MARINE SPONGES OF LEBANON

By

GEORGE KASSIS

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KASSIS

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ABSTRACT

A study of 21 species of sponges collected along the coast of Lebanon by SCUBA diving down to 35 meters.

A literature review of each species is made, comparisons conducted to see how well the species fit their description in the literature, and a dichotomous key is prepared.

Ecological data on each of the dominant sponges is documented and generalizations on the ecology of sponges are drawn.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	ii
ABSTRACT	iii
INTRODUCTION	1
HISTORICAL REVIEW	2
MATERIALS AND METHODS	5
LITERATURE REVIEW OF COLLECTED SPONGES	11
RESULTS	37
DICHOTOMOUS KEY TO THE SPONGES OF LEBANON	53
DISCUSSION AND CONCLUSIONS	57
LITERATURE CITED	63
APPENDICES	68
GLOSSARY	75
TABLES	78
FIGURES	81
MAP	89

LIST OF TABLES

Table		Page
I	Sites of collection and relative abundance of the different sponge species	79
II	Main form of sponge and type of substratum it grows on	80

LIST OF FIGURES

Figure	<u>.</u>	Page
1	Chondrilla nucula in situ	82
2	Chondrosia reniformis aquarium close-up	82
3	Cliona viridis and Tylodesma sp. in situ	83
4	Axinella polypoides aquarium close-up	83
5	Agelas oroides aquarium close-up	84
6	Petrosia ficiformis in situ	84
7	Ircinia fasciculata and Cliona copiosa in situ.	85
8	Ircinia fasciculata in situ	85
9.	Spicules of Leuconia sp. and Alectona millari	86
10	Spicules of Chondrilla nucula	87
11	Spicules of Cliona viridis	87
12	Spicules of Cliona copiosa	87
13	Spicules of Axinella polypoides	87
14	Spicules of Crambe crambe	87
15	Spicules of Agelas oroides	87
16	Spicules from secondary fibers of Dysidea	
	etheria	88

I. INTRODUCTION

This work is aimed at a taxonomic and ecological treatment of the poriferan fauna along the coast of Lebanon to a depth of 35 meters observed in situ and collected using SCUBA gear.

Indications for such a study are, the lack of information on the types of sponges found and the ecological factors governing their growth. Although commercial sponges have been collected from the eastern Mediterranean since 1750 (Obeid, 1962), the shores of Lebanon were and still are famous for their fine natural sponges (Gruvel, 1931, Bodenheimer, 1935 and Obeid, 1962). Lebanon still produces an estimated 10.8 tons of natural sponges annually (Obeid, 1962).

II. HISTORICAL REVIEW

Although the shores of Lebanon have been very important sponge fishery grounds since as early as 1750 (Obeid, 1962), and miscellaneous publications have appeared since dealing with the commercially important sponges (Sheikho, 1902, Gruvel, 1931 and Bodenheimer, 1935), it was not until the second quarter of the twentieth century that works dealing with the taxonomy of the group per se have appeared. All were based on specimens collected by dredging and hardly any ecological data is available.

The mention of sponges in works from the eastern Mediterranean comes from Ibn Bitar who in the late nin-teenth century quotes the botanist Abil Abbas claiming sponges were plants (Sheikho, 1902). It was not until 1902 that Father Louis Sheikho introduced into Arabic literature that they were animals. The rest of his work is a description of the quality, gross morphology, method of collection, processing and value of the commercially important sponges of the shores of Syria, (until 1920 Lebanon was considered part of Syria).

Gruvel (1931) indicates that sporadic and nonscientific exploitation, a wasting disease and fishing by foreigners had caused considerable exhaustion of sponges in the area. He notes that fishermen refused to use modern techniques such as hooka instead of naked diving for fear of overfishing and having some divers unemployed. He adds that the most important sponge beds lie around Beirut and between Nahr el Kalb and Tripoli and that Tripoli is the center of the trade.

In 1939, Miriet, the French general representative to Lebanon issued decree No. 95 organizing sponge fisheries that is still in operation. Noteworthy in this decree are the following:

- limiting the right for exploitation to Lebanese fishermen.
 - allowing the use of a hooka only below 20 meters.
- forbidding the fishing of <u>Spongia officinalis</u> with a diameter under five centimeters and <u>Hippospongia communis</u> under 12 centimeters.

In 1936, Burton did the first taxonomic study in the area and identified 45 sponges from Alexandria of which one was new and seven unknown from the Mediterranean. Three were Red Sea species and four were from the North Atlantic.

The only other taxonomic work on sponges of the area was done by Levi in 1957. He identified 29 species collected in Palestinean waters by dredging between ten and thirty meters. One was a new species and thirteen were described for the first time from the eastern Mediterranean.

The classification and taxonomy of sponges in general leaves much to be desired and is based chiefly on the type of skeleton. In this work the classification scheme of Hyman, based on the opinions of the three top spongiologists, Topsent, Wilson and deLaubenfels, has been adopted (appendix 1). Credit is due to Topsent who in 1945 accomplished the difficult job of revising the identifications of Schmidt, the pioneer worker on Mediterranean sponges. The nomenclature on sponge skeletal elements is quite old and appendix two and the glossary to this work are a compilation prepared from the works of Sollas (1888), Topsent (1900) and Perrier (1936).

III. MATERIALS AND METHODS

A. Description of collection sites:

The specimens identified and studied in this work were collected by the author from the coast of Lebanon.

Lebanon is a small eastern Mediterranean country with a coastline approximately 210 kilometers long extending between latitudes 36 80' and 38 40'. The specimens were collected by SCUBA (Self Contained Underwater Breathing Apparatus) diving in the period between April and December, 1966 mainly at four sites: Rabbit Islands, Tabarja, Beirut and Sidon Island.

- 1. Rabbit Islands are a group of several small islands extending from the Mina (Tripoli) out to a distance of approximately six and a half kilometers along a more or less straight line perpendicular to the coast. Each of the outermost two islands were visited on an overnight excursion. These are:
 - a) Fanar: the outermost island, 400 meters in diameter, rocky and barren except for a few resistant plants, a light house and one family responsible for the light house.

 Visited in July, 1966.
 - b) Nakhl: the island next to Fanar, 5.2 kilometers from the coast and 500 meters in diameter, sandy

on the onshore side and rocky on the offshore side. Gets its name from a few scrubby palm trees found there. Visited August, 1966.

Dives at both islands were made on onshore sides only because of rough waves and lack of private boat facilities. In both cases it does not get deeper than six meters up to 400 meters from the shore.

- 2. Tabarja: eight dives were made at this extremely interesting site on the headland between the Bay of Jounieh and Tabarja Bay proper. The rocky substratum slopes at a 45 degree angle from the shore to a depth of 15 meters after which it drops vertically for as far as we went (35 meters). The benthos is characterised by being highly biogenic and containing numerous small caves.
- 3. Beirut: monthly dives were effected on a transect at the American University of Beirut beach. This transect extended west from the beach on a line parallel to the coast and was marked by cement blocks spaced at five meter intervals from the shore down to a depth of 17 meters. The rocky substratum is characterised by horizontal areas extending for 10 to 20 meters followed by two to three meter drops.
- 4. Sidon Island: Three dives were made at this small island one kilometer off the shore of Sidon during

September and December of 1966. Dives were effected on the onshore and offshore sides of the island.

The rocky substratum is characterised by its gently
sloping character as one moves away from the island,
and a mild current around the western tip of the
island.

B. Methods of collection and preservation:

All collections were made by the author using SCUBA gear composed of the following:

- 1. Single tanks
- 2. Double hose regulator (U.S. Divers)
- 3. Neopreme wet suit (1/8 inch)
- 4. Mask and fins
- 5. Weight belt

Additional equipment carried for use in collecting specimens and recording data included the following:

- 1. Camera with protective plastic case and an electronic flash attachment
- 2. Knife and collecting bag
- 3. Writing pad
- 4. Depth gauge

All dives were made in company of my advisor,
Dr. Joseph H. Powell. A typical dive would start from
shore and follow the bottom down taking pictures and collecting data. Photography was by means of an Exa camera with a

wide angle lens protected by a half inch plastic case with a bronze back designed by Dr. Powell. This was attached to an electronic flash in a seperate case. A scale was introduced into the picture by a five centimeter square grid attached to the camera case by means of a brass pole approximately one meter in length in such a way that one side of it always appeared in the edge of the picture. Photos were taken by approaching the camera to the substratum until the grid touched the bottom and taking the picture. By using this pole and an electronic flash, the camera could be pre-set for diaphragm opening, shutter speed and angle of the flash attachment. Films used were 36 millimeter Ektachrome and Kodacolor. One 20 exposure role was used for each dive.

The data was recorded on a special erasable plastic sheet by means of a lead pencil. Depths were recorded by means of a Spirotechnique depth gauge calibrated in meters (1-60). Normally two of these were taken and their readings constantly checked against each other. They never differed more than one meter.

Ascent time was used for collection of specimens. These were either torn off the rocks with bare hands or pealed off with a knife and placed in the collecting bag. Thin nylon mesh bags similar to those used by housewives for shopping were found ideal for this purpose. After completion of the dive specimens were placed, while still

in the collecting bag, in a bucket full of fresh sea water and kept away from the sun until taken to the laboratory.

In the laboratory specimens were placed in seperate jars, properly labelled, and preserved in 95% ethyl alcohol. For each specimen a data chart was filled out (appendix 3).

