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Sponge fauna of the Lakshadweep Islands of Indian Ocean

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Original Article

Abstract

The present study deals with four new records of sponges found at Lakshadweep area and a checklist of sponges reported off. The new records are *Agelas oroides*, *Callyspongia* (*Cladochalina*) *aculeata, Raspailia (Clathriodendron) arbuscula* and *Stylissa massa*. Details about the species diversity of common sponges, massive sponges, boring sponges of the area are discussed and presented.

Keywords*: New records, Agelas, Callyspongia, Raspailia, Stylissa, massive sponges, boring sponges*

Introduction

Lakshadweep consists of 36 islands with an area of 32 km^2 of which 10 islands are inhabited. It stretches between 8°16′-13°58′ N latitude and 71° 44′- 74° 24′ E longitude. The islands are oceanic in nature, and continental shelf is narrow, extending to an area of 4336 km^2 (Murty, 2002). The lagoons are shallow except on Minicoy Island. The lagoons and coral reef flats are rich in corals and associated organisms like echinoderms, sponges, seaweeds, seagrasses, molluscs and ornamental fishes (Murty, 2002).

Pioneering work on the sponge fauna of Lakshadweep Island was done by Gardiner (1903). Thomas (1973, 1980a, 1980b, 1989) reported 82 species of sponges including the encrusting and shell boring sponges from Lakshadweep Islands. Although detailed systematic account and distribution pattern of 41 species of Demospongiae from Minicoy Island were available in those investigations, the total sponge fauna of other islands yet remained largely unexploited. Few reports during the past years included knowledge about the sponge diversity of Lakshadweep (Venkataraman *et al.,* 2004; George *et al.*, 2020). Investigations on the diversity of sponge fauna associated with seagrass ecosystem of the Minicoy atoll affirmed the existence of 22 species of sponges (Prabhakaran *et al.,* 2013). Examining the importance of the health of the coral ecosystem and diversification of coral related organisms, the present work on "Taxonomical investigations on lesser known marine animals of India-Phylum: Cnidaria (Class: Anthozoa) and Phylum: Porifera (Marine)" was taken up. It forms the part of the All India Coordinated project on Taxonomy (AICOPTAX) of the Ministry of Environment, Forest and Climate change, New Delhi to

establish an efficient database on the inventories of the fauna of India.

Material and methods

Sampling localities

We chose the following five Islands for sponge sample collection (Fig.1). Performed underwater visual survey, and carried out the sample collection of sponges for the period from March 2019 to January 2020.

Chetlat (11°41'42.18" N; 72°42'30.36" E): Chetlat is an inhabited Island with an area of 1.174 km^2. The coral reef flat extended to 8-10 m depth along the shore. Live coral cover is seen in the lagoon area of 1.4 km^2 with coral associated sponges and diverse creatures.

Kavaratti (10°33'35.09" N; 72°37'28.28" E): Kavaratti has an area of 3.63 km^2 and has a lagoon area of 6.75 km^2. The intertidal area comprises white coral sand and coral pieces with rocks (Fig.2). The depth of the lagoon ranges from 2 to 4 m.

Kalpeni (10°5'28.47"N; 73°38'6.05" E): Kalpeni possess a territory of 2.28 km^2 with a lagoon area of 5-20 km^2 which is mainly composed of coral sand and live standing corals. (Fig. 2).

Pitti (10° 46' 34.62" N; 72° 32' 0.98" E): Pitti Island is a remarkable nesting place of pelagic birds. This uninhabited Island is of 300x200 m in size and without vegetation. The shore area comprises fine coral sand (Fig. 2).

Agatti (10° 51' 8.23" N: 72°10' 21.73" E): Agatti Island has an area of 3.22 km^2 and lagoon area of 8.8 km^2. The bottom of the lagoon comprises of mainly corals and sand. The eastern shore of the island is rocky. The reef flat, comprises of live corals and associated fauna (Fig. 2).

Collection and identification

Sponges were collected by handpicking from the shores, snorkeling and SCUBA diving at different locations at a depth of 0-30 m. Underwater inspection of the sponge species were done and *in situ* photographs were captured. The collected samples were brought in to the laboratory and stored. During March, September and October 2019, besides January 2020, 49 sponge samples were collected from the seashore and the Sea. The sponges entangled in gill nets were also collected and preserved. Identified the sponges as per the accurate diagnostic methods given in past research (Lendenfeld, 1889; Bergquist, 1980; Cook and Bergquist, 2002; Hooper and Van Soest, 2002). Distribution and systematic position of the sponges were obtained from the world Porifera Database and analyzed

