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DEMOSPONGIAE OF THE GULF OF KUTCH

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ABSTRACT

The present collection of sponges from the Gulf of Kutch contains a total of 25 species referable to 22 genera and 15 families. Of these, 5 species are previously known from the coast of Gujarat and the rest, 20 species recorded from the Gulf of Kutch for the first time.

Analysis of sample indicated the following habitat preference patterns (1) 9 species (or 36%) prefered to colonise the under srufaces of hard objects, (2) 8 species (or 32%) were boring forms, (3) 6 species (or 24%) showed a tendency to incorporated silts/and into their surface or interior, (4) 1 species (or 4%) possessed specialised structures to lodge both incurrent and excurrent openings and (5) 1 species (or 4%) showed acute signs of 'stress' as it colonised an area which is ecologically forbidden to it. All the above habitat preferences indicate that the sponge fauna of the Gulf of Kutch is subjected to constant 'stress' arising from excessive silt fall.

INTRODUCTION

A RECONNAISSANCE survey of the major coastal and marine ecosystems in the Gulf of Kutch had been carried out by the Central Marine Fisheries Research Institute, Cochin, in 1978 with a view to obtaining first hand information on major marine and coastal habitats, particularly on coral formations and mangrove systems. A preliminary discussion on the physical features, animal and plant communities and their apparent impact on the ecosystems due to human intervention etc. have been dealt with in detail (Pillai *et al.* 1979).

Since the Gulf of Kutch area is declared as India's first National Marine Park, it is quite essential to have an exhaustive list of both animals and plants inhabiting the area; and with this end in view Pillai and Patel (1988) published an exhaustive list of extant corals of the Gulf of Kutch. It is hoped that the present account on the Demospongiae (silicious sponges) collected from the Gulf of Kutch may serve as an adjunct to this series.

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Though occasional reference to the sponge species of the Gulf of Kutch is made in Dendy (1916), a work which deals with the sponge fauna of the Okhamandal coast in general, no exhaustive investigation on the sponge fauna of the Gulf of Kutch has been undertaken yet. The present communication is based on the collections made by the senior author from Port Okha (Thomas, 1968) and by the reconnaissance survey team of C. M. F. R. I., in 1978 (Fig. 1).

The present account deals with 25 species falling under 22 genera and 15 families. Of these, 5 are previously known from Okhamandal coast (those marked with an asterisk(*) in the text) through the collections of James Hornell (1905-1906), which were later worked out by Dendy (1916), and hence the rest, i.e. 20 species are herein reported from the coast of Gujarat for the first time. Since detailed descriptions are available for all species (Thomas 1973, 1987), the future workers may consult the above works for details on each species. The specimens collected by the above survey team came from two spots, Adathra and Pirotan Island; the former contained 13 species while the latter, 11 species, only two being common to both centres. The collections made by the senior author from Port Okha included 3 species (Thomas, 1968) and these were not represented either at Adathra or at Pirotan Island.

Specimens collected were small and feeble looking when compared with their counterparts seen elsewhere in the Indian seas. Extra quantity of silt deposited on the surface, elongated oscular tubes, preference to lower strata of coral rock, predominance of encrusting specimens etc. may indicate that they were under constant stress. Pillai and Patel (1988) also came to the same conclusion as most of the genera of corals recorded were with larger polyps that can combat deleterious effect of silting.