C. Methods of study of the collected samples:

A portion of each sponge was used for preparation of wholemounts of skeleton. In case of the Calcarea and those sponges with spongin in their skeletons this was done by boiling one cubic centimeter of the sponge with approximately ten milliliters of a five percent solution of sodium or potassium hydroxide in a 20 milliliter beaker. Sponges with skeletons solely of silicon were digested by boiling with concentrated nitric acid. In both cases, the skeletal elements were allowed to settle, the supernatant poured off, washed with two changes of 95% alcohol followed by two changes of absolute alcohol and two changes of xylene. After this the residue was mixed in a small crucible with approximately two milliliters of Balsam. Wholemounts were prepared by placing a drop of this mixture on a slide labelled with a diamond pencil with the collection number of that particular sponge, covering with a coverslip and placing on a slide warming plate set at about 45 degrees centigrade. This method proved to be very efficient

giving wholemounts with a homogeneous distribution of spicules. In addition the balsam suspension could be kept in a properly labelled small bottle for quick preparation of wholemounts in the future.

Portions of the different sponges were sent to Dr. Michel Sara of the University of Bari in Italy for identification. These were packed in seperate plastic bags each with a label carrying the collection number and sealed with a rubber band.

D. Methods of study of the identified materials:

After the identifications were received, a literature review was conducted on each species. Each species was examined for how well it fitted its description in the literature. Drawings of the skeletal elements were made using a Leitz microprojector. The wholemounts were projected on a sheet of drawing paper and the spicules traced with a 3H lead pencil. Later these drawings were retraced with 0.4 or 0.5 India ink pen using French curves wherever possible. These drawings were later reduced to approximately a fourth of their original size.

IV. LITERATURE REVIEW OF COLLECTED SPONGES

This section will be limited to a literature review of each of the sponges collected during this study arranged according to their taxonomic order.

This section will be limited to the class

Demospongiae for all the collected species belong to it

except for one poorly identifiable calcareous sponge.

Class: Demospongiae Sollas

Characterised by a skeleton of silicous spicules, spongin fibers or both. Silicous spicules generally differentiable into megascleres and microscleres (Hyman, 1940).

Subclass I. Tetractinellida

Characterised by their tetraxon spicules and lack of spongin. Spicules sometimes wanting (Hyman, 1940).

Order: Carnosa Carter

Characterised by astrose microscleres. The typical tetraxon megasclere is the calthrops (deLaubenfels, 1936).

Family: Chondrillidae Gray

Spiculations: asters only. They are assumed to be descended from ancestors with megascleres. The rigidity

of these sponges is mainly due to an organic colloidal mesoglea or jelly (deLaubenfels, 1936).

Genus: Chondrilla Gray

This is the one valid genus in this family.

Characterised by microscleres that are enasters, usually spherasters (deLaubenfels, 1936).

Chondrilla nucula Schmidt, 1862. Figs. 1 and 10. Die Spongien des Adriatischen Meeres. Leipzig.

An encrusting sponge strongly adherent to nude rocks (Sara and Melone, 1963) in shallow waters (Sara, 1964), forming glossy brownish green patches about two centimeters in diameter and half a centimeter in thickness that enlarge and join together forming one solid plaque reaching fifty centimeters in diameter.

Skeleton: euasters only and usually spherasters (deLaubenfels, 1936). Oscula not visible to the naked eye.

Distribution: West Indes (deLaubenfels, 1936) and Mediterranean (Sara, 1964).

Family: Chondrosiidae Schulze

Remarkable in their total lack of a skeleton, having only a mesoglea or jelly for stiffening purposes.

Their resemblence to the Chondrillidae is very great and

they appear to be derived from such ancestors by still further reduction of spiculation (deLaubenfels, 1936).

Genus: Chondrosia Nardo

The only valid genus in the family Chondrosiidae (deLaubenfels, 1936).

Chondrosia reniformis Nardo, 1833. Fig. 2. Isis, Coll. 519-523.

Lacking a skeleton and supported by a framework of fine filaments instead. With a well delimited cortex, half to three millimeters in thickness, of rubber-like consistency when alive and leather like when dry. Surface smooth, glossy and varnish-like. Sponge large, rounded or lobed, at times spreading, at times erect from a projecting base. Color white to light grey to violet brown (Topsent, 1927-29, 1928, 1934, and Perrier, 1936).

Oscula one to two centimeters apart, slightly elevated above the surface, about two millimeters wide when alive and half to one millimeter when fixed in alcohol.

Distribution: Cosmopolitan (Burton, 1952 and Topsent, 1895).

Subclass II: Monaxonida

Characterised by a monaxonial megasclere spiculation

with or without spongin (Hyman, 1940).

Order: Hadromerina Topsent

Characterised by a megasclere spiculation chiefly of tylostyles. Frequently the head of the spicule is much larger than the shaft. The Hadromerina are notable among the Demospongiae for the total, or almost total, lack of spongin. It is divided into families largely on the basis of the presence or absence and the nature of the microscleres (deLaubenfels, 1936).

Family: Clionidae Gray

Characterised by megascleres that are tylostyles (chiefly in confusion) and microscleres that are spirasters. It is set off strictly by their being all borers of calcareous material (deLaubenfels, 1936).

Genus: Alectona Carter

Clionidae where the spicules are of two kinds:

- 1. Diactinal spicules: stout, thick, covered by tubercles and derived from polyactinal spicules by reduction.
- Elongate amphiasters of variable length (Topsent, 1900).

Alectona millari Carter, 1879. Fig. 9.

J. Roy Microscop. Soc. 2:493-499.

A perforating sponge digging large cavities in corals which communicate with the sea by narrow openings where an incurrent pore and an osculum open. The incurrent pore is flattened and cribriform; the osculum is conical. Papillae are held erect by diactinal spicules. The flesh is soft with loose spiculation.

Skeleton: I. Megascleres: absent.

II. Microscleres: of two kinds:

- 1. Diactinal: robust, curved, with rounded ends and studded by large conical tubercles. Size: 215 to 270 micra in length and 15 to 20 micra in diameter. Frequently they show a protuberance in their middle toward which points their central canal. This is the rudiment of an atrophied third branch. A few, ordinarily smaller and thinner, with pointed ends, remain smooth.
- 2. Amphiasters: cylindrical, with elongate axes and carrying at some distance from their extremities two whorls of five to six spines with somewhat rounded ends. The two ends of the axis and the rounded ends of the spines are covered by much finer spines. Only a small number of amphiasters have smooth pointed ends. Size: very variable, ranging from 10 to 70 micra in length and one to five micra in diameter. Diffusely distributed throughout the sponge.

Color: Completely decolorised in alcohol.

Distribution: Usually very deep. Atlantic and Mediterranean (Topsent, 1900).

Genus: Cliona Grant

Clionidae where the skeleton is composed of tylostyles, oxes and spirasters. In certain species, one or two of these forms of spicules are constantly atrophied (Topsent, 1900). As individuals of this genus grow older, they protrude farther and farther from their calcareous caverns until there may be a mass of several kilograms of sponge in which the beginning with its surrounding mineral material can scarcely be found.

Cliona viridis (O. Schmidt, 1862). Figs. 3 and 11.

Vioa viridis O. Schmidt, 1862. Die Songien des
Adriatischen meeres. Leipzig.

A perforating sponge, destroying calcareous rocks, corals and shells, possessing the ability to become massive. In the perforating state, it digs its shelter in cavities of two sorts; one in the form of numerous small intercommunicating chambers and the other in the form of large spacious galaries traversing the calcareous mass here and there, and ending in papillae. These papillae, generally few in number and dispersed, can reach a diameter of two to three millimeters.

Color: Flesh and surface: all shades of brown

green and yellow depending on the mode of life.

Skeleton: I. Megascleres: Tylostyles: very abundant, smooth, straight or curved. Axis uniform, acquiring its maximum thickness at its middle and narrowing down to a sharp point. The head is ordinarily prominent, variable in form, usually globular or elliptical and frequently surmounted by a prolongation of the axis. The axial canal goes into the head and does not enlarge into a vesicle. Average length: 400 micra. Thickness of shaft: 10 to 12 micra. Diameter of head: 12 to 15 micra.

II. Microscleres: Spiny spirasters: long, relatively thin and usually quite sinuous with two to five bends. Spines straight, pointed and of variable height. Spines mainly evident at the bending points and extremities of the axis. Size: 15 to 40 micra in length and two to five micra in diameter. Abundance: variable, depending on the individual species, but never numerous.

Distribution: from the superior limit of the littoral zone down to 70 meters. Mediterranean (Topsent, 1900).

Cliona copiosa Sara. Figs. 7 and 12. (Citation unavailable.)

A perforating sponge, destroying all forms of calcareous material. Grows in the form of an enlarging

mat half a centimeter in thickness and extending over horizontal or sloping rocky substrata. From this arise
prolongations three to five centimeters high, two centimeters wide at the base and ending in a round or oval
osculum one to one and a half centimeters wide when alive,
and three to seven millimeters wide when fixed in alcohol.

Consistency: Soft and fluffy, easily pealed off the rocks.

Color: Brownish green to green with the rims of the oscula of lighter coloration.

Skeleton: I. Megascleres: mainly styles and only a few tending towards tylostyles.

II. Microscleres: spirasters.

Distribution: Mediterranean (Sara, 1962).

Order: Halichondrina Vosmaer

Characterised by specialised ectosomal skeletons and often two or more categories of megascleres. These are often monactinal, diactinal or both. Microscleres are very rare; raphides if present may be spined (deLaubenfels, 1936).

