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MARINE LIVING RESOURCES OF THE UNION TERRITORY OF LAKSHADWEEP —

An Indicative Survey With Suggestions For Development

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Limited Circulation

13. SPONGE FAUNA OF LAKSHADWEEP

P. A. Thomas

INTRODUCTION

The present collection of sponges from Lakshadweep is of great significance since this group had been left out while Gardiner (1903-1906) dealt with the fauna and geography of the Maldive and Laccadive archipelagoes. Since then several works dealing with the sponge fauna of the Indian seas have appeared, but unfortunatly, few of these relating to the sponge fauna of Lakshawdeep. In this context the special interest taken by Dr. S. Jones, the then Director of the Central Marine Fisheries Research Institute in the 1960's in studying and documentting the fauna of Lakshadweep is worth mentioning. Besides obtaining data on the various fisheries of the island by the scientists posted at Minicoy, other scientists/research scholars, who were deputed to Minicoy from time to time also collected voluminous data and material from the different islands of this archipelago, to be later worked out by those interested. Sponges, thus collected, formed the part of a Ph. D. thesis (11 species including one new species) submitted by the present author in 1968 to the Kerala University. The subsequent collections of sponges from Minicoy were worked out and published serially (Thomas' 1973; 1979, 1980 and 1980a). The above works have helped to know mainly about the sponge fauna of Minicoy island and these accounted for a total of 41 species of Demospongiae falling under 23 families and 32 genera, while the sponge fauna of other islands still remained unexplored.

STRUCTURE AND COMPOSTION OF THE MAJOR TAXA OF SPONGES IN LAKSHADWEEP

The present review is based on sponges collected from various islands of the Lakshadweep Archipelago and hence species already recorded from Minicoy have also been included for the comprehensiveness of the account. A detailed systematic account of the sponges collected during the present survey will be published elsewhere.

It is customary to classify the extant sponges under 4 Classes—Demospongiae or silicious sponges, Calcispongiae or calcareous sponges, Hyalospongiae or hexactinellid sponges and Sclerospongiae. Of the above 95% of the recent sponges as the members of this class are better adapted to meet any vtcissitudes of nature, and hence collection of porifera made from any ocean will contain more of Demospongean members. From Lakshadweep only species belonging to this class have been recorded so far, But, this does not necessarily mean that the members of Calcispongiae are not represented in this area; careful examination might reveal the presence of a few calcareous species. However, the chances of encountering species of Hyalospongiae and Sclerospongiae are practically nil since hyalospongean species are, by nature, deep-water forms and Sclerospongiae form a highly specialised group with regard to their habitat preferance.

ORDERS OF THE CLASS DEMOSPONGIAE SOLLAS AND THEIR COMPOSTION IN LAKSHADWEEP

Species of this class are adapted for a life in both marine and freshwater realms and the skeleton is made of hydrated silica with or without an admixture of spongin. Some may also incorporate arenaceous objects (sand grains, spicules of other sponges etc.) into their body for maintaining sufficient rigidity. In a few families a specialised skelton of any sort may even be wanting. Species of this class dominate in shallow water areas throughout the world.

This class is divided into 8 orders based on general structure and spicular compostion. As in the other classes of the Phylum Porifera, here also there is considerable difference in the number of species falling under each order. The species of the order Poecilosclerida Topsent usually dominate in any collection of Porifera. The relative numerical abundance

(percentage) of species falling under each order from 5 Islands (Kavaratti, Suheli, Kalpeni, Androth and Minicoy) is given in Table 1. The corresponding figures for the other regions such as the Gulf of Mannar, Palk Bay and the Seychelles Bank are also included in the table for comparison.

least impressive numerically with 4 species, which forms about 4.4% of the total number of species. The above composition is based on the pooled data, when the number of species in each island is considered, the pattern may change considerably except in the case of the order Hadromerida. An order-wise appraisal of

Table : *Order-wise composition of species* (%)

Orders	K*	S	KA	A	M	P	SE	G
1. Keratosida	14.3	12.9	22.2	16.6	12.7	13.2	10.6	8.0
2. Haplosclerida	17.8	3.2	16.7	9.6	7.3	13.2	9.6	14.2
3. Poecilosclerida	17.8	16.1	16.7	11.1	21.8	19.7	26.0	26.9
4. Halichondrida	—	—	5.5	—	9.1	7.7	7.7	11.3
5. Hadromerida	35.7	38.7	30.6	61.1	29.1	23.1	20.2	15.6
6. Epipolasida	—	12.9	2.8	—	7.3	7.7	11.5	6.2
7. Choristida	7.2	3.2	—	—	9.1	11.0	10.6	10.9
8. Carnosida	7.2	12.9	5.5	5.6	3.6	4.4	3.8	6.9

* K=Kavaratti; S=Suheli; KA=Kalpeni; A=Androth; M=Minicoy;
P=Pooled data for all islands; SE=Seychelles Bank;
G=Gulf of Mannar and Palk Bay; — = not represented

As has been mentioned earlier, species of the Order Poecilosclerida dominate in any collection (see the percentage composition of species from the various orders in areas like Seychelles Bank, Gulf of Mannar and Palk Bay), but in the present collection from Lakshadweep, both Island-wise and in pooled data for all the 5 islands, the members of the Order Hadromerida dominate (21 species). This deviation from the normal distribution is due to the abundance of species belonging to the families Clionidae and Spirastrellidae that are well known for their boring habit. The abundance of calcium carbonate, in the form of coral skeleton, affords a condition quite congenial for the growth and proliferation of boring sponges belonging to the aforesaid two families.