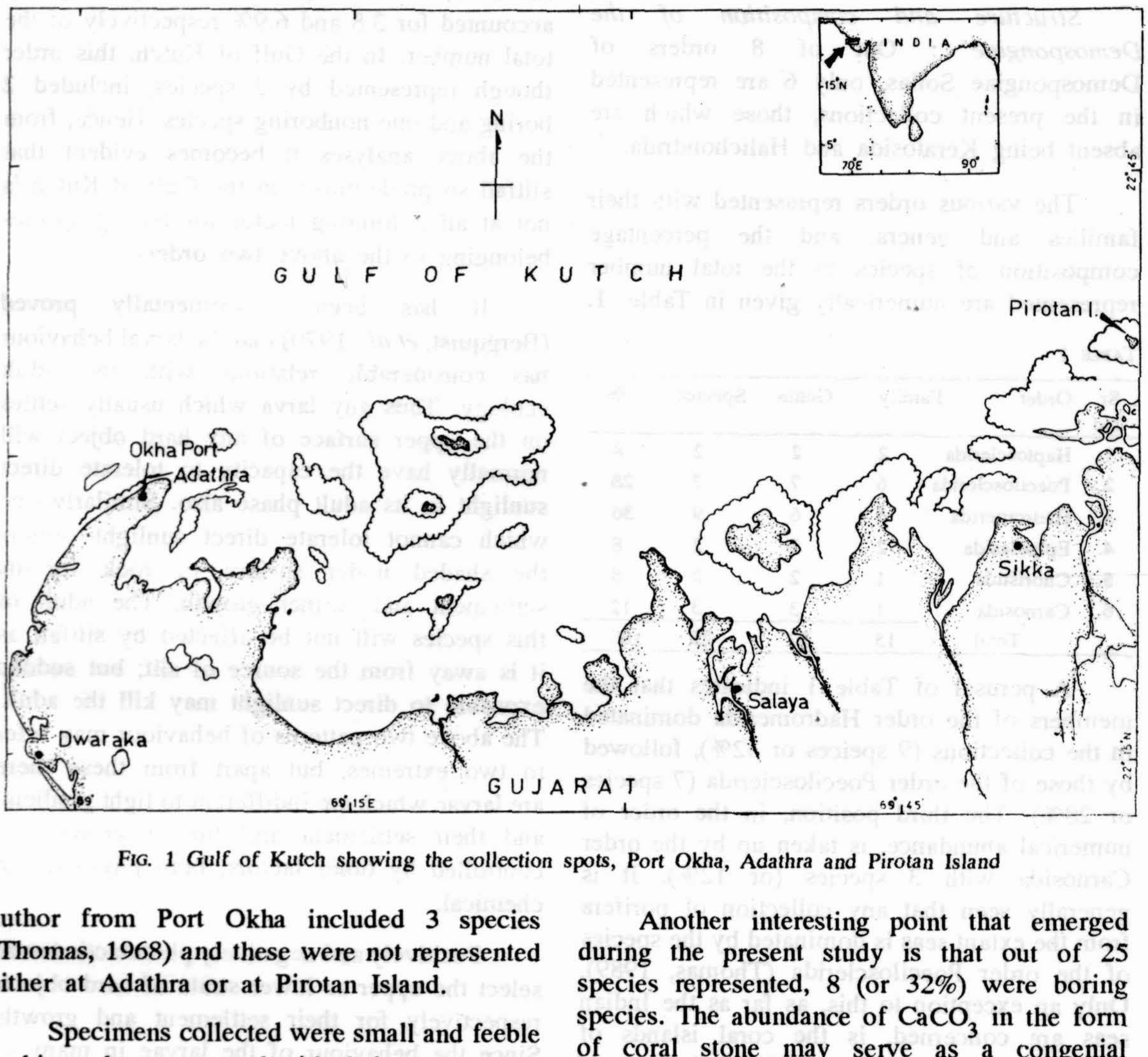

FIG. 1 Gulf of Kutch showing the collection spots, Port Okha, Adathra and Pirotan Island

Another interesting point that emerged during the present study is that out of 25 species represented, 8 (or 32%) were boring species. The abundance of $CaCO_3$ in the form of coral stone may serve as a congenial condition for these borers. Besides, these boring sponges may also show considerable adaptations to combat siltfall, and this is done mainly through the reduction in the number of papillar projections (both incurrent and excurrent) and also through directing them away from the source of silt.