Family: Axinellidae Ridley and Dendy

Sponges with a tendency for interchangable occurence of monactines and diactines. Typical members lack
miscroscleres, but raphides may be present. The megascleres

are frequently much curved and sinuous. Most characteristic is their hispid ectosome (deLaubenfels, 1936).

Sponge very plumose, consisting of ascending axes of fibers from which arise subsidiary fibers radiating to the surface (Ridley and Dendy, 1887).

Subfamily: Axinellinae

Lack microscleres (deLaubenfels, 1936).

Genus: Axinella Schmidt

Characterised by having both styles and oxea, with axial specialisation and an exceedingly plumose hispid structure (deLaubenfels, 1936).

Axinella polypoides Schmidt, 1862. Figs. 4 and 13.

Die Spongien des Adriatischen Meeres. Leipzig.

The type of genus of the subfamily (deLaubenfels, 1936). Yellow to orange in color. Generally ramified with subcylindrical or compressed thick branches reaching 30 to 70 centimeters in length (Topsent, 1934) and five centimeters in diameter at their base (Perrier, 1936).

Oscula may be grouped in a star-like fashion (Topsent, 1934).

Skeleton: A thick axial fiber of spongin in the center of each branch with subsidiary fibers radiating from it towards the surface (Ridley and Dendy, 1887).

Megascleres: mainly smooth styles and oxea (deLaubenfels, 1936) frequently curved or sinuous (Perrier, 1936).

Microscleres: lacking.

Distribution: Between 50 and 70 meters. Mediterranean (Topsent, 1934) and West Indes (deLaubenfels, 1936).

Axinella damicornis (Esper, 1794)

Spongia damicornis Esper, 1794. Die Pflanzenthiere in Abbildungen nach der Natur mit Fabben erleuchtet nebst Beschreibungen. Zweyter Thiel, Nurnberg.

Lighter yellow in color and smaller in size than Axinella polypoides. Ramifications rarely cylindrical; frequently coalescent for quite a while. Oscula not apparent grossly (Topsent, 1925 and 1934).

Skeleton: Similar to <u>Axinella polypoides</u>. The similarity of their skeletons led Topsent (1925) to contemplate the possibility that they are two varieties of the same species.

Distribution: Between 50 and 100 meters.
Mediterranean (Topsent, 1934).

Family: Monanthidae deLaubenfels

Closely related to the Axinellidae. Set apart by their possession of desmas (deLaubenfels, 1936).

Genus: Crambe Vosmaer

Characterised by a megasclere spiculation of styles and a microsclere spiculation of greater or smaller quantities of desmas (deLaubenfels, 1936).

<u>Crambe crambe</u> (Scmidt, 1862). Fig. 14.

<u>Suberites crambe</u> Schmidt, 1862. Die Spongien des Adriatischen Meeres. Leipzig.

A very common encrusting or diversly lobed sponge, bright red in color (Topsent, 1925).

Skeleton: I. Negascleres: styles of two distinct sizes. Those lying deep are robust with the rounded end very slightly enlarged and those on the surface shorter and thinner. Mainly grouped in bunches with the sharp points quite long and accrate.

- II. Microscleres: 1. Isancres: almost always deformed. Frequently rare or absent due to degeneration and disappearance.
- 2. Desmas: localised at the point of contact of the sponge with the support or in the axis of the branches, of variable abundance and at times totally lacking. These desmas in their smallest forms are asters with four to five pointed spines containing in the center a group of small vesicles and may have a few poorly developed spines. These could lie upon small losange-shaped plaques with small vesicles in their center oriented as the poorly

developed spines. Ordinarily, the asters lengthen their spines which enlarge and become flattened distally. These may be regular or irregular depending on the original form of the spicule. The flattened distal end may contain a small vesicle as well. In the more developed desmoids the ends of the spines may divide becoming lobed or hollowed out like an arc. The number of spines is variable in the same and in different sponges. At times they may be hexactines. Very frequently they are highly deformed (Topsent, 1925).

Distribution: Mediterranean (Topsent, 1925).

Order: Poesilosclerina Topsent

Characterised by two or more categories of megascleres each confined to a particular part of the sponge. Spicules are regularly aggregated into reticulations by some spongin.

A. Principal spicules: making up the fibrous or main skeleton.

B. Auxilliary spicules: of one or more categories different from those in the fibers and lying around loose-ly in the flesh, mainly located near the surface. These may be echinating, having a fraction of their length embedded in the fibers and the remainder protruding thus making the fibers spiny (deLaubenfels, 1936).

Family: Agelasidae Verrill

No principal or auxilliary spicules except for echinating ones. It may be assumed that primitively other spicules were present that were later lost. Further reduction would lead in the direction of the Spongiidae (deLaubenfels, 1936).

Genus: Agelas Duchassaing and Michelotti

Characterised by spongin fibers free from foreign materials but echinating profusely by acanthostyles which have their spines arranged in nodal whorls.

Agelas oroides (Schmidt, 1864). Figs. 5 and 15.

Ectyon oroides Schmidt, 1864. Supplement der Spongien des Adriatischen Meeres. Leipzig.

Yellow to red polymorphic sponge composed of deep tubes with thick walls. Surface hollowed out by grooves and channels with an aspiculate ectosome covering quite large pores. Consistency: Firm and slightly compressible (Topsent, 1927-29).

Skeleton: Dense with fibers armed with seperate acanthostyles. These may be a bit curved with short points, 100-190 micra long and four to six micra thick. Their spines, upright and short, are disposed most frequently in 10 to 13 whorls (slightly more in the larger ones). The whorls rarely have over four spines and loose their

regularity near the pointed end, containing only two or three spines or even one. The rounded end is crowned with a whorl frequently surmounted by a spine thus the spicule appearing as an acanthoxea (Topsent, 1927-29).

The primary fibers extend to the surface and contain numerous spicules. Between them, the connective fibers are unequal, without order and have only solitary spicules implanted in them by their bases (Topsent, 1927-29).

Distribution: Mediterranean and Adriatic (Topsent, 1927-29).

Family: Adociidae deLaubenfels

Characterised by megascleres that are all, or nearly all, diactinal, numerous sorts of microscleres and a specialised dermal skeleton. None possess echinating spicules. Their possession of at least a trace of a special dermal skeleton sets them off from the Haliclonidae (deLaubenfels, 1936).

Genus: Pellina Schmidt

Remarkable for its external shape. There is a massive fragile main portion, and from this arise tall, brittle, chimney-like processes. They appear to be enormous prolongations of the raised rims or collars often found about oscules. They have barely enough spongin to

cement the spicules together.

Pellina semitubulosa (Leiberkuhn, 1859)

Reniera (?) semitubulosa Leiberkuhn, 1859. Müller's

Arch. f. Anat., S. 353 und 515. Leipzig.

In the form of thick large white plaques remarkable in possessing finger-like projections. These are long, slender, hollow and radially arranged.

Spencimens collected in shallow waters show better growth on the well lit side. Projections may reach seven to eight centimeters in length, are half a centimeter wide near the base and two to three millimeters at the summit.

The body is irrigated by numerous canals, the thin framework between which holds the flesh together. This tremendous development of the water system makes the sponge very fragile.

Skeleton: Made up of exea of two different sizes cemented together by a very small amount of spongin. The larger exea are curved, with accrate points and measure 200 - 220 micra in length and eight to nine micra in diameter. The smaller exea measure about fifty micra in length and two micra in diameter.

Distribution: In shallow waters. Mediterranean (Topsent, 1925).

Genus: Petrosia Vosmaer

Characterised by having four types of megascleres: strongyles of two lengths and oxea of two lengths.

<u>Petrosia ficiformis</u> Poiret. Fig. 6. (Citation unavailable)

A large sponge of variable shape, characterised by its wine red color and hard consistency although it is quite fragile. Oscula seen with the naked eye, of variable size depending on the specimen but always of the same size in the same sponge.

Skeleton: I. Megascleres: oxea: numerous and mostly curved slightly.

II. Microscleres: lacking.

Distribution: Mediterranean (Sara and Melone, 1963).

Family: Ophlitaspongiidae deLaubenfels

Characterised by fibers echinating with smooth styles commonly with the tylote modification. Microscleres are almost always present (deLaubenfels, 1936).

Genus: Tylodesma Thiele

Characterised by a simple spiculation of megascleres that are tylostyles and only sigmas for microscleres (deLaubenfels, 1936).

Order: Haplosclerina Topsent

Characterised by diactinal megascleres of one kind, without specialised localisation. Microscleres may be found. Spongin generally present.

Family: Haiclonidae deLaubenfels

Characterised by simple megascleres and lack of microscleres. By simple megascleres it is meant that they are rarely any other than diactines, and these are of the same sort throughout all portions of the sponge. There is a notable lack of ectosomal or dermal specialisation. Spongin fibers are often present, or again there may be merely small bonds of spongin uniting spicules point to point (deLaubenfels, 1936).

Genus: Haliclona Grant

Set apart from other genera of the group chiefly for such minor items as external shape. Usually massive to ramose (young forms may be encrusting).

Skeleton: I. Megascleres: small oxeas in a decidedly reticulate structure (deLaubenfels, 1936).