Next, in order of abundance in the Lakshadweep region, comes Poecilosclerida which accounts for 18 species (19.7 %). Species belonging to the orders Keratosida and Haplosclerida are equally abundant with 12 species (13.2%) each. The order Choristida has 10 species (11.0%) while the orders Halichondrida and Epipolasida have 7 species (7.7%) each. Of all the orders represented Carnosida is the

the sponge fauna of the Lakshadweep may be made as follows:

1. Order Keratosida Grant

This is a polyphyletic group with utmost variation in shape, size and colour. Mineral skeleton, as a rule, is absent and its place is taken by spongin fibres which may be reticulate or dendritic in arrangement. Fibres may contain arenaceous objects in varying degrees; spicules made of spongin may be rarely noted in some. Some genera may completely be devoid of any skeleton.

Three families, Spongiidae Gray, Dysideidae Gray, Aplysillidae Vosmaer are represented in Lakshadweep, accounting for a total of 12 species referable to 10 genera. Species of the first family have elastic spongin fibres and hence they are, at least some species, used as 'bath sponge'. The most common and widely distributed 'bath sponge' on the mainland of India (*Spongia officinalis* Lin.) is represented by its variety *ceylynensis* Dendy in Lakshadweep and was collected, at least in stray numbers, from almost all the islands surveyed. Specimens collected f rom the lagoon had an encrusting

growth form while those washed ashore on the open side of the island (mainly Kavaratti and Kiltan) were of irregular, tuberous morphology. The fibres, in all these cases, were rather robust and with poor resilience, indicating poor commercial possibilities.

Species falling under this family may be divided into two subfamilies based on the nature of skeleton. Fibres represented in the first subfamily (Spongiinae de Laubenfels) may or may not be trellised or fascicular. Similarly, a sand cortex also may or may not be present. Genera like *Spongia* Lin., *Hippiospongia* de Laubenfels, *Heteronema* Keller, *Hyattella* Lendenfeld and *Pyllospongia* Ehlers fall under this subfamily. The second subfamily, Verongiinae de Laubenfels, may be divided into two subdivisions based on the nature of the fibres whether trellised and fascicular or not. The genus *Fasciospongia* Burlon, comes under the former subdivision while the genus *Thorectopsamma* Burton, under the latter. Generally, the species falling under this subfamily have very tough fibres with poor resiliency and hence are of no commercial value.

The second family, Dysideidae Gray, is represented at Lakshadweep by two genera, *Dysidea* Johnston and *Dendrilla* Lendenfeld, the former with two, and the latter with a single species. Species of *Dysidea* incorporate sand grains etc., into their skeleton and hence are quite friable on drying. The fibres of *Dendrilla* never incorporate sand grains, and are laminated and pithed. These fibres often run in a feebly dendritic fashion. The species represented is *D. cactus* Selenka. and the specimens, when macerated, ooze out a secretion of the same colour.

The third family, Aplysillidae Vosamer, is quite different from the aforementioned two families in that the fibres are distinctly dendritic and, besides, there may be diactinal or triactinal spicules made of a substance very close to spongin in chemical composition. The only genus represented is *Psammaplysilla* Keller, which has no spongin spicules at all. *P. purpurea* (Carter) could be collected from 7 of the islands surveyed. Though a branching body form is very well noted in advanced stages, such specimens were not present in any of the islands surveyed, and all of them were encrusting indicating the early stage in the life cycle.

This order ranks second numerically in both Kalpeni and Androth.

2. Order Haplosclerida Topsent

The skeleton, in this order, is very simple. It is reticulate with rectangular to triangular meshes and the fibres may be uni or multispicular with spongin covering the spicules in degrees. Spicules are represented by diactinal (oxeas or strongyles) megascleres and sigmoid or toxoid microscleres. Spongin may be seen cementing the spicules at their corners or just covering the spicules (as in Haliclonidae de Laubenfels) or thickly (as in Callyspongiidad de Laubenfels), forming stout fibres. In Adociidae de Laubenfels the microscleres seen may be sigmas (genus *Sigmadocia* de Laubenfels) or sigmas and toxas (genus *Orina* Gray) in addition to the characteristic megascleres of the family. Genus *Damirina* Burton, also of the family Adociidae, has dermal tornotes over an isodictyal reticulation of spined (often verticillately) acanthostrongyles. During the present survey a new species of this genus (*D. laccadivensis*) could be collected. This has irregularly spined acanthostrongyles instead of the normal verticillate type. Specimens of the new species were collected from two islands, Kalpeni (D-2) and Minicoy (J-3). The substratum beneath the specimen, in both cases, presented a highly disintegrated look and it could not be confirmed weather the sponge is intruding into cavities made by other boring sponges or not. The most common and widely distributed species of the family is *Sigmadocia fibulata* (Schmidt). This sponge grows in association with the alga *Ceratodictyon spongiosum* (Zanard) and hence drefer to colonise well-lighted areas of the lagoon. This species could be collected from 5 islands of this archipelago.

The fourth family Desmacidonidae Gray, has reticulate or plumoreticulate skeleton with diactinal megascleres. Microscleres are represented by chelas and sigmas mostly, the former often with some curious modifications. Genus *Iotrochota* Ridley has both monacts and diacts as megascleres. Genus *Cornulum* Carter is represented by a single specis, *C. vesiculatum* (Dendy) from Kalpeni (I-3). This species was

first reported from the Gulf of Mannar by Dendy (1905). The body is vase or bladder shaped with fistules arising from the upper parts. Usually these fistules project from the bottom as the main body remains buried in the sand. Spicules consist of strongyles and oxeas for megascleres and isochelas for microscleres.