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Structure and composition of the Demospongiae : Out of 8 orders of Demospongiae Sollas, only 6 are represented in the present collections, those which are absent being Keratosida and Halichondrida.

The various orders represented with their families and genera, and the percentage composition of species in the total number represented are numerically given in Table. 1.

TABLE 1

Sr. No	Order	Family	Genus	Species	%
1.	Haplosclerida	2	2	2	8
2.	Poecilosclerida	6	7	7	28
3.	Hadromerida	3	6	9	36
4.	Epipolasida	2	2	2	8
5.	Choristida	1	2	2	8
6.	Carnosida	1	3	3	12
	Total	15	22	25	100

A perusal of Table 1 indicates that the members of the order Hadromerida dominated in the collections (9 speices or 32%), followed by those of the order Poecilosclerida (7 species or 28%). The third position, in the order of numerical abundance, is taken up by the order Carnosida with 3 species (or 12%). It is generally seen that any collection of porifera from the extant seas is dominated by the species of the order Poecilosclerida (Thomas, 1989). Only an exception to this, as far as the Indian seas are concerned, is the coral islands of Lakshadweep surveyed by the Scientists of C.M.F.R.I. in 1987, where the members of the order Hadromerida dominated both in the pooled as well as in the island-wise estimates. This is due to the abundance of coral boring species in all the islands. In the Gulf of Kutch also 6 out 9 species of the order Hadromerida were boring species.

Likewise, members of the order Carnosida are perhaps the least dominant among the various orders of the class Demospongiae. In the general collections from Seychelles or from the Gulf of Mannar (Thomas, 1989) this group accounted for 3.8 and 6.9% respectively of the total number. In the Gulf of Kutch, this order though represented by 3 species, included 2 boring and one nonboring species. Hence, from the above analyses it becomes evident that siltfall so predominant in the Gulf of Kutch is not at all a limiting factor for boring species belonging to the above two orders.

It has been experimentally proved (Bergquist, *et al.*, 1970) that the larval behaviour has considerable relations with the adult ecology. Thus any larva which usually settles on the upper surface of any hard object will normally have the capacity to tolerate direct sunlight in its adult phase also. Similarly one which cannot tolerate direct sunlight prefers the shaded under surface of rock for its settlement and further growth. The adult of this species will not be affected by siltfall as it is away from the source of silt; but sudden exposure to direct sunlight may kill the adult. The above two patterns of behaviour may refer to two extremes, but apart from these there are larvae which are indifferent to light gradient, and their settlement and further growth are controlled by other factors, both physical and chemical.

Positively and negatively phototactic larvae select the upper or lower strata of hard objects respectively for their settlement and growth. Since the behaviour of the larvae in many of the sponges are not known through laboratory trials, it is quite difficult to arrive at any plausible conclusion in this regard. An examination of the adult habitat in relation to heavy siltfall, so characteristic of the Gulf of Kutch, may give some indirect evidence to this problem.

Too much silting will kill any filter-feeding organism and sponges are in no way an exception. Sponges always try to combat this situation by structural and functional modifications as outlined below: 1. by incorporating silt/sand into the body, 2. by developing elongated tube-like structures to aid free entry/exit of water, 3. by boring into $CaCO_3$, 4. by selecting areas where the siltfall is less or negligible and 5. by tolerating silt-fall and leading a 'stressful' life.

The number of species falling under the above 5 categories, and their percentage in total number of species represented are given in Table 2.

TABLE 2.