Burton (1926) showed that there were no radical differences between the genera Reniera, Chalina, Pachychalina and Ceraochalina for the transitions from one to another of these so-called genera may occur within a single specimen. As sponges of the genus Haliclona grow older, they

may not accumulate much spongin, but in some cases they do. In the same article, Burton depreciates the value of spicule size. A spicule begins small and gradually attains its full dimensions. Nevertheless, in some species the maximum and average sizes attained are very different from those attained by other species and only a difference of more than 50% in the average size of spicule should have value as a specific criterion (deLaubenfels, 1936).

Within each species of <u>Haliclona</u> there is no variation in color except on the part of pathological or abnormally treated specimens. There is frequently one color for members of a species living in the light and another for those living in the shade, yet both are distinctive for the species (deLaubenfels, 1936).

Haliclona cratera (Schmidt, 1862)

Reniera cratera, Schmidt, 1862. Die Spongien des Adriatischen Meeres. Leipzig.

Sponge made up of a cluster of subspherical units adhering together by connectives of less diameter than themselves each ending in an osculum. These subunits are approximately 1 centimeter in diameter and the oscula are half a centimeter across. Sponge of fluffy consistency and releases a mucus-like substance when squeezed.

Skeleton: Made up of strongyles of equal size

joined together by small bonds of spongin uniting the spicules end to end (Topsent, 1925).

Subclass III: Keratosa Bowerbank

Comprises those sponges with no proper spicules at all, and usually well provided with the horny skeletons of the substance collectively known as spongin (deLaubenfels, 1936). Also called horny sponges (Hyman, 1940).

Family: Spongiidae Gray

Contains the type genus and species for the entire phylum. Characterised by a reticulate skeleton of very elastic spongin (deLaubenfels, 1936). Contains the most important keratose sponges commercially (Vacelet, 1959).

Genus: Spongia Linné

Differentiated from the rest of the family by its possession of principal fibers cored with foreign material and an enormous number of secondary narrow fibers free from inclusions (deLaubenfels, 1936).

Spongia officinalis Linné, 1758.

Systema Naturae, 1758.

This species is the type species for the entire phylum (deLaubenfels, 1936). Its great variability in gross appearance led to the creation of many varieties.

These are difficult to differentiate due to the large number if intermediary forms.

The sponge may be in the form of thin plaques, thick rounded plaques with apical oscula or sausage shaped. They may reach ten centimeters in length and three to four centimeters in diameter (Vacelet, 1959).

The color is highly variable and varies from pure black to pure white. Specimens exposed to direct sunlight are darker in color than those in shaded areas. Also, the base of the sponge, which receives less light than the surface, is always lighter in color. The interior of the sponge is rust colored normally, but may be completely white at times (Vacelet, 1959).

The sponge is very elastic and supple. The surface is generally quite regular but at times is covered by conical protuberances half to two centimeters in height terminating in oscula. The epidermis is thin and glossy (Vacelet, 1959).

Oscula frequently without any order, usually slightly elevated and number one to about ten per sponge (Vacelet,
1959).

Skeleton: Primary fibers of variable diameter and irregular. Frequently anastomosed at their extremities with secondary fibers. They contain foreign particles in large quantities. Secondary fibers lack foreign particles and vary from 20 to 35 micra in diameter. In the center

of the sponge they are filled with rust colored particles of unknown nature. At the surface they are smooth and colored yellowish brown. At times they may be finer (10-11 micra) (Vacelet, 1959).

Distribution: Mediterranean.

Genus: Ircinia Nardo

Superficially resembles Spongia. Characterised by an enormous number of filaments running throughout the reticulated primary fibers. They are thin, long and intermingled with the primary fibers such that they break when one attempts to isolate them. They are one to 13 micra in diameter and taper at the extremities to end in a spherical enlargement up to 20 micra in diameter. They are believed to be proper constituents of the sponge. The consistency of these sponges is such that upon drying they do not make good commercial sponges, (delaubenfels, 1936 and Vacelet, 1959).

Ircinia fasciculata (Pallas, 1766). Figs. 7 and 8.

An extremely variable species, hence many varieties of it have been established. The lack of fixed characteristics makes these varieties difficult to define and they appear of little value.

Form: Generally massive but at times encrusting forms have been encountered. May reach a considerable size.

Color: Very variable, ranging from white to light grey, at times reddish or brownish or even black. The inside is often white but at times may be reddish because the fibers and filaments may be covered by reddish corpuscles. Consistency: Firm and difficult to detach. The epidermis is usually covered by sand. Oscula are distributed in a disorderly fashion.

Skeleton: Primary fibers reticulate, full of foreign particles and reaching 200 to 250 micra in diameter. Secondary fibers, thinner, stratified and only rarely may contain a few grains of sand. The filaments, numerous and packed, are two to eight micra in diameter.

Distribution: Cosmopolitan, on rocky substrates from a depth of one to 100 meters approximately (Vacelet, 1959).

Ircinia oros (O. Schmidt, 1864)

Hircinia oros O. Schmidt, 1864. Die Spongien des

Adriatischen Meeres, Supplement, Leipzig.

Characterised by its massive form with large erect lobes, usually conical and terminating in an osculum; at times it does not form true lobes but oscula are raised at least one centimeter over the surface. Specimens may reach considerable size and lobes can reach ten centimeters in length and four to five centimeters in diameter. The color is constant and characteristically dark grey. The

interior is reddish.

Skeleton: Resembles that of <u>Ircinia fasciculata</u> except that the filaments are thicker (nine to 13 micra) and taper to five to seven micra before undergoing their terminal oval enlargement (22 by 15 micra).

Distribution: In caves and faults over rocky substrata from 15 to 60 meters. Adriatic and Mediterranean (Vacelet, 1959).

Ircinia dendroides (O. Schmidt, 186).

Hircinia dendroides O. Schmidt, 1862 - 1866. Die spongien des Adriatischen meeres. Leipzig.

Characterized by its highly ramified form with anastomoses between the branches that may reach one to two centimeters. The branches are flattened or cylindrical. The major portion of the sponge, however, is crustose and firmly attached to the substrate. Color: Greyish white or grey. Consistency: Firm and solid. The surface is covered by conules one millimeter hight, a little thick and obtuse. Oscula: Small and not visible grossly.

Skeleton: Primary fibers full of inclusions, 120 to 200 micra thick and forming a large branching meshwork that later separate near the surface and terminate in the conules. Secondary fibers are 30 to 90 micra in diameter, stratified and lack foreign particles except for the largest among them which may contain a few sand particles here and

there. The meshwork may be so thick they appear like a perforated plaque. The filaments are densely crowded together with a diameter of 3.5 to 4.8 micra and their terminal enlargements are eight to ten micra in diameter (Vacelet, 1959).

Distribution: Over coralline rock. Cosmopolitan (deLaubenfels, 1936 and Vacelet, 1959).

Family: Dysideidae Gray

Characterised by a reticulate skeleton where fibers without foreign material are relatively rare; the typical fibers have more foreign material than spongin (deLaubenfels, 1936 and Vacelet 1959).

Genus: Dysidea Johnston

Very characteristic of the family in general with fibers consisting mainly of detritus connected by small quantities of spongin (Vacelet, 1959).

Dysidea etheria deLaubenfels, 1936.

Papers from Tortugas Labs. 30:28-29.

A sponge, about two by four centimeters, of skyblue coloration, hence the scientific name ascribed. It is soft, very compressible and highly fragile. The fibers, cored with masses of coral sand, project at the conules one millimeter or more, and are one to three millimeters apart.

Skeleton: Primary fibers are full of sand particles with very little spongin holding them together. They branch at acute angles and irregularly anastomose, making a very irregular reticulation with meshes in the neighborhood of two millimeters in diameter.

Secondary fibers are rare and mainly near the surface. They are of spongin, cylindrical, about 150 micra in diameter and contain numerous small fragments about 35 micra in diameter, often consisting of broken bits of silicous spicules.

The species may be distinguished by its color alone, for there are no other species of the same coloration. The coarsness of the contents of the main fibers is remarkable, but more so is the chemical difference between the contents of the two types, the calcareous material confined to the main fiber, and the silicous to the smaller secondary fibers (deLaubenfels, 1936).

Distribution: West Indes (deLaubenfels, 1936).

<u>Dysidea tupha</u> (Martens, 1824). <u>Spongia tupha Martens</u>, 1824.

Characterised by its branched cylindrical shape, eight to ten centimeters long and four to six millimeters in diameter. These are true rami which, contrary to the ideas of Schmidt and Schulze, are not erect. In reality

they crawl on the surface of rocks and only their branches stand erect.

Color: White, but frequently the epidermis is filled with brown unicellular algae giving it a brown color. Surface: Conules small, rounded and rare; more visible at the extremities of branches where they are numerous. Oscula: One millimeter in diameter, distributed irregularly and never terminal. Consistency: Quite firm.

Skeleton: Fibers full of foreign particles with very little spongin usually making them easy to break. Primary and secondary fibers not distinguishable except near the surface (Vacelet, 1959).

V. RESULTS

This section is limited to a comparison of how well the collected species fit their description in the literature and the ecological data from in situ observations of each sponge. The same order of study is followed here as in the fourth section.

Class: Calcarea

As mentioned earlier, the Calcarea are represented in the collection by one species that could only be keyed out to the genus Leuconia. This is a drab colored sponge collected in very shallow waters (three to four meters) during the months of October to November at the Beirut transect only. During latter months it could no longer be collected. This could be due to the sponge being swept away by wave action because of its fragility.

Skeleton: Made up of calcium carbonate spicules divisible into three types:

- 1. Regular triradiate spicules: where all three branches have the same shape and are equal in length.