The total number of species falling under the present order from Lakshadweep is 13 and may be classified under 8 genera and 4 families.

3. Order Poecilosclerida Topsent

This is structurally the most diverse order of the class Demospongiae and is very well known for the different categories of spicules it contains. Megascleres are represented by both monacts and diacts and are with curious modifications of some sort or the other. Spiny spicules are rather common. Spicules may show considerable regional differentiation. Spongin may be noted in varying degree and in some cases spicules may even get aggregated into a reticulation of a very complicated nature Microscleres represented may be of different types, sigmas, chelas, toxas, raphides and so on. But there are some genera in which the microscleres may totally be absent.

The body form, in this order, may vary considerably; some may be encrusting throughout their life, but others may be ramose, bushy, massive or foliate. Species falling under this order may be beautifully coloured. Some species which cannot tolerate direct sunlight may prefer to grow attched to the under surface of hard objects away from siltfall.

A very large fraction of all the described genera of the Phylum Porifera fall under this order, but this order has only second position in Lakshadweep in the order of numerical abundance, the first being the order Hadromerida Topsent. It is still not known whether the abundance of calcium carbonate in the form of coral produces a favaurable condition for the growth of boring sponges of the order Hadromerida or the sea bottom covered with coral sand inhibits the growth of species of order Poecilosclerida. However, this is an exceptional condition noted in the species composition of individual islands as well as in the pooled data for all islands surveyed at present.

de Laubenfels (1936) suggested 4 artificial 'Divisions' for this order based on the nature of principal and auxiliary spicules, whether diactinal or monactinal. In the first Division, Phorbasiformes, the principal and at least some of the auxiliary spicules are diactinal while auxiliaries are monactinal; in the third, Myxilliformes, the principal ones are monactinal and auxiliaries, diactinal and finally, in the fourth, Microcioniformes, both principal and auxiliary spicules are monactinal. Judging from the above grouping, families such as Phorbasidae de Laubenfels, and Agelasidae Verrill fall under the first Division, family Plocamiidae Topsent under the second; families Myxillidae Hentschel, Tedaniidae Ridley and Dendy and Raspailiidae Hentschel under the third; and families Microcionidae Hentschel, Ophlitaspongiidae de Laubenfels and Amphilectidae de Laubenfels under the fourth Division.

Only two genera of the family Phorbasidae, viz, *Echinodictyum* Ridley and *Damiriana* de Laubenfels, are represented at Lakshadweep. The spiculation in the former genus consists of oxeas in fibres accompanied by partly projecting styles; the fibres are echinated by acanthostyles and no microscleres are represented. The only species represented is *E. longistylum* Thomas. Genus *Damiriana* has dermal tylotes and endosmal oxeas; microscleres are represented by arcuate chelas and sigmas. *D. schmidti* (Ridley) is a widely distributed Indo-Pacific species which, in the reef environment, retains the encrusting habit throughout life. This species has been collected from four of the islands surveyed. The next family of the present Division is Agelasidae. The members of this family have neither principal spicules or auxiliaries in the strict sense and those represented may be put under the category 'echinating,. Spongin fibres are developed and form a fine reticulum. The inclusion of this family under this Division is open to criticism and a better position for this would be the fourth Division. Since reduction of spicules is so characteristic here, de Laubenfels (1936) concluded that the family is polyphyletic and a still

further reduction of spicules will lead to the absence of spicules at all, as seen in the case of spongiidae Gray. Bergquist and Hartman (1969) concluded that a better place for this family would be among Axinellida since they noted some similarities in free amino acid patterns and sterol composition of these two groups. Genus *Agelas* D & M, the representative of this monogeneric family, has unique echinating spicules in which the spines are arranged in nodal whorls. Two well-known species (*A. mauritiana* (Carter) and *A. ceylonensis* Dendy) and an unidentified species (*Agelas* sp. Thomas, 1980) have been hitherto known from Minicoy. However, no species of this genus could be collected during the present survey. Of the aforementioned two species the first one is a widely distributed Indo-Pasific species while the second enjoys distribution only in the Indian Ocean.

Only one family (Plocamiidae Topsent) of the second Division is represented at Lakshadweep and a s pecies (*Plocamilla mannarensis* (Carter) has been recorded by Burton and Rao (1932). This is a widely distributed Indian Ocean species and the specimens grow to a bushy structure with a short peduncle bearing several dichotomously dividing branches of 3 to 5 mm diameter.