Sr. No.	Category	No.	%
1.	Those which incorporate silt/ sand into the body	6	24
2.	With pores and oscules on specialised structures	1	4
3.	Boring species	8	32
4.	Those which prefer the under surface of coral/rock	9	36
5.	Those species exhibiting 'stress'	1	4
	Total	25	100

It is evident from Table 2 that (1) species which prefer the under surface of hard objects as well as those which bore into calcareous material together contribute 68% of the total number of species collected from the Gulf of Kutch, (2) species which are capable of incorporating silt/sand into their interior formed about 24% of the total number. Larvae of such species, as evidenced from their adult ecology, usually settle on the upper parts of the substrata. Only some species of demospongiae exhibit this capacity of incorporating silt into their body and only such species can thrive well in the Gulf of Kutch. (3) One species (*Callyspongia diffusa*) showed a 'stressful' growth form. There is every possibility that the larvae of this species got settled at Adathra area at a time when the siltfall was quite low or even negligible. This being a species which prefers the well lighted upper parts of the substrata, the enhanced siltfall it experienced subsequently might have forced it to lead a 'stressful' life which is very well manifested in its morphology. (4) Specialised finger-like structures bearing oscula/pores at their extremities are quite characteristic of *Biemna fortis*. Specimens usually remain buried in sand with only the finger like structures projecting out of the substrata. This growthform indicates that this species, atleast in advanced stages, can tolerate direct sunlight and silt fall alike. The surface, in this case, is covered with a uniform layer of silt, and sand grains may be seen in the interior also.

As mentioned earlier, only 6 orders of the class Demospongiae are represented in the present collection. Details on the numerical abundance of the families, genera and species are furnished in Table 1. An order-wise evaluation of the sponge fauna of this area may be made as follows:

1. Order Haplosclerida Topsent

This order includes species with more or less simple skeleton, i.e. reticulate with triangular to rectangular meshes formed of negligible to appreciable amount of spongin. Megascleres diactinal and microscleres, if present, may be sigmoid and/or toxoid forms only.

Of the two families represented here the first one, viz. Adociidae de Laubenfels, has diactinal megascleres (oxeas) and sigmoid and/or toxois microscleres. Megascleres may be arranged in a triangular pattern with spongin at their corners only, or sometimes in illdefined fibers. The species represented is *Sigmadocia petrosioides* (Dendy), and grow attached to the under surface of coral rocks. This species could be collected only from Adathra. The second family, Callyspongiidae de Laubenfels, has well defined main and connecting fibers forming a fine reticulation of rectangular meshes. The skeleton is divisible into main and dermal categories. The dermal skeleton consists of primary, secondary and even tertiary fibers with ultimate meshes arranged in a triangular pattern. Fibers are cored by oxeas, and the quantity of spongin may be quite appreciable. The body shape is highly variable from species to species, but the common form is erect with tubular branches (diameter, 5-10 mm) which may become procumbent in advanced stages. The species represented is *Callyspongia diffusa* (Ridley), and was present at Adathra only. This species prefers well-lighted areas of the bottom. Specimens collected were frail-looking with slender branches (diameter, 3-5 mm), and were rather a typical as compared to the growth form noted for this species elsewhere in the Indian seas.

2. Order Poecilosclerida Topsent

Structurally this is the most diverse order with different categories of both mega and microscleres. Megascleres may be represented by both monactinal and diactinal forms. This order is represented in the Gulf of Kutch by 6 families, 7 genera and 7 species.

The body form noted among members of this order may vary considerably from thinly encrusting to massive. In some cases the encrusting body pattern may be retained throughout life while in others they may become massive as the growth advances. But in some cases, instead of becoming massive in advanced stages, they may retain their encrusting form throughout life indicating 'stress'. In such specimens the increase in the body volume is effected only through lateral spreading. Such species are common in the Gulf of Kutch.

Usually species of this order dominate in any collection of sponges from the extant seas, but in the Gulf of Kutch this order ranks only second numerically (Table 1).

de Laubenfels (1936), based on the nature of principal and auxiliary spicules, whether monactinal or diactinal, artificially grouped the species of this order under four 'Divisions'. In the first Division, Phorbasiformes, the principal and some of the auxiliaries are diactinal; in the second, Plocamiiformes, the principal spicules are diactinal but the auxiliaries are monactinal; in the third, Myxilliformes, the principals are monactinal while the auxiliaries are diactinal and finally, in the 4th, viz. Microcioniformes, both principal and auxiliaries are monactinal. From among the various families representd in the Gulf of Kutch, Phorbasidae falls under the first Division; Myxillidae and Tedaniidae under the third Division; and Microcionidae, Amphilectidae and Ophilitaspongiidae under the 4th Division.