 Each arm is 170 to 220 micra long and 15 to 20 micra in diameter.
- 2. Irregular triradiate spicules: where one arm is straighter and longer than the other two. The longer arm ranges between 630 to 520 micra in length while the

shorter arms range between 400 and 300 micra. All arms are 40 to 50 micra in diameter at their thickest ends.

3. Oxea with one end flattened and enlarged to resemble half a spear head. These ranged from 670 to 1000 micra in length and 35 to 45 micra in diameter.

It is noteworthy that the spicules of this sponge were always found mixed with those of <u>Alectona millari</u>, but the two could not be differentiated grossly.

It is always found on vertical walls in areas shaded from direct sunlight and sheltered from wave action.

Class II: Hexactinellida

No members of this class were collected because they are characteristically deep sea species and this collection is limited to a depth of 35 meters.

Class III: Demospongiae

This class contained all the sponges in this collection except for the <u>Leuconia</u> species mentioned above.

Subclass I: Tetractinellida

In this subclass only two sponges belonging to the order Carnosa were collected. These are Chondrilla nucula and Chondrosia reniformis.

Chondrilla nucula Figs. 1 and 10.

Observed at Sidon Island and Beirut in shallow waters (down to six meters) on fully exposed nude rocky substrata.

One large colony of this sponge was observed in a large artificial pool one meter deep at Sidon Island where it was the dominant living organism. It covered over 50% of the nude rocky base both vertically and horizontally in fully exposed areas and shady ones. Its thinness, solid consistency and strong adherence to the substratum makes it difficult to collect. This sponge has been growing in this artificial tidepool for at least one year as reported by a fellow worker. Observations at the tidepool indicate that the sponge must have a very low oxygen requirement, can live in quiet waters and can withstand moderate changes in salinity since water only enters the pool when the waves are high.

Chondrosia reniformis Fig. 2.

Very abundant all along the coast over vertical rocky bottoms in shallow waters (to 15 meters) although it has been collected as deep as 123 meters at other Mediterranean stations (Topsent, 1934). It may cover up to 40% of the surface area, spreading in all directions wherever there is a free vertical rocky substratum. Its absence over horizontal substrata could be because of its

inability to withstand direct sunlight. It is frequently passed unnoticed for it grows mainly in shaded areas with algae growing all over it. Keeps well in aquaria (Topsent, 1934). One specimen lived over a month in the aquarium becoming attached to the bottom until the water went off accidentally.

Extremely hard to detach due to its solid, rubberlike consistency. It is attached to the substratum only at certain points.

Specimens collected were light brown to dark brown to dark grey shading into black. No correlation could be found between color and amount of exposure for two touching specimens living under the same conditions would have distinctly different colors.

Subclass II: Monaxonida

This class with its four orders contains twelve of the species. These will be studied in the sequence of the orders to which they belong (appendix 1).

Order: Hadromerina

This order contains three of the species, namely Alectons millari, Cliona viridis and Cliona copiosa.

Alectona millari Fig. 9.

This sponge itself has not been observed grossly

but its spicules are always found mixed with those of the Leuconia species. This could possibly be a symbiotic relationship between the two species. Another possibility could be that this is a new species with spiculation common to both. Dr. Sara (personal communications) favours the view that they are the spicules of both species mixed together.

Skeleton: Only diactinal megascleres studded with conical tubercles were observed (Fig. 9). These were generally shorter (110 to 145 micra) and thicker (25 to 30 micra) than expected. Amphiasters were totally lacking.

Although it is generally reported as a very deep water species (Topsent, 1900), our material has only been collected in very shallow waters (three to four meters).

Cliona viridis Figs. 3 and 11.

Although this sponge is known to become massive (Topsent, 1900 and Perrier, 1936) only the encrusting form was collected. It is known to utilize any form of calcareous substratum (calcareous rock, molluscan shells and corals) but all specimens collected were overlying calcareous rock.

Topsent (1900) reports this sponge as deep as 70 meters but the specimens collected all came from depths ranging between six and sixteen meters. At Tabarja it was not collected below 15 meters although it was quite abundant above this level.

The sponge was always found overlying vertical or sloping substrata but never horizontal ones fully exposed to sunlight.

Skeleton: The only skeletal elements observed were tylostyles. These ranged in length from 400 to 530 micra. The diameter of the shaft ranged from ten to 12.5 micra and of the head 17.5 to 20 micra. These figures fit well those of the species. Although Topsent (1900) claims that the axial canal is these tylostyles does not enlarge in the head of the spicule, it was found to do so in about half of the spicules. Spiny spirasters were totally lacking. This could be because these microscleres are known to lie in the deeper layers of the sponge which were not collected.

Cliona copiosa Figs. 7 and 12.

In contrast to <u>Cliona viridis</u> this sponge is never found except on horizontal rocky substrata in shallow waters (to ten meters) fully exposed to the rays of sunlight. It was particularly abundant around the western tip of Sidon Island where a continuous mild current was observed on every dive.

As no literature was available on this sponge, it was not possible to examine how well this sponge fits its description in the literature.

Skeleton: Megascleres were mainly in the form of

styles only a few of which showed a mild tendency towards tylostyles. These are 270 to 350 micra long and 7.5 to 12.5 micra in diameter.

Microscleres are in the form of spiny spirasters.

They are thin, long and relatively sinuous. The spines are straight with pointed ends and mainly evident at the bending points and extremities of the axis. They measure 11 to 27 micra in length and 1.3 to three micra in diameter.

Order: Halichondrina

In this order three sponges were collected, namely Axinella polypoides, Axinella damicornis, and Crambe crambe.

Axinella polypoides Figs. 4 and 13.

Found quite abundantly at the Tabarja transect hanging from a vertical wall between 20 and 35 meters. Failure to collect it at other sites could be due to our not going deeper than 17 meters at the other sites for Topsent (1934) reports it as a species found between 50 and 70 meters.

One specimen collected reached 70 centimeters in length and three centimeters in diameter at its base.

Although oscula are usually visible grossly in the form of asters (Perrier, 1936), none could be seen grossly.

Skeleton: Styles ranged from 190 to 270 micra in length and six to ten micra in diameter. Oxea were 137 to

250 micra in length and four to ten micra in diameter. Styles and oxea were about equal in number.

Axinella damicornis

Only one specimen was collected of this sponge from Sidon Island. It was five centimeters in diameter and hanging from a vertical wall.

Although Topsent (1934) reports this sponge to lie at depths between 50 and 100 meters, our material came from a depth of only six meters. The shape, however, fitted the description of the species.

Skeleton: Styles ranged from 1000 to 1580 micra in length and five to 12.5 micra in diameter. Oxea were 350 to 560 micra long and ten to 12.5 micra in diameter. The ratio of styles to oxea was one to ten.

Axinella polypoides could be different forms of the same sponge, but comparison of the size of spicules, the ratio of styles to oxea and the gross appearance of the two sponges leaves little doubt that they are separate species.

Crambe crambe Fig. 14

This species fits very well its description by

Topsent (1925). A specimen, 5 cm in diameter, was collected

at the western tip of Sidon Island at a depth of six meters.

At this point, a mild current was always observed. It was

hanging from a vertical wall well protected from the rays of sunlight.

Skeleton: Megascleres: styles of two different sizes. The larger ones were 300 to 320 micra in length and the smaller ones were 160 to 170 micra long. Both had approximately the same diameter and were five to 7.5 micra thick.

Microscleres: Isancres were absent. Desmas, however, were seen and were as deformed as expected (Fig. 14).

Order: Poecilosclerina

Four members of this order were collected: Agelas oroides, Pellina semitubulosa, Petrosia ficiformis and Tylodesma sp.

Agelas oroides Figs. 5 and 15.

This species is quite abundant and was collected at all sites except Sidon Island. It was generally hanging down from the roofs of small caves in vertical walls or on vertical walls directly. In both cases it was well protected from the direct rays of the sun. With its large size (up to 40 centimeters in diameter), its bright orange color and irregular shape, it is one of the most conspicuous specimens.

Skeleton: The acanthostyles are generally shorter (100 to 140 micra) and thicker (four to ten micra) than

expected. They have nine to fourteen whorls of spines, irregularly spaced, but never with more than four spines per whorl. The tendency for degeneration of some of the spines is certainly there and seen more in certain specimens than in others. Within the same acanthostyles the same tendency increases as we go from the rounded to the pointed end of the spicule.

Pellina semitubulosa

One specimen of this sponge was collected in shallow waters (about six meters) at Sidon Island. It was covered by algae and collected accidentally when collecting the alga. The specimen was drab colored, four centimeters in diameter with thin walls one to two millimeters in thickness.

Skeleton: Made up of oxea of two different sizes. The larger ones being 118 to 133 micra long and the shorter ones ranging between 65 and 70 micra. Both are of the same thickness (five to 7.5 micra). The smaller ones tended to end more abruptly than the larger ones which taper off slowly. These dimensions differ from those cited by Topsent (1925) who finds the larger oxea twice as long and the shorter ones half as thin.

Petrosia ficiformis Fig. 6.

A very abundant sponge over vertical rocky substrata.

Always wine red in color. All specimens were collected below ten meters. This could explain why no specimens were collected from Sidon Island, for all dives were above ten meters. At Rabbit Island it was collected inside a shallow cave (three meters).