The third Division, Myxilliformes, is represented at Lakshadweep by three families, Myxillidae Hentschel. Tedaniidae Ridley and Dendy and Raspailiidae Hentschel. Two Myxillid sponges, *Myxilla arenaria* Dendy and *Myxilla* sp. have been recorded so far, the first one from Kalpeni and the other from Minicoy (Thomas, 1980). The former species exhibits the habit of incorporating sand grains etc., into the body. Two genera of the family Tedaniidae, which are found rather well distributed in the Lakshadweep, are *Tedania* Gray and *Acanthacarnus* Levi. The first genus has diactinal auxiliaries and monactinal principal spicules together with characteristic 'onychaetas' of the genus. A widely distributed cosmopolitan species, *Tedania anhelans* (Lieberkuhn), has been collected from 7 islands of this archipelago. It appears from the collection that specimens here do not grow to a massive size unlike in the inshore areas of the mainland. Genus *Acanthacarnus* Levi, a close relative of the genus *Acarnus* Gray, differs from the latter in the presence of acanthostyles added to its spiculation. Principal spicules, in this case, are monactinal (styles) and the auxiliaries, diactinal (tylotes). In addition to these there are both acanthostyles and claydotylotes (or 'rose-stem') as echinating spicules. Microscleres are represented by isochelas and toxas. *A. souriei* Levi, a species common to the Atlantic Ocean, Mediterranean Sea and some parts of the Indian Ocean, is widely distributed in Lakshadweep. Family Raspailiidae Hentschel is represented by a single species, *Rhabderemia prolifera* Annandale. Annandale (1915), in the original description, mentioned that this species may utilise the cavities made by boring sponges, but during the present survey it was noted that no other boring sponge was present in galleries occupied by this species. The characteristic spicules are hockey stick-like rhabdostyles, microstyles, microstyles and twisted sigmas. This species could be collected from 5 islands in this archipelago.

Under the fourth Division, Microcioniformes, families such as Microcionidae Hentschel, Oplitaspongiidae de Laubenfels and Amphilectidae de Laubenfels are represented at Lakshadweep. Species falling under the first family retain the encrusting habit throughout their life time and are beautifully coloured. *M. acertoobtusa* Carter is devoid of any acanthostyle which is quite characteristic of the genus and the isochelas, at least some, have a twisted appearance. Two other species, *M. rhopalophora* (Hentschel , is quite peculiar in the respect that there are two types of acanthostyles. Genera falling under the family Ophlitaspongiidae from Lakshadweep are *Ophlitaspongia* Bowerbank, *Clathria* Schmidt, *Mycale* Gray and *Zygomycale* Topsent. The principal spicules, in all these cases, are monactinal (styles or subtylostyles) and auxiliaries, subtyoystyles, sometimes of different sets. In the first genus microscleres are represented by toxas and arcuate isochelas. In the case of the genus *Clathria* the subtylostyles may be basally spined, and may be of different sets; the acanthostyles that echinate the fibres are of common occurrence. Microscleres are representened by palmate isochelas, but in some cases they may be totally wanting. Genus *Mycale* has anisochelas, sigmas, toxas and raphides; there may be different sets in each

category. Genus *Zygomycale* is peculiar in the respect that it has isochelas added to the typical spiculation of the above genus. Species falling under the abova-mentioned genera are *Ophlitaspongia rimosa* (Ridley), *Clathria reinwardti* Vosmaer, *Mycale grandis* Gray and *Zygomycale parishii* (Bowerbank). Except for *O. rimosa*, all the others are known only from Minicoy.

The family Amphilectidae de Laubenfels is represented by a single species: *Biemna fortis* (Topsent), which has styles, sigmas (two sets) and raphides (often in groups). Specimens usually grow buried in sand with finger-like projections arising from the upper parts.

The total number of species falling under this order from Lakshadweep is 18 and may be classified into 9 families and 4 genera.

4. Order Halichondrida Vosmaer

Spicules encountered in this order may be monacts or diacts or a combination of both. Microscleres, as a rule, are rare. This order is represented at Lakshadweep by three families, Halichondridae Gray. Axinellidae Ridley and Dendy and Hymeniacidonidae de Laubenfels. The first family has exceedingly simple spiculation consisting of only oxeas. A rspecial dermal skelton is sometimes present and composed of tangentially placed oxeas over extensive subdermal spaces. *Halichondria panicea* Johnston, a typical cosmopolitan species of the family, could be collected from Androth. Another genus which may be considered under the present family is *Ciocalypta* Bowerbank. This has styles instead of oxeas and the dermal skeleton is composed of small styles. The subdermal spaces are quite extensive. Thomas (1973) recorded *C. Polymastia* (Lendenfeld) from Minicoy extending its distribution westward to the Indian Ocean (previously known from New Zealand and Australia).

Species of the family Axinellidae may be differentiated from those of the other families of the order in that the axial and extra-axial specialisations are well pronounced in this case Megascleres are represented by monacts and diacts and microscleres, if at all present, may be raphides and microxeas Those species without spiny microxeas are grouped under the subfamily Axinellinae de Laubenfels, while those with spiny microxeas under the subfamily Higginsiinae Higgin, Genera like *Bubaris* Gray and *Phycopsis* Carter fall under the former and *Myrmekioderma* Ehlers under the latter sufamilies. Genus *Bubaris* has both styles and/or subtylostyles erect on the substratum and sinuous strongyles that may be arranged in the form of mat over the substratum or in an axial column, depending on the form of growth. From Minicoy a specimen of *Bubaris* was reported as *Bubaris* sp. (Thomas, 1980a). Genus *Phycopsis* has only oxeas, and two specimens (of different species) could be collected. (Sp. 1 from Agatti and Sp. 2 from Minicoy) during the present survey. Specific identification, in both these cases, was not possible due to the small and inadequate nature of the material. The subfamily Higginfiinae is represented by the genus *Myrmekioderma* and the species already reported from Minicoy is *M. granulata* (Esper). This has a well developed cortex reinforced with small acanthoxeas. The main skeleton, in this case, is composed of smooth oxeas together with raphides.