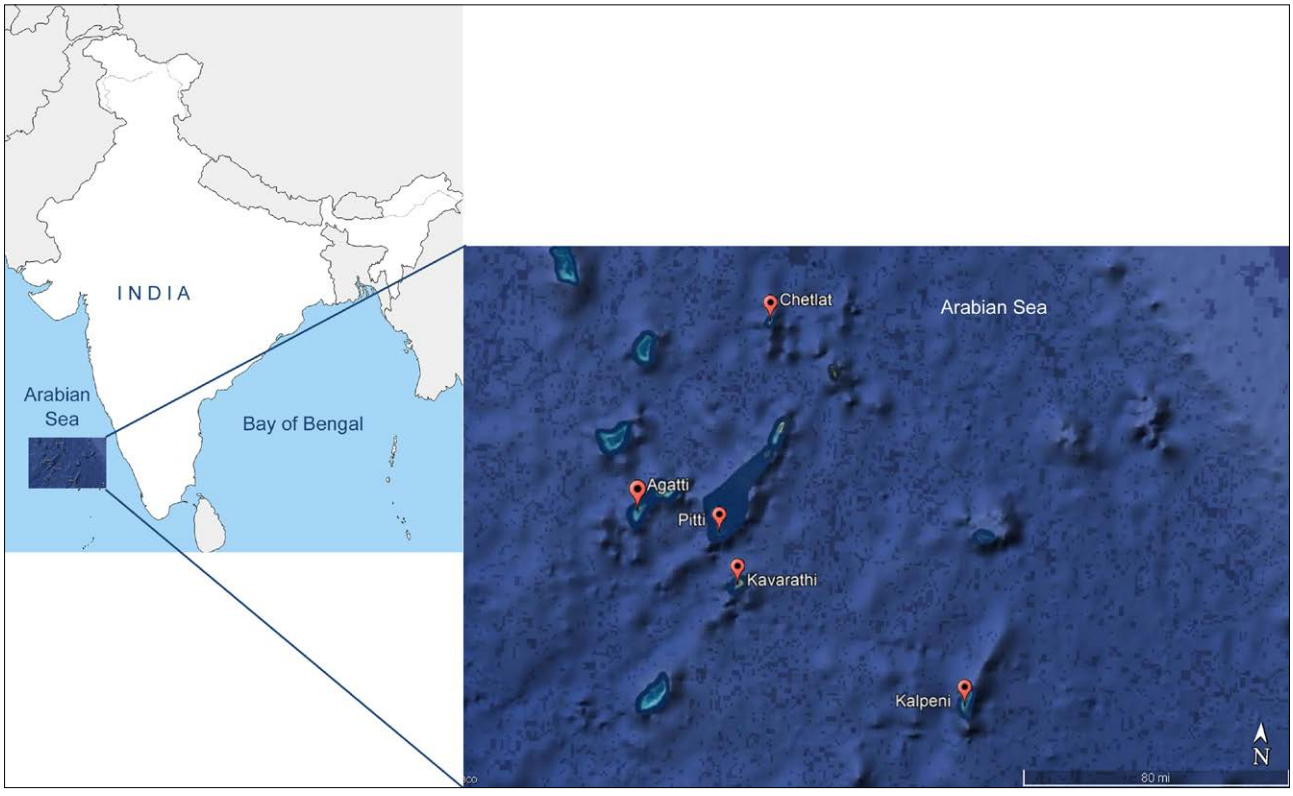

Fig. 1. Map showing sampling stations of sponges from Lakshadweep Islands (Chetlat, Kavaratti, Kalpeni, Pitti and Agatti)

Fig. 2. Sponge habitats of Lakshadweep Islands

(Van Soest *et al*., 2020). A checklist of sponges reported from Lakshadweep area was prepared and produced.

Results and discussion

New records

The taxonomic details of the four new records of sponges *viz Agelas oroides*, *Callyspongia* (*Cladochalina*) *aculeata, Raspailia (Clathriodendron) arbuscula* and *Stylissa massa* recorded during the current investigation are presented below.

1. *Agelas oroides* (Schmidt, 1864)

Systematics
Class : Demospongiae (Sollas, 1885)
Order : Agelasida (Hartman, 1980)
Family : Agelasidae (Verrill, 1907)
Genus : *Agelas* (Duchassaing & Michelotti, 1864)
Species : *Agelas oroides* (Schmidt, 1864)

Type species: *Clathria oroides* Schmidt, 1864, (Enthaltend die Histologie und systematische Ergänzungen). (Wilhelm Engelmann: Leipzig), 35, pl. IV fig.1-2). Valid as *Agelas oroides* (Schmidt, 1864).

Type locality: Adriatic Sea

Materials examined: *In situ* observation at Kalpeni Island on 17.01.2020 at Lat: 10° 5.37′ 16.39″; Long: 73° 38.42′ 37.80″.

Description: Sponge massive, skeleton composed of spined spicules. Two types of spicules- cylindrical blunt and round at each end and cylindrical bent in the middle spicules spines. Acanthostyle present in significant variability in the individual specimens as the size and strength of spines varies. Acanthostyle displayed with a bigger size and length and noted unpredictable flat whorls and spines. They had 11-15 whorls. The colour was orange. The species are native to the spaces of coral reefs in attached form.

Distribution: Kalpeni Island (present study), the Mediterranean Sea (Schmidt, 1864; Topsent, 1929; Lévi, 1957; Rützler, 1965; Pulitzer-Finali, 1983; Ben Mustapha *et al*., 2003; Voultsiadou, 2005) and the Atlantic Ocean (Van Soest, 2001).

Remarks: This species were noticed to exist in Mediterranean Sea and introduced to Lakshadweep area, presumably from Levantine Sea sector.

2. *Callyspongia (Cladochalina) aculeata* (Linnaeus, 1759)

Systematics
Class :Demospongiae (Sollas, 1885)
Order :Haplosclerida (Topsent, 1928)