Sponge firm and non-compressable although it is quite fragile and easy to tear off the rocks. Generally it was in the form of large plaques that reached 25 centimeters in diameter and three to four centimeters in thickness, with grossly visible oscula three to five millimeters in diameter surrounded by a slightly elevated edge. In certain specimens, not necessarily larger, oscula as wide as one centimeter were observed. The oscula, however, were always of the same size in the same specimen. Many of the larger specimens showed small polypoidal elongations around the periphery of the sponge. These were half a centimeter in diameter and two to four centimeters long.

Skeleton: Made up of oxea of all sizes in no definite order. These range in length from 70 to 225 micra and three to ten micra in diameter.

Tylodesma sp.

This species was found at all sites, on all dives and in great abundance. It appears to be the dominant species along the coast of Lebanon at depths ranging between three and seven meters. It may cover up as much as 40% of the surface area. It is thin (one to two millimeters), crustose and appears to grow wherever there is a vertical or sloping nude rocky substratum. It spreads in the form of a thin bright orange mat. The above characteristics made it very difficult to collect this sponge, and a piece of the rock had to be chopped off with a hammer and chisel before a large enough specimen could be collected.

Skeleton: Skeletal preparations of this sponge were poor and mixed with tylostyles of Cliona viridis and therefore no measurements will be based on them.

Order: Haplosclerina

Under this order only Haliclona cratera was collected.

Haliclona cratera

Only one specimen of this sponge was collected. It was found at Sidon Island at a depth of five meters. Grossly, the specimen fitted well its description in the literature. It was three and a half centimeters in diameter and extremely fragile.

Skeleton: Made up of strongyles mainly united at their extremities in a reticulate fashion by small amounts of spongin that did not spread over the whole length of the spicule. The strongyles were 250 to 350 micra long and 7.5 to ten micra in diameter.

Subclass: Keratosa

In this subclass the following six sponges were collected: Spongia officinalis, Ircinia fasciculata, Ircinia oros, Ircinia dendroides, Dysidea etheria and Dysidea tupha.

Spongia officinalis

This sponge was found quite abundantly at Rabbit Islands where many specimens were collected. These ranged in size up to 15 centimeters. All came from depths of five to seven meters where they lay attached to the horizontal rocky substratum. Only one small specimen was collected from Beirut.

All specimens collected were dark grey or black in color. The surface is covered by small projections approximately one millimeter in height and two to three millimeters apart. The interior of the sponge is light yellow. Oscula were not visible grossly.

Skeleton: Made up of primary fibers of variable diameter filled with foreign particles. Secondary fibers free from such particles showed a definite lamellation and tended generally to be slightly thicker than expected (25 to 45 micra).

Genus: Ircinia

This is the genus best represented along the coast of Lebanon. Division into genera is based on the diameter of the filaments in the skeleton. It is for this reason that besides the three species to be discussed shortly, a number of intermediary forms were identified by Dr. Sara as <u>Ircinia</u> sp. 1, <u>Ircinia</u> sp. 2, etc.

Ircinia fasciculata Figs. 7 and 8.

Many large specimens of this massive species were collected all along the coast growing over horizontal or sloping substrata at depths between five and fifteen meters. In general, two color varieties were collected. The first is black and the second is a dirty yellow shading into light pink. Both were found growing under direct sunlight. Both varieties could be collected side by side. In general, the black variety tended to be more uniform and larger (up to forty centimeters in diameter) than the lighter variety. The largest specimens of both varieties came around the western tip of Sidon Island where a mild current was always noticable. Oscula ranged in diameter from two to five millimeters and were most concentrated around the periphery of the sponge.

Ircinia oros

This sponge was found very abundantly at Rabbit

Islands where it is the dominant sponge species. Specimens were drab colored, and ranging up to ten centimeters in diameter and five centimeters in height being extremely hard to detach from their rocky substrata.

Ircinia dendroides

Only one specimen of this sponge was collected at Sidon Island. The main characteristic used for seperating it from other members of this genus is external shape. The specimen was five centimeters in diameter and gives rise to partially compressed prolongations two to three centimeters long. These are studded by small tuberces one millimeter high and two to three millimeters apart.

Dysidea etheria

Collected frequently from Beirut and Sidon Island. Its sky blue color, soft consistency and fragility makes it easy to identify. Specimens of it grow either on vertical walls over other sponges and algae or between the branches of <u>Cystoseira</u>. Generally, they are small (up to six centimeters).

Skeleton: Mainly of primary fibers packed with foreign particles and containing very little spongin.

Secondary fibers seen mostly near the surface and contain a mixture of foreign spicules (Fig. 16) and sand grains covered by moderate amounts of spongin.

Dysidea tupha

Collected frequently from Beirut and once from Sidon. Dark violet-brown in color. Growing over horizon-tal rocky substrata between eight and twelve meters. It grows in the form of highly compressed prolongations arising from a common base and growing parallel to one another. Each is three to four centimeters long, one to two centimeters wide and two to three millimeters thick. Oscula not visible grossly.

Skeleton: Very characteristic and simple, made up of fibers packed with foreign particles with a minimal amount of spongin.

VI. DICHOTOMOUS KEY TO THE SPONGES OF LEBANON

1.	Sponge with a skeleton 2
ı.	Sponge without a skeleton Chondrosia reniformis
2.	Skeleton of spicules or spicules and spongin 3
2'.	Skeleton of spongin alone
3.	Skeleton of silicon spicules, with or without
	spongin 4
3'.	Skeleton of calcium carbonate spicules only - Class:
	Calcarea. These are regular or irregular triradiate
	spicules and oxea with one end flattened into half
	a spear-head Leuconia sp.
4.	Skeleton of megascleres and microscleres 5
4'.	Skeleton of microscleres only in the form of
	euasters Chondrilla nucula
5.	Megascleres a mixture of monactinal and diactinal
	spicules 6
51.	Megascleres either monactinal or diactinal, with or
	without microscleres

6.	Megascleres composed of styles and oxea of approxi-
	mately equal size and ratio Axinella polypoides
61.	Megascleres composed of styles and oxea of unequal
	size and ratio Axinella damicornis
7.	Megascleres monactinal 8
7'.	Megascleres diactinalll
8.	Megascleres accompanied by microscleres 9
81.	Megascleres alone 10
9.	Megascleres styles, microscleres
	desmoids Crambe crambe
9'.	Megascleres styles and tylostyles and microscleres
	spiny spirasters Cliona copiosa
10.	Megascleres acanthostyles Agelas oroides
10'	. Megascleres tylostylesll
11.	Sponge perforating Cliona viridis
11'	. Sponge non-perforating Tylodesma sp.
12.	Megascleres strongyles
12'	. Megascleres oxea of different sizes 14

13.	Strongyles studded by conical protuberances
	Alectona millari
13'.	Strongyles smooth and joined together by a small
	amount of spongin Haliclona cratera
14.	Sponge large, compact and wine-red in color
	Petrosia ficiformis
14'.	Sponge small, mostly hollow and fragile
	Pellina semitubulosa
15.	Spongin fibers divisible into primary and secondary16
15'.	Spongin fibers all the same and packed with foreign
	particles <u>Dysidea</u> tupha
16.	Skeleton in addition contains fine filaments 17
161.	Skeleton lacks such filaments 19
17.	Sponge highly ramified Ircinia dendroides
17'.	Sponge massive 18
18.	Filaments two to eight micra in diameter
	Ircinia fasciculata
181.	Filaments nine to thirteen micra in diameter
	Trainis oros

19.	Secondary fibers free 1	from inclusions
		Spongia officinalis
19'.	. Secondary fibers contain	in sand grains and a large
	variety of spicules	Dysidea etheria

VII. DISCUSSION AND CONCLUSIONS

Poriferans constitute an important group of benthic animals due to their abundance, large size and number of different species. Works dealing with the ecology of these animals are very few (Sara, 1962). This is because the equipment necessary for such studies has only been developed recently. So far, most studies undertaken on sponges, Mediterranean or otherwise, are done on samples collected by dredging and the only data gathered is depth of collection and color.

The main factors that seem to affect sponges are the following:

- 1. Type of substratum
- 2. Amount of light
- 3. Angle of substratum
- 4. Surrounding algal growth
- 5. Waves and currents.

As sponges are sessile animals, they need a solid substratum to attach upon. Therefore, the only type of substrate they can use successfully is a rocky one.

The amount of light that falls upon a sponge appears to be a very important limiting factor. Certain sponges grow only at certain depths. For a few sponges light intensity appears to be the single most important factor

determining where they grow. Thus on several occasions sponges were collected from caves at shallower depths than that at which these sponges were previously known to grow (Petrosia ficiformis and Agelas oroides).

Substrate angle is also very important and certain sponges grow only on vertical substrata, others only on horizontal ones (Table II). One factor causing this is that the amount of light falling upon a sponge growing over a horizontal substratum is definitely greater than that falling on a sponge growing over a vertical substratum. A more important factor, however, appears to be the form of the sponge in relation to the angle of the substratum. By examining Table II we find the majority of sponges growing over horizontal substrata to be massive (elevated over the substratum) and the major part of the crustose sponges to be living over vertical substrata. The reason appears there always tends to be a certain amount of drift material over a horizontal substratum and not over a vertical one. Since sponges are filter feeders and their life depends on their ability to move a current of water inside their body, any factor that tends to hinder this would not be favourable for the sponge unless it is somehow elevated over the surface. Generally, only keratose sponges were collected over horizontal substrata.