Species falling under the family Hymeniacidonidae have fleshy ectosome; but the endosome is quite comparable to that of any typical exinellid species. Spicules are represented by smooth oxeas, styles and crooked strongyles. Only one species, *Acanthella cavernosa* Dendy, is known from Lakshadweep (Minicoy)

The order is represented at Lakshadweep by three families, 6 genera and 7 species.

5. Order Hadromerida Topsent

Demospongiae with radiate and corticate architecture; megascleres are represented by monacts (tylostyles or subtylostyles), smaller megascleres assume a brush-like arrangement at the surface giving a pronounced fur-like appearance to the surface. Microscleres may be of different types or totally absent; when present, they are of astrose type.

Of the four families represented at Lakshadweep, two families, viz., Spirastrellidae Hentschel and Clionidae Gray are unique in the respect that almost all the species falling under them exhibit the habit of boring into calcium carbonate material such as shell, coral calcareous algae etc., causing considerable

damage or even death to these calcium secreting animals. These species, hence, play an important role in the bioerosion of the reef system. Details on the bioerosion generated by the various species of sponges are furnished elsewhere in this Bulletin and hence such details are deleted from the present account. The only genus from the family Spirastrellidae represented in the present collection that does not bore into calcareous matter is *Timea* Gray. The spiculation consists of tylostyles, mostly erect on the substratum, and euasters of one or more sets. These asters are seen densely packed inside the sponge. Two species, *T. stellizeriens* (Carter) and *T. stellata* (Bowerbank), are represented at Lakshadweep. The other two families of this order, viz., Suberitidae Schmidt and Placospongiidae Gray are rather poorly represented. The former family possessess tylostyles/subtylostyles or rarely styles; and the radial arrangement of the skeleton is distinct only towards the outer part of the specimen. Species falling under four genera have been collected; they are, *Suberites* Nardo, Laxosuberites Topsent, *Pseudosuberites* Topsent and *Aaptos* Gray. Tylostyles form the main spicules in the former three genera, while in the last, spicules are represented by strongyloxeas and styles. The family Placospongiidae is represented at Lakshadweep by the genus *Placospongia* Gray. Spicules, in this case, are tylostyles for megascleres and sterrospires, spirasters, spherasters and spherules for microscleres. The sterrospires are densely packed in the cortical region to form a thick crust which is subdivided into polygonal areas by pore-bearing grooves. The only species represented at Lakshadweep is *Placospongia carinata* (Bowerbank), which is known only from Minicoy.

The total number of species falling under the present order is 21 and these may be classified under 11 genera and 4 families.

6. Order Epipolasida Sollas

Architecture radiate and with well developed cortex. Microscleres, if present, astrose type and Megascleres may be monactinal or diactinal. Spongin, as a rule, absent. Two families, Jaspidae de Laubenfels and Tethyidae Gray are known to occur at Lakshadweep. Genera falling under the former family are *Prostylyssa* Topsent, *Jaspis* Gray and *Zaplethea* de Laubenfels. In the genus *Prostylyssa* the megascleres may be monacts or diacts, and the microscleres are represented by microstyles. The only species represented is *P. foetida* (Dendy) which is widely distributed in the Indo-Pacific. Spiculation in tha genus *Jaspis* consists of oxeas as megascleres and euasters and microxeas as microscleres. *Jaspis penetrans* (Carter) is a boring species commonly distributed in tha reef environment in Lakshadweep. Genus *Zaplethea* resembles the above genus in spiculation, but the microxeas represented here are biangulated. A subspecies of *Zaplethea digonoxea* (ssp. *diastra* Vacelet and Vasseur), the only subspecies in the Indo-Pacific, has been collected from Suheli. Family Tethyidae is well defined family with strongyloxeas arranged in radial bundles. The cortex is well marked and is densely packed with spherasters. Other microscleres represented include euasters of one or more types. *T. robusta* Bowerbank, *T. japonica* Sollas and *T. diploderma* Schmidt are the species represented at Lakshadweep. Another genus of the same family, *Tethytimea* de Laubenfels, differs from the above genus in the possession of tylostyles in the place of strongyloxeas; microscleres resemble those of the genus *Tethya*. *T. repens* (Schmidt) is known only from Minicoy.

The total number of species included under this order from Lakshadweep is 7 and these are referable to 4 genera and two families.

7. Order Choristida Sollas

Radial architecture is well pronounced in this order; a well defined cortex may or may not be present. Long shafted triaenes (tetractines) form the most dominant type of spicules followed by oxeas. Microscleres represented are of different types; euasters, streptasters, sigmaspires, microxeas and so on.

Four families, Ancorinidae Gray, Geodiidae Gray, Craniellidae de Laubenfels and Kaliapsidae de Laubenfels, of this order are represented at Lakshadweep. The first family (Ancorinidae) may be divided into two subfamilies based on the nature of the microscleres. The first subfamily (Ancorininae) includes species having streptasters, with or without euasters; while the second subfamily