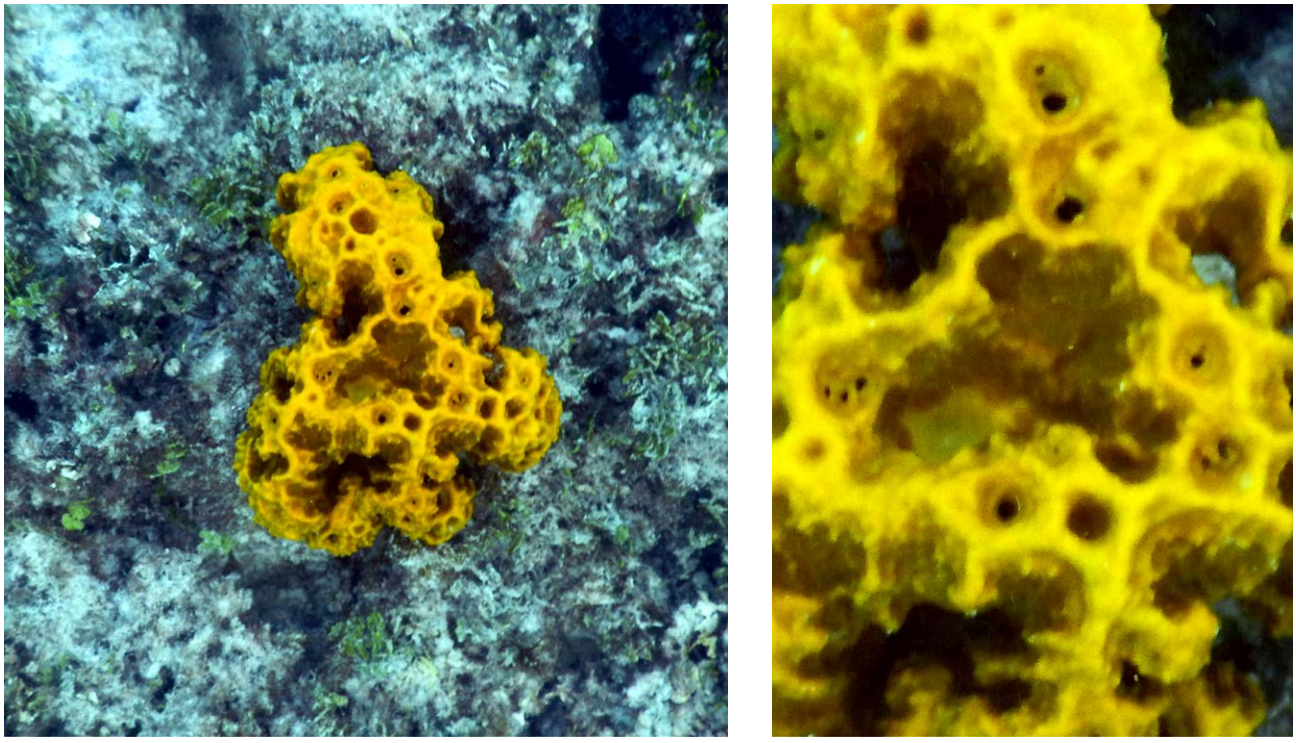

Fig. 3. a) In situ photograph of *Agelas oroides* from Kalpeni Islands b) Enlarged view of the specimen

Fig. 4. a) In situ photograph of *Callyspongia* (*Cladochalina*) *aculeata* from Kalpeni Islands b) Enlarged view of the specimen

Family :Callyspongiidae (Laubenfels, 1936)
Genus :*Callyspongia* Duchassaing & Michelotti, 1864
Species :*Callyspongia (Cladochalina) aculeata* (Linnaeus, 1759)

Type species: *Spongia aculeata* Linnaeus, 1759, 825-1384. (Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus II).

Type Locality: No type locality in Linnaeus, 1759.

Materials examined: *In situ* observation at Kalpeni Island on 17.01.2020 at Lat: 10° 4.22′ 46.39″; Long: 73° 37.42′ 29.99″.

Description: Tubular growth form with long tubes. Tubes are tapering at the top and wide at the base. The surface is rough and irregular. They are attached to corals. This species was originally described as *Spongia vaginalis* by Lamarck (1814) later shifted to *Callyspongia* by Laubenfels (1936). Sponge body composed of a single hollow cylinder and mostly six or more tubes arising from a single base. They occur in a single plane. The size of the tubes are 5 mm to 10 mm thick and 5 mm in diameter. The colour is violet and dead specimens fade to drab. Consistency is spongy. The surface is smooth and elevated into cross or cone shaped. Large apical oscula open into central tube.

Distribution: Kalpeni Island (present study), the Atlantic Ocean (Carter, 1882; Laubenfels, 1953; Hechtel, 1965; Collette and Rützler, 1977; Pulitzer-Finali, 1986; Rützler, 1986; Johnsson, 2002; Campos *et al.,* 2005; Moraes *et al.,* 2006; Muricy *et al.*, 2011), the Caribbean Sea (Duchassaing and Michelotti, 1864; Schmidt, 1870; Laubenfels, 1953; Hechtel, 1965; Van Soest, 1980; Pulitzer-Finali, 1986; Zea, 1987; Lehnert, 1993; Rützler *et al.*, 2000; Hooper and Van Soest (Eds.), 2002; Díaz, 2005) and the Pacific Ocean (Desqueyroux-Faúndez, 1984).

Remarks: This species is widely distributed in Atlantic Ocean and Caribbean Sea. The present record is new to Lakshadweep area of India.

3. *Raspailia (Clathriodendron) arbuscula* (Lendenfeld, 1888)

Systematics
Class : Demospongiae (Sollas, 1885)
Order : Axinellida (Lévi, 1953)
Family :Raspailiidae Nardo, 1833
Genus :*Raspailia* Nardo, 1833
Species : *Raspailia (Clathriodendron) arbuscula* (Lendenfeld, 1888)

Type species: *Clathriodendron arbuscula* Lendenfeld, 1888, 215, pl. 1-12. (Descriptive Catalogue of the Sponges in the Australian Museum, Sidney). Valid as *Raspailia (Clathriodendron) arbuscula* (Lendenfeld, 1888).