Under the Family Phorbasidae de Laubenfels only one genus, *Damiriana* de Laubenfels and is represented by the species *D. schemidti* (Ridley). The spicules in this genus consist of dermal tylotes and endosomal oxeas. Microscleres are represented by arcuate isochelas and sigmas. It is a widely distributed Indo-Pacific species, and is recorded from Adathra only.

The next Division, viz. Myxilliformes, is represented in the present collection by two families, of which the first one (Myxillidae) in turn, may be classified into 2 subfamilies Myxillinae and Grayellinae. In the first subfamily, which includes the bulk of the genera, the ectosomal spicules are smooth while in the second, they are spiny. No species belonging to the former subfamily is represented in the collections, and Grayellinae is represented by the species *Grayella ridleyi* Topsent. This has dermal diacts which are spiny and smooth endosomal monacts. *Grayella cyatophora* and *G. papillata* described by Levi (1958) are synonymous with this species. It has been reported previously from Red Sea and Indian Ocean, and is here recorded from the Indian seas. Specimens usually grow on the under surface of coral both at Adathra and at Pirotan Island.

Family Tedaniidae Ridley and Dendy has ectosomal diacts (tylotes) and endosomal styles. Genus *Tedania* Gray is typical of the family and has roughened onychaetes together with other characteristic spicules of the family. *Tedania anhelans* (Lieberkuhn) was collected from Pirotan Island only. The encrusting morphology is retained throughout life unlike in specimens of this species seen elsewhere which grow into globular form. Specimens collected show much arenaceous objects inside, and were harbouring the upper surface of hard objects. The genus *Acarnus* Gray has, apart from the typical spiculation of the family, isochelas, toxas and peculiar cladotylotes that are echinting. Only a thin, encrusting specimen could be collected from the under surface of coral at Adathra. Specific identification, in this case, was not possible for want of sufficient material.

Under the 4th Division, ie. Microcioniformes, three families (Microcionidae Hentschel, Ophlitaspongiidae de Laubenfels, and Amphilectidae de Laubenfels) are represented.

Only one species belonging to the family Microcionidae (under the subfamily Microcioninae) could be collected. Species belonging to this subfamily retain their thinly encrusting body form throughout life. Spicules are represented by monactinal forms both in the dermal and endosomal parts; and isochelas and toxas for microscleres. The only species represented is *Microciona aceratoobtusa* Carter, and is characterised by the presence of smooth styles in the place of acanthostyles that are echinating in other species and isochelas which are slightly twisted. It is a widely distributed Indo-Australian species and is here reported from Pirotan Island, and usually grow on the under surface of coral rock.

Family Ophlitaspongiidae is very much related to the above family but differs in that the fibers are echinated by smooth styles. Genus *Zygomycale* Topsent is represented by *Z. parishii* (Bowerbank) possessing subtylostyles for megascleres and anisochelas (different sets), sigmas (different sets), toxas, isochelas and raphides. This was collected from Port Okha and was thinly encrusting over coral rock with considerable quantity of silt settled on its surface.

Family Amphilectidae is characterised by a plumose reticulation of styles with no echinating spicules. Microscleres consist of sigmas (different sets) and raphides. Species represented is *Biemna fortis* (Topsent), from Pirotan Island. Specimens usually grow buried in sand with fistular branches projecting out of the substratum with terminal oscules. Specimen can withstand heavy siltfall and may even incorporate sand or silt into the interior.

3. Order Hadromerida Topsent

Demospongiae with radiate and corticate architecture; megascleres are represented by monacts (tylostyles or subtylostyles), and the dermal part with smaller ones of similar nature. Microscleres may be represented with astrose forms which may totally be absent in some genera.