(Stellettinae) includes only those with euasters. Genus *Ecionemia* Bowerbank, with its two species, *E. acervus* Bowerbank and *E. thielei* Thomas, fall under the first subfamily and genera such as *Aurora* Sollas and *Stelletta* Schmidt, under the latter. Genus *Aurora* is represented by *A. globostellata* (Carter) and *A. rowi* Dendy. Spicules are represented by oxeas and triaenes for megascleres and spherasters, oxyasters, and raphides for microscleres. Both these are widespread Indian Ocean species and are collected from Suheli and Amini respectively. Genus *Stelletta* has microscleres of two types; and is represented by a single species *S. tethyopsis* Carter. This species has dichtriaenes and is here reported outside its type locality, the Gulf of Mannar. Family Geodiidae is unique in the possession of a tough crust of sterrasters in the cortical region. The only representative of the family in Lakshadweep is *Geodia lindgreni* (Lendenfeld). Family Craniellidae has, along with the typical spiculation of the order, peculiar and minutely roughened sigmaspires as microscleres. Two genera of this family are known to occur in this archipelago; they are *Cinachyra* Sollas and *Paratetilla* Dendy, and are collected from Kavaratti and Minicoy respectively. The former genus has the typical spiculation of the family while the latter is characterised by the presence of short-shafted orthotriaenes at the junction of the ectosome and endosome. *Paratetilla bacca* (Selenka) is a well distributed Indo-Pacific species. Finally, the family Kaliapsidae, a family created by de Laubenfels (1936) for a group of genera that possess lithistid spicules, is represented at Lakshadweep by two genera *Theonella* Gray and *Lophacanthus* Hentschel. Spiculation in the former genus consists of ectosomal triaenes over endosomal desmas. Microscleres are represented by microstrongyles that are minutely roughened. Burton (1928) described *Theonella cupola* from Laccadives, but this species has not been obtained during the present survey. Genus *Lophacanthus* has lophotriaenes, desmas and rhabdostyles; but is devoid of any microscleres. *L. rhabdophorus* Hentschel is a widely distributed Indo-Australian species and has been reported from Minicoy.

The total number of species falling under this order from Lakshadweep is 10 and these are referable to 8 genera and 4 families.

8 Order Carnosida Carter

Corticate and radiate architecture is not well marked, unlike in the previous order. Long-shafted triaenes are rarely met with in this order, instead the tetraxon spicules represented here are with short, often stumpy, rays These spicules are called 'calthrops'.

Two families of this order, viz., Halinidae de Laubenfels and Chondrillidae Gray only are known from the present survey. The family Halinidae exemplifies to the fullest extent the characters of its order and has only calthrops and diactinal spicules for megacleres. The microscleres in this case are of astrose type. Based on the structure of microscleres this family may be divided into subfamilies; Halininae de Laubenfels having streptasters and Corticiinae Vosmaer, with euasters. Under the former subfamily two genera, *Halina* Bowerbank, the type of the family and *Dercitopsis* Dendy are recorded. *Halina* Bowerbank has peculiar calthrops provided with dichomodifications and the streptasters represented are straight. *Halina plicata* (Schmidt) is a boring species and is fairly well distributed in almost all the islands surveyed. The other genus, *Dercitopsis*, has calthrops, triods and oxeas, the last one often centrotylote in nature. The only species collected is *D. Minor* Dendy, from Suheli. The only genus falling to the subfamily Corticiinae from Lakshadweep is *Samus* Gray. It has lumpy amphitriaenes and lumpy sigmoid spicules. The species represented is *Samus anonyma* Gray which is circum equatorial in distribution. It is a coral boring species and has been collected from 6 of the islands surveyed. The spicules of this species are often found intermingled with those of the genus *Cliona*, and no spacimen could be located *in situ* to record its general morphology.

family Chondrillidae has only asters as spicules. There may be one or two categories of these spicules and no megasclere is represented. The typical genus, *Chondrilla* Schmidt, is represented at Lakshadweep by a single species *C. sacciformis* Carter. This species could be obtained only from Suheli

The total number of species falling under this order from Lakshadweep is 4. These species may be classified under 2 families and 4 genera. The maximum number of species (4) has been collected from Suheli.

ISLAND-WISE DISTRIBUTION OF SPECIES

The various species collected from the different islands of Lakshadweep are systematically enlisted in Table 2. The maximum number of species (58) was obtained from Minicoy.

Table 2. *Island-wise distribution of sponge species*

Sr. No:	Species/Classification	Distribution									
		Kavaratti	Suheli	Kalpeni	Androth	Minicoy	Kadmat	Amini	Kiltan	Kalpitti	Agatti
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Class Demospongiae Sollas											
	Order Keratosida Grant										
	Family Spongiidae Gray										
1.	*Spongia officinalis* Lin. ssp. *ceylonensis* Dendy	X	X	X	X	X	—	X	X	X	X
2.	*Hippiospongia* sp.	—	—	—	—	—	—	—	X	—	—
3.	*Heteronema erecta* Keller	—	—	X	—	—	—	—	—	—	—
4.	*Hyattella cribriformis* (Hyatt)	X	—	—	—	X	—	X	—	X	—
5.	*Phyllospongia foliascens* (Pallas)	—	X	—	—	X	—	—	X	—	—
6.	*P. dendyi* Lendenfeld	—	—	—	—	X	—	—	—	—	—
7.	*Thorectopsamma* sp.	—	—	X	—	—	—	—	—	—	—
8.	*Fasciospongia cavernosa* (Schmidt)	—	—	X	X	—	X	X	—	—	—
	Family Dysideidae Gray										
9.	*Dysidea fragilis* (Montagu)	—	—	X	—	X	—	—	X	—	—
10.	*D. herbacea* (Keller)	—	—	X	—	X	—	—	X	—	—
11.	*Dendrilla cactus* (Selenka)	X	X	X	—	—	—	—	—	—	—
	Family Aplysillidae Vosmaer										
12.	*Psammaplysilla purpurea* (Carter)	X	X	X	X	X	X	X	—	—	—
	Order Haplosclerida Topsent										
	Family Haliclonidae de Laubenfels										
13.	*Haliclona oculata* (Lin.)	—	—	X	—	—	—	—	—	—	—
14.	*H. tenuiramosa* Burton	—	—	X	—	—	—	—	—	—	—
15.	*H. exigua* (Kirkpatrick)	X	—	—	—	—	—	—	—	—	—
	Family Desmacidonidae Gray										
16.	*Iotrochota baculifera* Ridley	X	—	X	—	—	—	—	—	—	—
17.	*Gelliodes fibulatus* Ridley	X	—	—	—	—	—	—	—	—	—
18.	*Cornulum vesiculatum* (Dendy)	—	—	X	—	—	—	—	—	—	—
	Family Adociidae de Laubenfels										
19.	*Sigmadocia fibulata* (Schmidt)	X	X	X	—	X	—	—	—	X	—
20.	*S. pumila* (Lendenfeld)	—	—	—	—	X	—	—	—	—	—
21.	*Orina sagittaria* (Sollas)	X	—	—	—	—	—	—	—	—	—
22.	*Damirina laccadivensis* n. sp.	—	—	X	—	X	—	—	—	—	—
	Family Callyspongiidae de Laubenfels										
23.	*Callyspongia diffusa* (Ridley)	—	—	—	—	X	—	—	—	—	—
24.	*C. fibrosa* (Ridley and Dendy)	—	—	—	X	X	—	X	—	—	—
	Order Poecilosclerida Topsent										
	Family Phorabasidae de Laubenfels										
25.	*Echinodictyum longistylum* Thomas	—	—	—	—	X	—	—	—	—	—