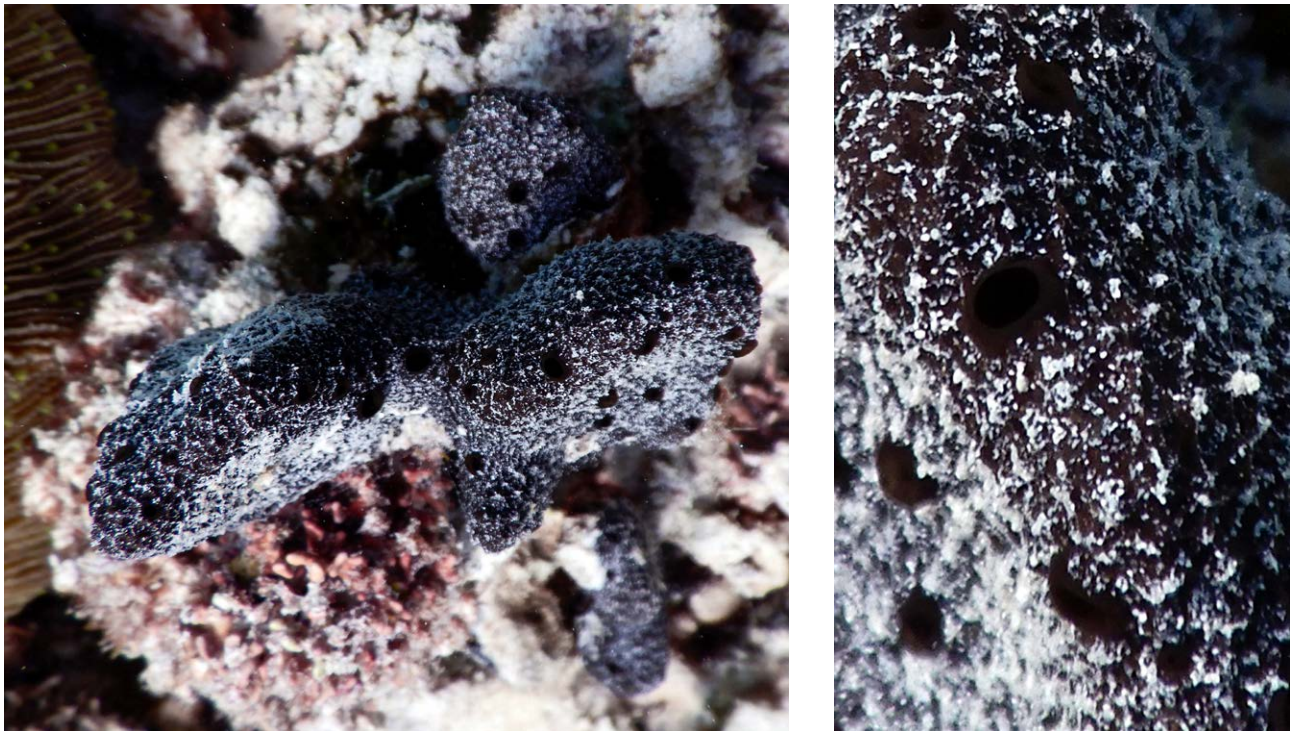

Fig. 5. a) In situ photograph of *Raspailia (Clathriodendron) arbuscula* from Kalpeni Islands b) Enlarged view of the specimen

Type Locality: Port Jackson, East coast of Australia.

Materials examined: *In situ* observation at Kalpeni Island on 18.01.2020 at Lat: 10° 7.6′ 26.99″; Long: 73° 39.3′ 94.19″.

Description: Arborescent, massive, conical, firm, fleshy with a lobe like branched projections, compressed and flattened. Skeleton comprises primary fibers. Fibers are echinate. Live color is bluish black. Smooth spicules present. Oxeas are predominant. Style, tylostyle and acanthostyle present. Oscules are small and visible in 1-2.5mm diameter. Thick encrustation. Surface is conulose in patches and projecting spicules give an overall silver appearance. The tree like sponge and the branches are conulated with uniform thickness. The small ostia scattered all around the body. Skeleton comprised of horny fibres with elongated meshes. The spines are stouts.

Distribution: Kalpeni Island (present study), the Pacific Ocean (Bergquist, 1961; Hooper, 1991; Kelly *et al.,* 2009) and Australia (Hooper and Van Soest, 2002).

Remarks: This species was reported from Australia and New Zealand. The present record was the first report from Lakshadweep Island.

4. *Stylissa massa* (Carter, 1887)

Systematics:

Class : Demospongiae (Sollas, 1885)
Order : Scopalinida Morrow & Cárdenas, 2015
Family : Scopalinidae Morrow *et al*., 2012
Genus : *Stylissa* Hallmann, 1914
Species : *Stylissa massa* (Carter, 1887)

Type species: *Axinella virgultosa var. massa* Carter, 1887, 61-84, pl. 5-7. (*Journal of the Linnaean Society, Zoology).*

Type locality: Andaman Sea Coral Coast.

Materials examined: *In situ* observation at Kalpeni Island on 17.01.2020 at Lat: 10° 5.1′ 67.39″; Long: 73° 38.21′ 91.80″

Description: Massive, compressed, lobate and plumose in display. Irregular surface is more or less hispid and attached to coral substratum. Short stalks support the lamina joined at the basal attachment. Live coloration is yellow. De Laubenfels collected the specimen *Stylissa conulosa var mauritiana* (Dendy, 1922) from Aling-lap-lap Atoll on a dead coral. The skeleton is irregular and specular fibres and spicules held together with spongin. The skeleton contains Styles. The dermal spicules are visible between the conuli. The exhalant surface is rugose with the network of rounded ridges. Two

Fig. 6. A) In situ photograph of *Stylissa massa* from Kalpeni Islands (b) Enlarged view of the specimen

types of smooth styles displayed 1. Short stout and common, 2. Long, slender and rare.

Distribution: Kalpeni Island (present study), The Pacific Ocean (Topsent, 1897; Lindgren, 1898; Lévi *et al.,*1998; Hooper and Van Soest, 2002), the Indian Ocean (Lindgren, 1898; Kirkpatrick, 1900; Pettit *et al.,* 1997; Barnes and Bell, 2002) and the Arabian Sea (Burton, 1959).

Remarks: This is the first report from the Lakshadweep Island of India.

Checklist of species

Compiled a list of 121 species of sponges from the study and previous reports (Table 1). The checklist includes species of siliceous (Class: Demospongiae) and one calcareous (Class: Calcarea) sponge representing 65 genera, 37 families and 16 orders. We compiled the list by reviewing the old names and several systematic and nomenclature alterations of the past names, to draw a uniform checklist of the species. Pioneering studies by Gardiner (1903) and Thomas (1973, 1979). Contributed to the knowledge of the sponge fauna of Lakshadweep. Gopi and Ajithkumar (2012) listed 21 species of sponges of 19 genera, 14 families, 9 order and two classes. The most abundant group belongs to the order Dictyoceratida from Agatti Island followed by Poecilosclerida and Haplosclerida. Out of the 21 species, two i.e. *Spongia officinalis* and *Cliona celata* are already listed, whereas other 19 species are new records to Agatti Island (Gopi and Ajithkumar, 2012).

Common species

24 species of sponges were found to be most common and abundant in Chetlat, Kavaratti, Kalpeni, Pitti and Agatti. They are *Agelas ceylonica*, *Cliona celata*, *Cliona ensifera*, *Cliona mucronata*, *Ecionemia thielei*, *Clathria (Microciona) aceratoobtusa*, *Dysidea fragilis*, *Fasciospongia cavernosa*, *Gelliodes fibulata*, *Callyspongia (Cladochalina) diffusa*, *Callyspongia (Cladochalina) fibrosa*, *Echinodictyum longistylum*, *Haliclona (Gellius) cellaria*, *Ircinia campana*, *Jaspis digonoxea*, *Mycale (Mycale) grandis*, *Mycale (Zygomycale) parishii*, *Spheciospongia inconstans*, *Spirastrella coccinea*, *Spongia (Spongia) ceylonensis*, *Spongia (Spongia) officinalis*, *Suberites carnosus*, *Thoosa armata* and *Rhabdastrella globostellata*.