Sponges appear to flourish best in areas where there is little algal growth or the algae growing are small. This

could be explained on the following basis: first, algae complete with sponges for a foothold and second, the presence of algae around a sponge would tend to hinder the sea currents that facilitate its nutrition. Certain sponges, e.g. <u>Dysidea etheria</u> and <u>Tylodesma</u> sp., solve this problem by growing on top of the larger algae such as <u>Cystoseira</u> and <u>Posidonia</u>.

Waves tend to interfere and disturb the growth of a sponge. As soon as a sponge grows beyond a certain size, waves would tend to dislodge it. Thus for a sponge to grow in the intertidal zone, it would have to be very small and grow in a sheltered area. Mild sea currents, however, tend to enhance sponge growth by aiding water circulation. This is why a large number of specimens were collected around the western tip of Sidon Island as there is always mild current coursing through the wave cut channel.

Although certain species had distinctive colors, color appears to be highly variable in sponges. It depends upon the amount of exposure and the presence or absence of symbiotic unicellular algae in the sponge. Generally, sponges exposed directly to sunlight tend to have darker coloration than those in shady areas. Even in the same sponge, the upper surface tends to be of darker coloration than the under surface.

Zonation is very definitely observed in sponges.

On a vertical substratum we first encounter at a depth of

five meters Tylodesma sp. Chondrosia reniformis and Cliona viridis. Tylodesma disappears at about ten meters while Chondrosia reniformis and Cliona viridis usually extend as deep as fifteen meters. At this depth we start to see Agelas oroides, Petrosia ficiformis and Axinella polypoides (Table I). If any of these three are encountered at a shallower depth, it is usually seen inside a small cave under subdued light conditions.

Zonation of sponges occuring over horizontal substrata, although assumed present, could not be studied as thoroughly due to the wide extent of the zones and absence of sharp boundaries between them as seen on vertical substrata.

Examination of the horizontal substrata at Rabbit
Islands reveals two dominant species, namely, Ircinia oros
and Spongia officinalis and two less common species,
Chondrilla nucula and Cliona copiosa. It is only at the
vertical or sloping walls close to the islands that Chondrosia
reniformis and Tylodesma sp. occur. Petrosia ficiformis
and Agelas oroides were only collected inside a moderately
sized cave under subdued light conditions.

The transect at Tabarja can be divided into two main sections. The first is from shore down to fifteen meters which slopes at a 45 degree angle and is characterised by Tylodesma sp., Cliona viridis and Chondrosia reniformis. The genus Ircinia was quite common too. The second part is a vertical wall which drops from fifteen meters down. Along

this wall, the dominant species are <u>Petrosia ficiformis</u>,

<u>Agelas oroides</u> and <u>Axinella polypoides</u> which were approxi
mately ten meters apart. <u>Axinella polypoides</u> was collected

only at this transect. This could be because we did not

go any deeper than seventeen meters on any of the other

transects.

The Beirut transect was the most thoroughly studied one. At a depth of five meters <u>Cliona viridis</u> and <u>Tylodesma</u> sp. and <u>Chondrosia reniformis</u> were the dominant living organisms over the vertical portions and covered up as much as 80 to 90% of the surface area (Fig. 3). Over the horizontal stretches between six and twelve meters <u>Ircinia</u> sp., <u>Ircinia fasciculata</u> and <u>Dysidea tupha</u> were the dominant species. Over the vertical wall below twelve meters the dominant species were, like at Tabarja, <u>Petrosia ficiformis</u> and <u>Agelas oroides</u>.

At Sidon Island we have mainly a horizontal transect at a depth of five to twelve meters except close to shore where it becomes vertical. The vertical portion is characterised by Chondrosia reniformis, Cliona viridis and Tylodesma sp. Tylodesma in addition grows over the tops of Cystoseira and Posidonia. Posidonia is only over the drift covered bottom. This offers proof that it is not the angle of the substrate that affects growth of this sponge but rather the presence or absence of drift material. Over the horizontal substratum we find a preponderance of the light and dark

where large specimens could be as close as five meters to each other. Cliona copiosa was also observed abundantly also.

Sponge Fisheries in Lebanon:

Although the shores of Syria and Lebanon were world famous for their commercial sponges, exhaustion of the sponge beds, as predicted by Gruvel in 1932, and the cheap manufacture of synthetic sponges have caused a tremendous decline in sponge fisheries as a trade. For the past year and the two years to come (1967-69), sponge fishing is forbidden by law in Lebanon. This is in an effort to restore the exhausted fishing grounds for despite the many kinds of synthetic sponges on the market, the natural sponges still maintain a superior poistion in many respects. are softer, more absorbant, more elastic and last longer. But it is doubtful whether such a ban can be effected or will be useful for as soon as the fishing grounds are open again they will be re-exhausted in a much shorter period because of the high demand and profitability of the trade and more efficient methods of collection.

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 Ecyton oroides flavus, Tethya auranticum, Chondrosia

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APPENDIX 1.

CLASSIFICATION OF THE PHYLUM PORIFERA*

Class I. Calcarea or Calcispongiae, the calcareous sponges. Skeleton composed of seperate calcareous spicules, one-, three-, or four-rayed, not divisible into megascleres and microscleres.

Order 1. Homocoela, the ascon sponges. Structure asconoid.

Order 2. Heterocoels. Structure syconoid or leuconoid.

Class II. Hexactinellida or Triaxonida or Hyalospongiae, the glass sponges. Skeleton composed of triaxon (six-rayed) siliceous spicules or some modification of the triaxon form, seperate or united into networks; choanocytes limited to finger-shaped chambers arranged in a simple or folded layer; without surface epithelium.

Order 1. Hexasterophora. With hexasters, without amphidisks.

Order 2. Amphidiscophora. With amphidisks, no hexasters.

Class III. Demospongiae. Skeleton of siliceous spicules or horny fibers or both; siliceous spicules not triaxon, generally differentiated into megascleres and microscleres; flagellated chambers mostly small, round, of the leuconoid type.

^{*}Taken from Hyman, 1940.

Subclass I. Tetractinellida. With tetraxon spicules; no spongin; spicules sometimes wanting.

Order 1. Myxospongida. Without spicules; structure simple.

Order 2. Carnosa or Homosclerophora or Microsclerophora.

Megascleres and microscleres not sharply differentiated;

mostly without triaenes; asters may be present.

Order 3. Choristida. With long-shafted triaenes; megascleres and microscleres distinct.

Suborder 1. Astrophora. Microscleres include asters.

Suborder 2. Sigmatophora. Microscleres when present are sigmas.

Subclass II. Monaxonida. Megascleres monaxonial; with or without spongin.

Order 4. Hadromerina or Astromonaxonellida. Megascleres mostly tylostyles; microscleres when present some form of aster; without spongin.

Order 5. Halichondrina. Megascleres mostly of two or more kinds; microscleres wanting or are rhaphides; with little spongin.

Order 6. Poecilosclerina. Megascleres often of two or more sorts, localized in distribution; reticulate, united by more or less spongin; often with echinating spicules; microscleres include sigmas, chelas, and toxas.

Order 7. Haplosclerina. Megascleres of one kind, diactinal, without special localization; with or without microscleres; spongin generally present.

Subclass III. Keratosa, the horny sponges. Skeleton composed of spongin fibers, without siliceous spicules.

APPENDIX 2.

SPONGE SPICULES*

- I. Megascleres: Large or skeletal spicules.
 - A. Diactinal spicules: rod-like, straight or curved with ends similar.
 - 1. Oxea: ends pointed (Fig. 13 a and b)
 - 2. Strongyles: ends rounded off.
 - B. Monactinal spicules: rod-like, straight or curved with ends different.
 - Styles: one end pointed and one rounded (Fig. 12 a and c).
 - Tylostyles: styles with rounded end enlarged into a spherical ball (Fig. 11).
 - C. Triaens: four rayed, with one longer than the others (rhabdome) whose extremity carries the other three rays (cladi) all directed the same way forming the cladome.
 - D. Desmas: (pl. desmata) originate from a spicule, the crepis, upon which are laid layers of silica, first in concentric layers, and later developing irregular branches more or less covered with nodosities (Fig. 14).

^{*}Compiled from Sollas (1888), Topsent (1900) and Perrier (1936).

- II. Microscleres: Small spicules, mainly protective or ornamental.
 - Orthodragmates: needle shaped spicules arranged in bundles.
 - Toxea: slender spicules with pointed ends and curved like an arc.
 - Calthropses: triaenes where the four rays are alike. Smaller forms are called microcalthropses.
 Reduction of the rays to three gives microtriodes, and further loss gives centrotylote microxea.
 - Sigmaspires: simple, rod-like and curved in a spiral fashion.
 - 5. Asters: branched stars with a variable number of rays divisible into two major groups:
 - a. Strepasters: where the actines (spines) develop from an elongate, usually spiral axis.
 - (i) Spirasters: the axis makes one or more spiral turns, and is packed at certain points with spines.
 - (ii) Metasters: the axis makes less than one spiral turn, and has fewer and longer spines than in spirasters.
 - (iii) Plesiasters: the axis is so short the spines appear to radiate from a common center.

- (iv) Amphiasters: the axis is straight and the spines make a whorl at each end. The axis is frequently continued by a single spine at each end.
- (v) Sandiasters: have a rod-like axis with spines at certain points along all its axis. The central spines are perpendicular to the axis, and those at the ends oblique. The spines may be spirally arranged.
- b. Euasters: actines arise from a common center (Fig. 10).
 - (vi) Chiasters: small stars with actines that are slender and cylindrical, rounded or enlarged at the tips.
 - (vii) Oxyasters: asters with a small center or none at all, and pointed conical spines.
 - (viii) Spherasters: asters with a large centrum.
 - (ix) Sterrasters: asters where the actines are excessively numerous and fused to one another by successive depositions of silica which nearly envelopes them completely making thus a form of centrum. Their form is variable: spherical, ellipsoidal discoid or losange shaped. Usually each of the actines carries a few spines on its surface.