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
26.	*Damiriana schmidti* (Ridley)	X	X	X	—	X	—	—	—	—	—
	Family Agelasidae Verrill										
27.	*Agelas mauritiana* (Carter)	—	—	—	—	X	—	—	—	—	—
28.	*A. ceylonica* Dendy	—	—	—	—	X	—	—	—	—	—
29.	*Agelas* sp.	—	—	—	—	X	—	—	—	—	—
	Family Plocamiidae Topsent										
30.	*Plocamilla mannarensis* (Carter)	—	—	—	—	X?	—	—	—	—	—
	Family Myxillidae Hentschel										
31.	*Myxilla arenaria* Dendy	—	—	X	—	—	—	—	—	—	—
32.	*Myxilla* sp.	—	—	—	—	X	—	—	—	—	—
	Family Tedaniidae Ridley and Dendy										
33.	(*Tedania anhelans* Lieberakuhn)	X	X	X	X	X	X	X	—	—	—
34.	*Acanthacarnus souriei* Levi	X	—	X	—	—	—	—	—	—	—
	Family Raspailiidae Hentschel										
35.	*Rhabderemia prolifera* Annandale	X	X	X	X	X	—	—	—	—	—
36.	*Microciona aceratoobtusa* Carter	X	X	—	—	—	—	—	—	—	—
37.	*M. rhopalophora* (Hentschel)	—	X	—	—	—	—	—	—	—	—
	Family Ophlitaspongiidae de Laubenfels										
38.	*Ophlitaspongia rimosa* (Ridley)	—	—	—	—	—	—	—	—	—	X
39.	*Clathria reinwardti* Vosmaer	—	—	—	—	X	—	—	—	—	—
40.	*Mycale grandis* Gray	—	—	—	—	X	—	—	—	—	—
41.	*Zygomycale parishii* (Bowerbank)	—	—	—	—	X	—	—	—	—	—
	Family Amphilectidae de Laubenfels										
42.	*Biemna fortis* (Topsent)	—	—	—	—	X	—	—	—	—	—
	Order Halichondrida Vosmaer										
	Family Halichondridae Gray										
43.	*Halicondria Panicea* Johnstom	—	—	X	—	—	—	—	—	—	—
44.	*Ciocalypta Polymastia* (Lendenfeld)	—	—	—	—	X	—	—	—	—	—
	Family Axinellidae Ridley & Dendy										
45.	*Buberis* sp.	—	—	—	—	X	—	—	—	—	—
46.	*Myrmekioderma granulata* (Esper)	—	—	—	—	X	—	—	—	—	—
47.	*Phycopsis* sp. 1	—	—	—	—	—	—	—	—	—	X
48.	*Phycopsis* sp. 2	—	—	—	—	X	—	—	—	—	—
	Family Hpmeniacidonidae de Laubenfels										
49.	*Acanthella cavernosa* Dendy	—	—	—	—	X	—	—	—	—	—
	Order Hadromerida Topsent										
	Family Spirastrellidae Hentschel										
50.	*Spirastrella coccinea* (D & M)	X	—	—	X	X	—	—	—	—	—
51.	*S. cuspidifera* (Lamarck)	—	X	—	—	X	—	—	—	—	—
52.	*S. inconstans* (Dendy)	X	X	X	X	X	X	X	X	—	X
53.	S. *aurivilli* Lindgreu	—	X	X	X	—	—	X	—	—	—
54.	*Timea stellivarians* (Carter)	—	—	—	—	X	—	—	—	—	—
55.	*T. stellata* (Bowerbank)	—	—	—	—	—	—	X	—	—	—
	Family Suberitidae Schmidt										
56.	*Suberites csrnoses* (Johnston)	—	—	—	—	X	—	—	—	—	—
57.	*Laxosuberites crucistus* (Dendy)	—	X	—	—	X	—	—	—	—	—
58.	*Pseudosuberites* sp.	—	—	X	—	X	—	—	—	—	—