Boring Sponges

Lakshadweep comprises 36 Coral Islands enclosing an area of 32 km^2 and a lagoon area of 73.93 km^2 which affords a wide opportunity for the rich growth of coral associated sponges. The most abundant species were *Amorphinopsis excavans* Carter, 1887; *Aka minuta* Thomas, 1972; *Aka laccadivensis* Thomas (1972) (=*Cliona ensifera* Sollas, 1878); *Cliona celata* Grant, 1826; *Cliona vastifica* Hancock, 1849; *Cliona viridis* (Schmidt, 1862); *Cliona carpenteri* Hancock, 1867; *Cliona ensifera* Sollas,

Table 1. Checklist of sponges of Lakshadweep Islands

Sl. No	Species name	Order	Family	Reference
1	*Aaptos aaptos* (Schmidt, 1864)	Suberitida	Suberitidae	Thomas, 1989
2	*Acanthella cavernosa* Dendy, 1922	Bubarida	Dictyonellidae	Thomas, 1989
3	*Acarnus souriei* (Lévi, 1952)	Poecilosclerida	Acarnidae	Thomas, 1989
4	*Agelas ceylonica* Dendy, 1905	Agelasida	Agelasidae	Thomas, 1989
5	*Agelas mauritiana* (Carter, 1883)	Agelasida	Agelasidae	Thomas, 1989
6	*Agelas oroides* (Schmidt, 1864)	Agelasida	Agelasidae	New record, present study
7	*Amorphinopsis excavans* Carter, 1887	Suberitida	Halichondriidae	Thomas, 1989
8	*Amorphinopsis foetida* (Dendy, 1889)	Suberitida	Halichondriidae	Thomas, 1989
9	*Antho (Plocamia) manaarensis* (Carter, 1880)	Poecilosclerida	Microcionidae	Thomas, 1989
10	*Auletta aurantiaca* Dendy, 1889	Axinellida	Axinellidae	George *et al.*, 2020
11	*Axinella donnani* (Bowerbank, 1873)	Axinellida	Axinellidae	George *et al.*, 2020
12	*Axinella manus* Dendy, 1905	Axinellida	Axinellidae	George *et al.*, 2020
13	*Axinella tenuidigitata* Dendy, 1905	Axinellida	Axinellidae	George *et al.*, 2020
14	*Biemna ehrenbergi* (Keller,1889)	Biemnida	Biemnidae	George *et al.*, 2020
15	*Biemna fortis* (Topsent, 1897)	Biemnida	Biemnidae	Thomas, 1989
16	*Callyspongia (Callyspongia) tubulosa* (Linnaeus, 1759)	Haplosclerida	Callyspongiidae	Gopi and Ajithkumar, 2015
17	*Callyspongia (Cladochalina) aculeata* (Linnaeus, 1759)	Haplosclerida	Callyspongiidae	New record, present study
18	*Callyspongia (Cladochalina) diffusa* (Ridley, 1884)	Haplosclerida	Callyspongiidae	Thomas, 1989
19	*Callyspongia (Cladochalina) fibrosa* (Ridley & Dendy, 1886)	Haplosclerida	Callyspongiidae	Thomas, 1989
20	*Callyspongia crassifibra* (Dendy, 1889)	Haplosclerida	Callyspongiidae	George *et al.*, 2020
21	*Carteriospongia foliascens* (Pallas, 1766)	Dictyoceratida	Thorectidae	Thomas, 1989
22	*Cervicornia cuspidifera* (Lamarck, 1815)	Clionaida	Spirastrellidae	Thomas, 1989
23	*Chondrilla sacciformis* Carter, 1879	Chondrillida	Chondrillidae	Thomas, 1989
24	*Cinachyrella cavernosa* (Lamarck, 1815)	Tetractinellida	Tetillidae	Thomas, 1989
25	*Ciocalypta digitata* (Dendy,1905)	Suberitida	Halichondriidae	George *et al.*, 2020
26	*Ciocalypta polymastia* (Lendenfeld, 1888)	Suberitida	Halichondriidae	Thomas, 1989
27	*Clathria (Clathria) indica* Dendy, 1889	Poecilosclerida	Microcionidae	George *et al.*, 2020
28	*Clathria (Microciona) aceratoobtusa* (Carter, 1887)	Poecilosclerida	Microcionidae	Thomas, 1989
29	*Clathria (Microciona) rhopalophora* (Hentschel, 1912)	Poecilosclerida	Microcionidae	Thomas, 1989
30	*Clathria (Thalysias) reinwardti* Vosmaer, 1880	Poecilosclerida	Microcionidae	Thomas, 1989; Prabhakaran *et al.*, 2013
31	*Cliona celata* Grant, 1826	Clionaida	Clionaidae	Thomas, 1989
32	*Cliona ensifera* Sollas, 1878	Clionaida	Clionaidae	Thomas, 1989
33	*Cliona mucronata* Sollas, 1878	Clionaida	Clionaidae	Thomas, 1989
34	*Cliona viridis* (Schmidt, 1862)	Clionaida	Clionaidae	Thomas, 1989
35	*Cliothosa aurivillii* (Lindgren, 1897)	Clionaida	Spirastrellidae	Thomas, 1989
36	*Coelocarteria singaporensis* (Carter, 1883)	Poecilosclerida	Acarnidae	Thomas, 1989
37	*Dendrilla cactos* (Selenka, 1867)	Dendroceratida	Darwinellidae	Thomas, 1989
38	*Dercitus (Stoeba) plicatus* (Schmidt, 1868)	Tetractinellida	Ancorinidae	Thomas, 1989
39	*Desmanthus rhabdophorus* (Hentschel, 1912)	Bubarida	Desmanthidae	Thomas, 1989
40	*Dragmacidon agariciforme* (Dendy, 1905)	Axinellida	Axinellidae	George *et al.*, 2020
41	*Dysidea fragilis* (Montagu, 1814)	Dictyoceratida	Dysideidae	Thomas, 1989; Prabhakaran *et al.*, 2013
42	*Dysidea granulosa* Bergquist, 1965	Dictyoceratida	Dysideidae	Annie and Shanta, 2010; George *et al.*, 2020
43	*Echinoclathria rimosa* (Ridley, 1884)	Poecilosclerida	Microcionidae	Thomas, 1989

