, northeastern Indian Ocean may be due to transport by ship fouling or in ballast water as well as this region provides the presence of suitable

substrata, temperature and salinity for its survival and growth.

The size ranges of most of cnidocysts mentioned for both species in this study are agreed with the data from Carlgren (1949); Hand (1956) and Fautin *et al.* (2009). However, number of tentacles observed in the presently studied specimen of *A. arboreum* is comparatively less (36) as 48 tentacles found in the species described by Fautin *et al.*, 2009 in Kusu Island, Singapore. Variation in number of tentacles might be due to the size of the specimens observed. The records of presently noticed two species of sea anemones enhanced the total number of actinarian sea anemones in Indian seas to 73. Further exploration on this lesser known faunal group may bring out more species in Indian context.

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References

- Annandale, N., 1907. The fauna of brackish ponds at Port Canning, Lower Bengal. P.I. *Rec. Indian Mus.*, 1(4): 45-74.
- Annandale, N., 1915. Fauna of the Chilka Lake. The Coelenterates. Mem. Indian Mus., 5: 21-55.
- Ardelean, A., 2003. Reinterpretation of some tentacular structures in actinodendronid and thalassianthid sea anemones (Cnidaria: Actiniaria). *Zool. Verh. Leiden* 345: 31-40.
- Carlgren, O., 1945. Further contributions to the knowledge of the cnidom in the Anthozoa especially in the Actiniaria. *Kungliga Fysiografiska Sällskapets Handlingar*, 56 (9): 1-24
- Carlgren, O., 1949. A survey of the Ptychodactylaria, Corallimorpharia and Actiniaria. *Kungliga Svenska Vetenskaps- Akademiens Handlingar*, 1(1): 1-121.
- Carlton, J. T. 1979. History, Biogeography, and Ecology of the Introduced Marine and Estuarine Invertebrates of the Pacific Coast of North America. Ph. D. thesis, Univ. California, Davis, 904 pp.
- Carlton, J.T. and L. G. Eldredge, 2009. Marine bioinvasions of Hawaii: the introduced and cryptogenic marine and estuarine animals and plants of the Hawaiian archipelago. *Bish. Mus. Bull. Cult. Environ. Stud.* 4, 1e203.
- Choudhury, S., C. Raghunathan and K. Venkataraman, 2015. First record of black coral, associated Sea anemone (*Nemanthus anamensis* Carlgren 1943; Family Nemanthidae) from India. *Rec. Zool. Surv. India*, 115 (Part 4): 351-356.
- Choudhury, S., C. Raghunathan, R. Raghuraman and K. Venkataraman. New record of Actinarian Sea Anemones (Class Anthozoa) from Andaman Sea, India. *Journal of Threatened Taxa* (in Press).
- Cohen, A. N. and J. T. Carlton, 1995. Nonindigenous aquatic species in a United States Estuary: A case study of the biological invasions of the San Francisco Bay and Delta. A report for the United States fish and wildlife service, Washington D. C. and The National sea grant college program Connecticut sea grant. NOAA Grant Number NA36RG0467.
- England, K.W., 1987. Certain Actiniaria (Cnidaria, Anthozoa) from the Red Sea and tropical Indo-Pacific Ocean. *Bulletin of the British Museum of Natural History (Zoology)*, 53: 205-292.
- England, K.W., 1991. Nematocysts of sea anemones (Actiniaria, Ceriantharia and Corallimorpharia: Cnidaria), *Nomenclature*, pp. 691-697.
- England, K.W., 1992. Actiniaria (Cnidaria: Anthozoa) from Hong Kong with additional data on similar species from Aden, Bahrain and Singapore. In B.Morton (ed), *The Marine Flora and Fauna of Hong Kong and Southern China III*, Hong Kong University Press, Hong Kong., pp. 49-95.
- Fautin, D.G., 2008. Hexacorallians of the world. <http://geoportal.Kgs.ku.edu/hexacoral/anemone2/index.cfm>.
- Fautin, D.G., S.H. Tan and R. Tan, 2009. Sea anemones (Cnidaria: Actiniaria) of Singapore: Abundant and well-known shallow-water species. *Raffles Bull. Zool.*, 22: 121-143.

- Fautin, D., 2015a. *Actinodendron*. In: Fautin, Daphne G. (2013) Hexacorallians of the World. Accessed through: World Register of Marine Species at <http://www.marinespecies.org/aphia.php?p=taxdetails&id=267199> on 20160318
- Fautin, D., 2015b. *Diadumene* Stephenson, 1920. In: Fautin, Daphne G. (2013) Hexacorallians of the World. Accessed through: World Register of Marine Species at <http://www.marinespecies.org/aphia.php?p=taxdetails&id=100728> on 20160318
- Fautin, D., 2015c. *Actinodendron arboreum* (Quoy & Gaimard, 1833). In: Fautin, Daphne G. (2013) Hexacorallians of the World. Accessed through: World Register of Marine Species at <http://www.marinespecies.org/aphia.php?p=taxdetails&id=289346> on 20160318
- Fautin, D., 2015d. *Diadumene leucolela* (Verrill, 1866). In: Fautin, Daphne G. (2011) Hexacorallians of the World. Accessed through: World Register of Marine Species at <http://www.marinespecies.org/aphia.php?p=taxdetails&id=158230> on 2016-01-23.
- Hand, C. 1956. The sea anemones of central California. Part II. The acontiarian anemones. *Wasmann J. Biol.* 13: 189-251.
- Humason, G. L. 1967. *Animal Tissue Techniques*, 2nd ed, Freeman, San Francisco.
- Hausserman V., 2004. Identification and taxonomy of soft-bodied hexacorals exemplified by Chilean sea anemones; including guidelines for sampling, preservation and examination. *J Mar Biol Ass. U.K.* 84: 931-936.
- Madhu, R. and K. Madhu, 2007. Occurrence of anemone fishes and host sea anemones in Andaman and Nicobar Islands. *J. Mar. Biol. Ass. India*, 49 (2): 118-126.
- Mariscal, R.N., 1974. Nematocysts. In: Muscatine L, Lenhoff H.M., (Eds). Coelenterate biology. *Academic Press, New York.*, pp.129-178.
- Mitra, S. and J.G. Pattanayak, 2013. Diversity and Distribution of sea-anemones (cnidaria: actiniaria) in the estuaries and mangroves of Odisha, India. *Rec. zool. Surv. India*: 113 (Part-3): 113-118
- Ocana, O. and J.C. den Hartog 2002 A catalogue of actiniaria and corallimorpharia from the Canary Islands and from Madeira. *Life and Marine Sciences*, 19A:33-54.
- Parulekar, A., 1990. Actiniarian sea anemone fauna of India. In: Marine Bio fouling and Power Plants (Eds. K.V.K. Niltil and V.P. Venugopalan) P.218-228.
- Raghunathan, C., R. Raghuraman, Smitanjali Choudhury and K. Venkataraman, 2014. Diversity and distribution of sea anemones in India with special reference to Andaman and Nicobar Islands. *Rec. zool. Surv. India*, 114(2): 269-294.
- Sander, N., 1936. Bank fauna, Alameda Estuary. Univ. California, Berkeley, Dept. Zoology, Student Reports, *Zoology* 112, Vol. II, 11 pp.
- Uchida, H. and I. Soyama, 2001. Sea anemones in Japanese Waters. *TBS, Japan*. 157 pp.
- WoRMS, 2014. Actiniaria. In: Fautin, D.G., 2013. Hexacorallians of the World. Accessed through: World Register of Marine Species at <http://www.marinespecies.org/aphia.php?p=taxdetails&id=1360> on 20160824