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
59.	*Aaptos aaptos* (Schmidt)	—	—	—	—	X	—	—	—	—	—
	Family Placospongiidae Gray										
60.	*P acospongia carinata* (Bowerbank)	—	—	—	—	X	—	—	—	—	—
	Family Clionidae Gray										
61.	*Amorphinopsis excavans* Carter	X	X	X	X	X	X	—	—	—	—
62.	*Aka minuta* Thomas	X	X	X	X	X	—	—	—	—	—
63.	*A. laccadivensis* n. sp.,	—	—	—	—	X	—	—	—	—	—
64.	*Cliona celata* Grant	X	X	X	X	X	—	X	—	—	X
65.	*C. vastifica* Hancock	X	X	X	—	—	—	—	—	—	—
66.	*C. viridis* (Schmidt)	X	—	X	—	—	—	—	—	—	—
67.	*C. carpenteri* Hancock	X	X	X	X	X	X	—	—	—	—
68.	*C. ensifera* Sollas	X	X	X	X	X	X	—	—	—	—
69.	*C. murconata* Sollas	—	X	—	X	X	—	—	—	—	—
70.	*Thoosa armata* Topsent										
	Order Epipolasida Sollas										
	Family Jaspidae de Laubenfels										
71.	*Prostylyssa foetida* (Dendy)	—	—	—	—	X	—	—	—	—	—
72.	*Jaspis penetrans* (Carter)	—	X	X	—	—	—	—	—	—	—
73.	*Zapleihea digonoxea* ssp. *diastra* (V & V)	—	X	—	—	—	—	—	—	—	—
	Family Tethyidae Gray										
74.	*Tethya robusta* Bawerbank	—	X	—	—	X	X	—	—	—	—
75.	*T. japonica* Sollas	—	—	—	—	X	X	—	—	—	—
76.	*T. diploderma* Schmidt	—	X	—	—	—	—	—	—	—	—
77.	*Tethytimea repens* (Schmidt)	—	—	—	—	X	—	—	—	—	—
	Order Carnosida Sollas										
	Family Ancorinidae Gray										
78.	*Ecionema acervus*	—	—	—	—	—	—	—	—	—	—
79.	E. *thielei* Thomas	—	—	—	—	X	X	—	—	—	—
80.	*Aurora rowi* Dendy	—	—	—	—	—	—	X	—	—	—
81.	*A. globostellata* (Carter)	—	X	—	—	—	—	—	—	—	—
82.	*Stelletta tethyopsis* Carter	X	—	—	—	—	—	—	—	—	—
	Family Geodiidae Gray										
83.	*Geodia lindgreni* (Lendenfeld)	—	—	—	—	X	—	—	—	—	—
	Family Craniellidae de Laubenfels										
84.	*Cynachyra cavernosa* (Lamarck)	X	—	—	—	—	—	—	—	—	—
85.	*Paratetilla bacca* (Selenka)	—	—	—	—	X	—	—	—	—	—
	Family Kaliapsidae de Laubenfels										
86.	*Theonella cupola*	—	-	—	—	X ?	—	—	—	—	—
87.	*Lophacanthus rhabdophorus* Hentschel	—	—	—	—	X	—	—	—	—	—
	Order Carnosida Carter										
	Family Halinidae de Laubenfels										
88.	*Halina plicata* (Schmidt)	X	X	X	—	X	X	X	—	—	—
89.	*Dercitopsis minor* Dendy	—	X	—	—	—	—	—	—	—	—
90.	*Samus anonyma Gray*	X	X	X	X	X	X	—	—	—	—
	Family Chondrillidae Gray										
91.	*Choudrilla sacciformis* Carter	—	X	—	—	—	—	—	—	—	—
	Total	28	31	35	18	58	13	12	6	3	5

X = Present; — = Absent; ? = Doubtful

ZOOGEOGRAPHY OF THE SPONGE FAUNA OF LAKSHADWEEP

Four the purpose of assessing the inter-relationship of the sponge fauna of Lakshadweep, the distribution of the various species represented was tabulated under 7 widely separated zoogeographical regions such as the Atlantic Ocean, Mediterranean Sea, Red Sea, Australian regions (same as the Indo-Australian region given in 'Challenger' Report), Pacific Ocean, Arctic and Antarctic. The present analysis indicates that the sponge fauna of Lakshadweep is very closely related to that of Australian region and 51 species (or 62.6%) are common to both these areas. Next to this the Lakshadweep fauna has more similarity with that of the Pacific Ocean and this is evident from the number (40 or 43.9%) of common species. The next zoogeographical area with which the present fauna has more in common is the Red Sea where 33 species (or 36.3%) are found to occur. The Atlantic sponge fauna has 25 species (27.5%), Mediteranean fauna has 16 species (17.6%), Arctic has 4 species (4.4%) and Antarctic has 3 species (3.3%) in common with the Lakshadweep sponge fauna.

Burton (1930) advocating the theory of water currents in relation to sponge abundance and distribution in the oceans opined that indian Ocean forms a closed system since it is bounded at its north and west by continents and south by an impassable boundary of cold waters of the west wind drift. The water currents prevailing in this closed system flow mainly from east to west and this may be the prime reason for the spreading of Australian and Pacific fauna into the Indian Ocean. Whenever any species is introduced into this system its further migration is governed by equatorial and monsoon currents which prevail to a greater extent along the continental shelf in different areas.

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