44	*Echinodictyum longistylum* Thomas, 1968	Axinellida	Raspailiidae	Thomas, 1989, Prabhakaran *et al*., 2013
45	*Ecionemia acervus* Bowerbank, 1862	Tetractinellida	Ancorinidae	Thomas, 1989
46	*Ecionemia thielei* Thomas, 1986	Tetractinellida	Ancorinidae	Thomas, 1989
47	*Fasciospongia anomala* (Dendy, 1905)	Dictyoceratida	Thorectidae	George *et al*., 2020
48	*Fasciospongia cavernosa* (Schmidt, 1862)	Dictyoceratida	Thorectidae	Thomas, 1989; Prabhakaran *et al*., 2013
49	*Gelliodes fibulata* (Carter, 1881)	Haplosclerida	Niphatidae	Thomas, 1989
50	*Gelliodes pumila* (Lendenfeld, 1887)	Haplosclerida	Chalinidae	Thomas, 1989
51	*Geodia lindgreni* (Lendenfeld, 1903)	Tetractinellida	Geodiidae	Thomas, 1989
52	*Halichondria (Halichondria) panicea* (Pallas, 1766)	Suberitida	Halichondriidae	Thomas, 1989
53	*Haliclona (Gellius) cellaria* (Rao, 1941)	Haplosclerida	Niphatidae	Prabhakaran *et al.,* 2013
54	*Haliclona (Gellius) fibulata* (Schmidt, 1862)	Haplosclerida	Chalinidae	Thomas, 1989; Prabhakaran *et al*., 2013
55	*Haliclona (Haliclona) oculata* (Linnaeus, 1759)	Haplosclerida	Chalinidae	Thomas, 1989
56	*Haliclona pigmentifera* (Dendy, 1905)	Haplosclerida	Chalinidae	Prabhakaran *et al*., 2013
57	*Haliclona tenuiramosa* (Burton, 1930)	Haplosclerida	Chalinidae	Thomas, 1989; Prabhakaran *et al*., 2013
58	*Hyattella cavernosa* (Pallas, 1766)	Dictyoceratida	Spongiidae	George *et al*., 2020
59	*Hyattella cribriformis* (Hyatt, 1877)	Dictyoceratida	Spongiidae	Thomas, 1989; Prabhakaran *et al*., 2013
60	*Hyattella intestinalis (*Lamarck, 1814)	Dictyoceratida	Spongiidae	George *et al*., 2020
61	*Hyattella macrophylla* Varsha, Joshi & Jasmine, 2020	Dictyoceratida	Spongiidae	Varsha *et al*., 2020
62	*Hyattella tubaria* Lendenfeld, 1889	Dictyoceratida	Spongiidae	George *et al*., 2020
63	*Hyrtios erectus* (Keller, 1889)	Dictyoceratida	Thorectidae	Thomas, 1989
64	*Hyrtios reticulatus* (Thiele, 1899)	Dictyoceratida	Thorectidae	George *et al*., 2020
65	*Ianthella flabelliformis* (Linnaeus, 1759)	Verongiida	Ianthellidae	Gopi and Ajithkumar, 2015
66	*Iotrochota baculifera* Ridley, 1884	Poecilosclerida	Iotrochotidae	Thomas, 1989
67	*Ircinia campana* (Lamarck, 1814)	Dictyoceratida	Irciniidae	Prabhakaran *et al*., 2013
68	*Ircinia vallata* (Dendy, 1887)	Dictyoceratida	Irciniidae	George *et al*, 2020
69	*Jaspis digonoxea* (de Laubenfels, 1950)	Tetractinellida	Ancorinidae	Thomas, 1989
70	*Jaspis penetrans* (Carter, 1880)	Tetractinellida	Ancorinidae	Thomas, 1989
71	*Lamellodysidea herbacea* (Keller, 1889)	Dictyoceratida	Dysideidae	Thomas, 1989
72	*Lendenfeldia dendyi* (Lendenfeld, 1889)	Dictyoceratida	Thorectidae	Thomas, 1989
73	*Leucetta chagosensis* Dendy, 1913	Clathrinida	Leucettidae	George *et al*., 2020
74	*Lissodendoryx* (Waldoschmittia) *schmidti* (Ridley, 1884)	Poecilosclerida	Coelosphaeridae	Thomas, 1989
75	*Luffariella herdmani* (Dendy, 1905)	Dictyoceratida	Thorectidae	George *et al*., 2020
76	*Mycale (Mycale) grandis* Gray, 1867	Poecilosclerida	Mycalidae	Thomas, 1989
77	*Mycale (Zygomycale) parishii* (Bowerbank, 1875)	Poecilosclerida	Mycalidae	Thomas, 1989; George *et al*., 2020
78	*Myrmekioderma granulatum* (Esper, 1829)	Axinellida	Heteroxyidae	Thomas, 1989
79	*Myxilla (Ectyomyxilla) arenaria* Dendy, 1905	Poecilosclerida	Myxillidae	Thomas, 1989
80	*Neopetrosia chaliniformis* (Thiele, 1899)	Haplosclerida	Chalinidae	Thomas, 1989
81	*Oceanapia sagittaria* (Sollas, 1902)	Haplosclerida	Chalinidae	Thomas, 1989
82	*Paratetilla bacca* (Selenka, 1867)	Tetractinellida	Tetillidae	Thomas, 1989
83	*Pericharax heteroraphis* Poléjaeff, 1883	Clathrinida	Leucettidae	Gopi and Ajithkumar, 2015
84	*Pione carpenteri* (Hancock, 1867)	Clionaida	Clionaidae	Thomas, 1989
85	*Pione margaritiferae* (Dendy, 1905)	Clionaida	Clionaidae	Thomas, 1989
86	*Pione vastifica* (Hancock, 1849)	Clionaida	Clionaidae	Thomas, 1989
87	*Placospongia carinata* (Bowerbank, 1858)	Clionaida	Placospongiidae	Thomas, 1989
88	*Plakinastrella minor* (Dendy, 1916)	Homosclerophorida	Plakinidae	Thomas, 1989