Numerically this order includes about 36% of the total number of species collected. The families represented are: 1. Spirastrellidae Hentschel, 2. Suberitidae Schmidt and 3. Clionidae Gray. Of the above three families, Clionidae and Spirastrellidae are quite unique in that all genera of the former and at least a few of the latter exhibit the habit of boring into $CaCO_3$ material (shell or coral). The total number of boring species represented in the Gulf of Kutch, under these two families, is 6 out of a total of 8 boring species represented in the collection.

Family Spirastrellidae may be divided into two subfamilies based on the nature of microscleres. In the first subfamily represented by its typical genus *Spirastrella*, the microscleres are spirasters or modification thereof, while in the second one (Timeinae) they are euasters or other related forms. Species representing the former subfamily are *Spirastrella vagabunda* Ridley, *S. aurivilli* Lindgren and *S. coccinea* (D. & M.). Of these, the first and the second are boring species, and especially the first one exhibit the habit of growing into a massive form (gamma stage) after disintegrating the substratum totally, while in the second one this stage is never attained in the Indian seas (growth only up to beta stage). In *S. vagabunda* upright branches are formed in advanced stages, and these branches as in *Biemna fortis (vide supra)*, bear terminal oscules. *S. aurivilli* usually bore into massive coral making larger cavities inside. Specimens of *S. coccinea* prefer the under surface of hard objects forming thick encrustations in advanced stages. The subfamily Timeinae is represented by a single species. *Timea stelligera* (Carter), which can withstand heavy siltfall. Asters represented here are of two types and the tylostyles may be arranged at right angles to the substratum. Of the above 4 species of this family, *S. vagabunda* and *S. coccinea* were collected from Pirotan Island and the others from Adathra only.

The only species of the family Suberitidae represented here is *Suberites carnosus* (Johnston). Specimens are usually seen attached to the lateral surfaces of hard objects, and in advanced stages may grow vertically up into club-like structures. Only encrusting specimens were represented in the present collection. The surface is covered with a layer of fine silt. This species could be collected only at Adathra.

Family Clionidae includes a heterogeneous assemblage of boring species. Genus *Aka* de Laubenfels has only oxeas as spicules. *Aka minuta* Thomas, collected from Pirotan Island, has oxeas measuring 0.13 mm. Genus *Amorphinopsis* Carter, similarly, includes only boring species, and has oxeas and small styles as spicules. *Amorphinopsis excavans* Carter, a widely distributed Indo-Australian species, is here recorded from Pirotan Island. Genus *Cliona* Grant, which has spicules comparable to those of the genus *Spirastrella* includes only boring forms with tylostyles and spirasters mainly; but other spicules such as spined oxeas, bacilliform spicules etc. may also be included. There are about 24 species of boring sponges falling under the family from Indian seas which can cause considerable damage to commercially important molluscs such as the pearl oyster, chank, rock oysters etc. Coral reefs of Indian waters are also infected heavily by clionids (Thomas, 1988). The common species met with in the Gulf of Kutch are *Cliona celata* Grant and *C. vastifica* Hancock, of which the former could be collected from Adathra and the latter from Pirotan Island.

4. Order Epipolasida Sollas

This is a polypyletic order with its families and genera derived from other orders either by reduction or addition of spicular categories. Megascleres, in this order, may be monactinal or diactinal; and microscleres, if present, may be of astrose type. Spongin, as a rule, is absent.

Only two families, Jaspidae de Laubenfels and Tethyidae Gray, are represented with a total of 2 species.

Of the above two families, Jaspidae has diactinal megascleres and astrose microscleres. Genus *Zaplethea* is represented by its species *digonoxea* and subspecies, *diastra* Vacelet and Vasseur. This subspecies is characterised by the presence of long oxeas, biangulated small oxeas and euasters (two sets). This was collected both from Adathra and Pirotan Island.