89	*Pseudoceratina purpurea* (Carter, 1880)	Verongiida	Pseudoceratinidae	Thomas, 1989; Prabhakaran *et al*., 2013; George *et al*., 2020
90	*Raspailia (Clathriodendron) arbuscula* (Lendenfeld, 1888)	Axinellida	Raspailiidae	New record, present study
91	*Rhabdastrella globostellata* (Carter, 1883)	Tetractinellida	Ancorinidae	Thomas, 1989; Prabhakaran *et al*., 2013
92	*Rhabdastrella rowi* (Dendy, 1916)	Tetractinellida	Ancorinidae	Thomas, 1989
93	*Rhabderemia prolifera* Annandale, 1915	Biemnida	Rhabderemiidae	Thomas, 1989
94	*Samus anonymus* Gray, 1867	Tetractinellida	Samidae	Thomas, 1989
95	*Sigmadocia fibulata* (Schmidt, 1862)	Haplosclerida	Chalinidae	Annie and Shanta, 2010
96	*Sigmaxinella flabellata* (Carter, 1885)	Biemnida	Biemnidae	Gopi and Ajithkumar, 2015
97	*Siphonodictyon minutum* (Thomas, 1972)	Haplosclerida	Phloeodictyidae	Thomas, 1989
98	*Spheciospongia inconstans* (Dendy, 1887)	Clionaida	Spirastrellidae	Thomas, 1989; Prabhakaran *et al*., 2013
99	*Spheciospongia vagabunda* (Ridley, 1884)	Clionaida	Clionaidae	George *et al*., 2020
100	*Spirastrella coccinea* (Duchassaing & Michelotti, 1864)	Clionaida	Spirastrellidae	Thomas, 1989
101	*Spongia (Spongia) ceylonensis* (Dendy, 1905)	Dictyoceratida	Spongiidae	Thomas, 1989; George *et al*., 2020
102	*Spongia (Spongia) officinalis* Linnaeus, 1759	Dictyoceratida	Spongiidae	Prabhakaran *et al*., 2013
103	*Spongionella nigra* Dendy 1889	Dendroceratida	Dictyodendrillidae	George *et al*., 2020
104	*Spongosorites topsenti* (Dendy, 1905)	Suberitida	Halichondriidae	George *et al*., 2020
105	*Stelletta tethyopsis* Carter, 1880	Tetractinellida	Ancorinidae	Thomas, 1989
106	*Stellitethya repens* (Schmidt, 1870)	Tethyida	Tethyidae	Thomas, 1989
107	*Stylissa carteri* (Dendy,1889)	Scopalinida	Scopalinidae	George *et al*., 2020
108	*Stylissa massa* (Carter, 1887)	Suberitida	Halichondriidae	New record, present study
109	*Suberites carnosus* (Johnston, 1842)	Suberitida	Suberitidae	Thomas, 1989
110	*Sycon ciliatum* (Fabricius, 1780)	Leucosolenida	Sycettidae	Prabhakaran *et al*., 2013
111	*Tedania (Tedania) anhelans* (Vio in Olivi, 1792)	Poecilosclerida	Tedaniidae	Thomas, 1989
112	*Terpios cruciatus* (Dendy, 1905)	Suberitida	Suberitidae	Thomas, 1989; George *et al*., 2020
113	*Tethya diploderma* Schmidt, 1870	Tethyida	Tethyidae	Prabhakaran *et al*., 2013
114	*Tethya diplomat* Schmidt, 1870	Tethyida	Tethyidae	Thomas, 1989
115	*Tethya japonica* Sollas, 1888	Tethyida	Tethyidae	Thomas, 1989
116	*Tethya robusta* (Bowerbank, 1873)	Tethyida	Tethyidae	Thomas, 1989
117	*Theonella cupola* Burton, 1928	Tetractinellida	Theonellidae	Thomas, 1989
118	*Thoosa armata* Topsent, 1888	Tetractinellida	Thoosidae	Thomas, 1989
119	*Timea stellata* (Bowerbank, 1866)	Tethyida	Timeidae	Thomas, 1989
120	*Timea stellivarians* (Carter, 1880)	Tethyida	Timeidae	Thomas, 1989
121	*Zyzzya fuliginosa* (Carter, 1879)	Poecilosclerida	Acarnidae	Thomas, 1989

1878; *Cliona mucronata* Sollas, 1878; *Spirastrella coccinea* (Duchassaing & Michelotti, 1864); *Spirastrella cuspidifera* (Lamarck, 1815); *Spirastrella inconstans* (Dendy, 1887) and *Spirastrella aurivillii* Lindgren, 1897 from the coral habitat of Lakshadweep.

The present study has documented four new records of sponges from Lakshadweep area viz. *Agelas oroides*, *Callyspongia* (*Cladochalina*) *aculeata, Raspailia (Clathriodendron) arbuscula* and *Stylissa massa* which added to the sponge fauna of Lakshadweep. The present study and analyses of sponge fauna from Kavaratti, Kalpeni, Chetlat, Agatti and Pitti boosted the knowledge about the diversity of sponge fauna of Lakshadweep Islands, which is drawn into a checklist of 121 species (Table 1). Thomas (1973, 1980a, 1980b) published three new records of species, *Phyllospongia dendy* Lendenfeld, *Ciocalypta polymastia* (Lendenfeld) and *Clathria reinwardi* Vosmer from Minicoy Island. The previous investigations at Minicoy Island recorded 43 species of Demospongiae falling under 23 families and 32 genera (Thomas 1979, 1980a, 1980b). Those collections comprised of four species of sponges (*Spirastrella cuspidifera*, *Spirastrella inconstans*, *Cliona celata*, *Cliona vastifica*) capable of destroying the coral reefs and molluscs. Earlier Thomas (1989) published a checklist of 91 species of sponges from Lakshadweep islands based on his own studies and previous ones. According to

Thomas (1989) the order Hardomerida dominated with 21 species followed by Poecilosclerida (18 species), Keratosida (12 spp.), Haplosclerida (12 spp.), Choristida (10 spp.), Halichondrida (7 spp.) Epipolasida (7 spp.) and Carnosida (4 spp.). Sponges belonging to the class of Calcispongia, Hyalospongiae and Sclerospongiae are rare because of habitat choices and other hydrobiological factors (Thomas, 1989).

George *et al.* (2020) listed 21 new records from Lakshadweep area, *viz. Auletta aurantiaca* Dendy, 1889, *Axinella donnani* (Bowerbank, 1873), *Axinella manus* Dendy, 1905, *Axinella tenuidigitata* Dendy, 1905, *Biemna ehrenbergi* (Keller, 1889), *Callyspongia crassifibra* (Dendy, 1889), *Ciocalypta digitata* (Dendy,1905), *Clathria (Clathria) indica* Dendy, 1889, *Dragmacidon agariciforme* (Dendy, 1905), *Fasciospongia anomala* (Dendy, 1905), *Hyattella cavernosa* (Pallas, 1766), *Hyattella intestinalis* (Lamarck, 1814), *Hyattella tubaria* Lendenfeld, 1889, *Hyrtios reticulatus* (Thiele, 1899), *Ircinia vallata* (Dendy, 1887), *Leucetta chagosensis* Dendy, 1913, *Luffariella herdmani* (Dendy, 1905), *Spheciospongia vagabunda* (Ridley, 1884), *Spongionella nigra* Dendy, 1887, *Spongosorites topsenti* (Dendy, 1905) and *Stylissa carteri* (Dendy, 1889).

Prabhakaran *et al.* (2013) listed 22 species of sponges belonging to 21 genera, 19 families and 10 orders from the seagrass ecosystems of Minicoy. The most abundant among them were *Scypha ciliata*, *Dysidea fragilis*, *Fasciospongia cavernosa*, *Ircinia compana*, *Aurora globostellata*, *Spirastrella inconstans*, *Tethya diploderma*, *Haliclona pigmentifera*, *Haliclona tenuiramosa*, *Gelliodes cellaria*, *Sigmadocia fibulata*, *Hyatella cribriformis*, *Spongia officinalis*, *Echinodictyum longistylum*, *Thalysias reinwardti* and *Psammaplysilla purpurea*.

Previously two valid species of sponges belonging to the family Agelasidae were identified from Lakshadweep area (Thomas,1989). These are *Agelas ceylonica* Dendy, 1905 and *Agelas mauritiana* (Carter, 1883). The new record in the present investigation *Agelas oroides* (Schmidt, 1864) is distinguished by lobe type sponge body and presence of two types of spicules and acanthostyles. The existence of primary and secondary uncored fibres and the acanthostyles longer than 300 μm also distinguished the species. Whereas the *Agelas mauritiana* (Carter, 1883) consist of two types of spicules acanthoxeas and acanthostyles, the sponge body are lobed.

Three species represent the genus *Callyspongia* in Lakshadweep. *Callyspongia (Callyspongia) tubulosa* (Linnaeus, 1759), *Callyspongia (Cladochalina) diffusa* (Ridley, 1884) and *Callyspongia (Cladochalina) fibrosa* (Ridley and Dendy, 1886) which were recorded earlier. Among these the *Callyspongia diffusa* found with characters like vertical terminal branch, marginal oscules, surface is reticulate with conulose. Consistency hard, dermal skeleton is developed and reticulate fibres sub divided into secondaries. Skeleton comprises fibres and oxea. Violet yellowish in living condition (Thomas, 1989). Massive encrusting ramose and tubular sponge was identified as *Callyspongia tubulosa*. Tubes are coalesced for a greater or lesser distance and are united. Surface is smooth, microhispid and oscules on the top of the tubular form. Soft texture, compressible and colour *in situ* biege with purple (Samaai and Gibbon, 2005). *Callyspongia fibrosa* is a finger shaped or flattened branched sponges. Surface may or may not have strong conules and, they are prominent at growing tips on young sponges. Oscules small and scattered all over the body. Color is pale yellow in live. Dermal skeleton reticulates with triangular meshes. The present study reports *Callyspongia (Cladochalina) aculeata* from Lakshadweep area.

Hooper (1991) reviewed the sponges of the family *Raspailiidae* of Australian region and recognized 17 genera. Sponges are branching or lobate, cylindrical or flattened, which attaches to substratum. According to Hooper (1991) *R. arbuscula*, *R. cacticutis*, *R. darwinensis* and *R. wardi* did not have any well marked axial compression, with a reticulate or halichondroid axial skeletons instead, and these species have differentiated axial and extra axial components. Whereas the species like *R. atropurpurea*, *R. clathrata*, *R. pinnatifida* and *R. vestigifera* have developed axial and extra axial differentiation. The new record from Lakshadweep area *R. arbuscula* bearing more or less similar characters as described above.

Hallman (1914) established the Genus *Stylissa* and revised by Van Soest *et al.*, (2002) and contains seven species. None of the species was reported from Lakshadweep earlier. This is the first report of the species *Stylissa massa*. Alvarez and Hooper (2010) described the systematic position and distinctive characters of the species in the genus *Stylissa*. They have summarised that the morphological characters of the species within the genus *Stylissa* was overlapping and subject to a high degree of variability. They have indicated that generally separated species like *Stylissa carteri* and *Stylissa massa* constitute a species complex.

Sponge fauna of Lakshadweep are unique and shows an affinity towards the representatives of Demospongiae group as compared to other ocean areas. Their relationship and affinities towards the sponge fauna of the Australian zone, Atlantic Ocean, Mediterranean Sea and Red Sea can be traced back to the Gondwana Hypothesis. The presence of two new records of *Raspailia* and *Stylissa* makes a definite agreement that Lakshadweep sponge fauna are more divergent, as expected from previous studies. The use of scuba for sampling and molecular analysis of the samples may disclose the knowledge treasure of the systematic and phylogenic relationship of diverse groups

of sponges. Global warming and the bleaching events lead to the deterioration of corals which in turn give impetuous to the growth and proliferation of boring sponges in these Islands. Further, studies will reveal the distribution pattern, the intensity of the attachment and growth kinetics of the boring sponges may lead to policy options for the biodiversity conservation and the management of sponge fauna of Lakshadweep.

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