Family Tethyidae has radial architecture with well defined cortex charged with sphereasters. Strongyloxeas are arranged in radial bands originating from a central 'nucleus'; the microscleres include spherasters and euasters (sometimes of different sets). *Tethya robusta* Bowerbank collected from Okha, generally prefer the under surface of hard objects.

5. Order Choristida Sollas

Radial architecture is well pronounced in this order with well developed cortex in many. Long-shafted triaenes (ortho, pro and ana) form the important spicule category together with long oxeas. Microscleres represented may be of different types, euasters, streptasters, sigmaspires, microxeas etc.

The only family represented is Craniellidae de Laubenfels with two genera *Cinachyra* Sollas and *Tetilla* Schmidt. Both have characteristically roughened sigmaspires along with other megascleres typical of the family. Both *Tetilla dautyloidea* (Carter) and *Cinachyra cavernosa* (Lamarck) are in the habit of tolerating silt, and represented in the collection from Pirotan Island and Adathra respectively.

6. Order Carnosida Carter

This order includes species devoid of distinct cortex and radial architecture. Long-shafted triaenes, so characteristic of the above order, are rarely represented but are replaced by tetracts with short and stumpy rays that are called 'calthrops'.

There is only one family representing this order from the Gulf of Kutch (ie. Halinidae de Laubenfels). This family may be divided into two subfamilies based on the nature of microscleres. In the first subfamily (Halininae) the microscleres are streptasters while in the other (Corticiinae) they are euasters. The former subfamily is represented by a single species of the genus *Halina* Bowerbank (*Halina plicate* (Schmidt). In this case the triaenes represented are with dicho-modifications. It is a common coral boring sponge widely distributed in the Indian Ocean, and was represented in the collection from Adathra.

The subfamily Corticiinae is represented by its typical genus *Corticium* Schemidt, possessing small calthrops and heterolophous candelabra. This species usually forms thin encrustation on the under or lateral surfaces of coral boulders at Okha. The second genus under the present subfamily is *Samus* Gray and has lumpy amphitriaenes and sigmas. This is a common coral boring sponge with circum-equatorial distribution, and is represented at Adathra.

In conclusion it may be stated that most of the species distributed in the Gulf of Kutch are widely distributed in the Indian Ocean. The abundance of Hadromerid species, mainly boring forms; dominance of negatively phototactic species; presence of positively phototactic species that are silt tolerant are some points worth mentioning while dealing with the sponge fauna of the Gulf of Kutch in general.

List of species and their distribution in the Gulf of Kutch

Species	*Locality**
1. *Sigmadocia petrosioides* (Dendy)	A
2. *Callyspongia diffusa* (Ridley)	A
3. *Damiriana schmidti* (Ridley)	A
4. *Grayella ridleyi* Topsent	A/P
5. *Tedania anhelans* (Lieberkuhn)	P
6. *Acarnus* sp.	A
7. *Microciona aceratoobtusa* Carter	P
8. *Zygomycale parishii* (Bowerbank)	O
9. *Biemna fortis* (Topsent)	P
10. *Spirastrella vagabunda* Ridley	P
11. *S. coccinea* (D. & M.)	P
12. *S. aurivilli* Lindgren	A
13. *Timea stelligera* (Carter)	A
14. *Suberites carnosus* (Johnston)	A
15. *Amorphinopsis excavans* Carter	P
16. *Aka minuta* Thomas	P
17. *Cliona vastifica* Hancock	P
18. *C. celata* Grant	A
19. *Laplethea digonoxea* ssp. *diastra* V & V	A/P
20. *Tethya robusta* Bowerbank	O
21. *Cinachyra cavernosa* (Lamarck)	A
22. *Tetilla dactyloidea* (Carter)	P
23. *Halina plicata* (Schmidt)	A
24. *Corticium candelabrum* Schmidt	O
25. *Samus anonyma* Gray	A

* Okha -O; Adathra -A and Pirotan Island -P.

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