APPENDIX 3.

SPONGE COLLECTION

GEORGE KASSIS

BIOLOGY DEPARTMENT

AMERICAN UNIVERSITY OF BEIRUT

		Serial No.
Sci. Name:		
Location:		
	Date of Collection: _	
Remarks:		
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		

^{*}Sample Data Chart

GT.OSSARY

Acantho: spiny.

Actines: aster spines.

Amphiaster: strepaster with straight axis, the spines making a whorl at each end with axis frequently continued by a single spine.

Aster: branched star with variable number of rays.

Calthropses: triaenes with four rays alike.

Centrotylote: middle of spicule is enlarged into a spherical ball.

Chiaster: small emaster with slender cylindrical spines rounded or enlarged at the tips.

Cladi: the three short rays of a triaene.

Cladome: the part of a trisene formed by the three cladi.

Desmas: (pl. desmata) spicule originating from a crepis
upon which are laid concentric layers of silica
which later develop branches more or less covered
with nodosities.

Diactinal: with similar ends.

Euaster: an aster where the spines arise from a common center.

Megascleres: large skeletal sponge spicules, one or four rayed.

Metaster: a strepaster where the axis makes less than one spiral turn and has few long spines.

Microscleres: small ornamental or protective spicules.

Microtriodes: microcalthropses with number of rays reduced to three.

Monactinal: with ends different.

Orthodragmates: needle-shaped microscleres arranged in bundles.

Oxea: diactinal megascleres with ends pointed.

Oxyaster: a cuaster with a small center or none at all, and pointed conical spines.

Plesiaster: strepaster with axis so short spines appear to radiate from a common center.

Protoclade: proximal part of a bifurcated clade.

Rhabdome: elongate ray of a triaene.

Sandiaster: strepaster having rod-like axis with spines at certain points along all its axis. The central spines being perpendicular to the axis and those at the ends oblique.

Sigmaspires: simple, rod-like microscleres curved in a spiral fashion.

Spheraster: euaster with a large centrum.

Spiraster: strepaster where the axis makes one or more spiral turns, and is packed at certain points with spines.

Sterraster: enaster with spines excessively numerous and fused to one another by successive depositions of silica which nearly envelopes them completely making thus a form of centrum, of variable shape,

and each of the spines carrying few projections on its surface.

Strepaster: asters where the spines develop from an elongate, usually spiral axis.

Styles: monactinal megascleres with one end pointed and one rounded.

Strongyles: diactinal megascleres with ends rounded off.

Toxea: slender microscleres with pointed ends and curved like an arc.

Triaenes: four rayed megascleres with one ray longer than others and whose extremity carries the other three rays all directed the same way.

Tylostyles: styles with rounded end enlarged into a spherical ball.

TABLES

Table 1. Sites of collection and relative abundance of the different sponge species. (+ collected once, ++ collected more than once, and +++ very abundant.)

Name of Sponge	Site of Collection			
same of sponge	Rabbit Isl.	Tabarja	Beirut	Sidon Isl.
Agelas oroides	+	+++	+++	-
Alectona millari	-	-	+	-
Axinella polypoides	-	+++	-	-
Axinella damicornis	-	-	-	+
Chondrilla nucula	+++	-		+
Chondrosia reniformis	+++	+++	+++	+++
Cliona copiosa	++	-	-	++
Cliona viridis	-	+++	+++	++
Crambe crambe	-	-		+
Dysidea etheria	-	-	++	+
Dysidea tupha	-	-	++	+
Haliclona cratera	-			+
Ircinia sp.	+	+++	+++	+++
Ircinia dendroides	-			+
Ircinia fasciculata	+	++	+++	+
Ircinia oros	+++	-	-	-
Leuconia sp.	-	-	+++	-
Pellina semitubulosa	-	-	-	+
Petrosia ficiformis	+++	+++	+++	++
Spongin officinalis	+++	4	+	-
Tylodesma sp.	+++ '	+++	+++	+++

Table II. Main form of sponge and type of substratum it grows on (m: massive, s: small, c: crustose).

### Axinella polypoides m	Name of Sponge	Form	Main type of Horizontal	substratum Vertical
Axinella polypoides	Agelas oroides	m		+
### Axinella damicornis	Alectona millari	8	_	+
Chondrilla nucula e + - Chondrosia reniformis e - + Cliona copiosa s + - Cliona viridis e - + Crambe crambe s - + Dysidea etheria s - + Dysidea tupha s + - Haliclona cratera s - + Ircinia dendroides s - + Ircinia fasciculata m + - Pellina semitubulosa s - + Spongia officinalis m - +	Axinella polypoides	m	-	+
Chondrosia reniformis c - + Cliona copiosa s + - Cliona viridis c - + Crambe crambe s - + Dysidea etheria s - + Dysidea tupha s + - Haliclona cratera s - + Ircinia dendroides s - + Ircinia fasciculata m + - Ircinia oros m + - Pellina semitubulosa s - + Spongia officinalis m + -	Axinella damicornis	8	_	+
Cliona copiosa s + - Cliona viridis c - + Crambe crambe s - + Dysidea etheria s - + Dysidea tupha s + - Haliclona cratera s - + Ircinia dendroides s - + Ircinia fasciculata m + - Pellina senitubulosa s - + Petrosia ficiformis m - + Spongia officinalis m + -	Chondrilla nucula	e	+	-
Cliona viridis c - + Crambe crambe s - + Dysidea etheria s - + Dysidea tupha s + - Haliclona cratera s - + Ircinia dendroides s - + Ircinia fasciculata m + - Ircinia oros m + - Pellina semitubulosa s - + Petrosia ficiformis m - + Spongia officinalis m + -	Chondrosia reniformis	e		+
Crambe crambe s - + Dysidea etheria s - + Dysidea tupha s + - Haliclona cratera s - + Ircinia dendroides s - + Ircinia fasciculata m + - Ircinia oros m + - Leuconia sp. s - + Petrosia ficiformis m - + Spongia officinalis m + -	Cliona copiosa	8	+	-
Dysidea etheria s - + Dysidea tupha s + - Haliclona cratera s - + Ircinia dendroides s - + Ircinia fasciculata m + - Ircinia oros m + - Leuconia sp. s - + Pellina semitubulosa s - + Spongia officinalis m + -	Cliona viridis	e	-	+
Dysidea tupha s + - Haliclona cratera s - + Ircinia dendroides s - + Ircinia fasciculata m + - Ircinia oros m + - Leuconia sp. s - + Pellina semitubulosa s - + Spongia officinalis m + -	Crambe crambe	s		+
Haliclona cratera S	Dysidea etheria	a	_	+
Ircinia dendroides	Dysidea tupha	s	+	-
Ircinia fasciculata m + - Ircinia oros m + - Leuconia sp. s - + Pellina semitubulosa s - + Petrosia ficiformis m - + Spongia officinalis m + -	Haliclona cratera	8		+
Ircinia oros	Ircinia dendroides	s	-	+
Leuconia sp. s - + Pellina semitubulosa s - + Petrosia ficiformis m - + Spongia officinalis m + -	Ircinia fasciculata	m	+	
Pellina semitubulosa s - + Petrosia ficiformis m - + Spongia officinalis m + -	Ircinia oros	m	+	
Petrosia ficiformis m - + Spongia officinalis m + -	Leuconia sp.	8	-	+
Spongia officinalis m + -	Fellina semitubulosa	8		+
	Petrosia ficiformis	m	-	+
Tylodesma sp. c +	Spongia officinalis	n	+	_
	Tylodesma sp.	e	_	+

FIGURES



Fig. 1. Chondrilla nucula in situ

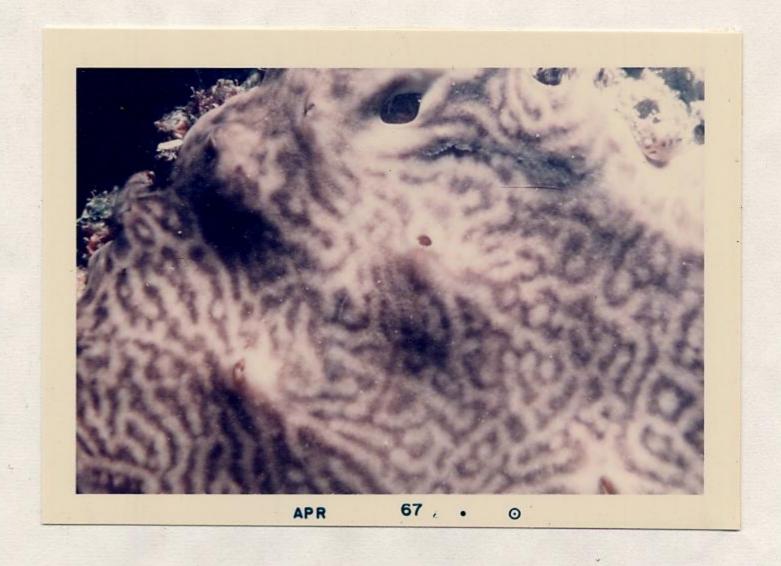


Fig. 2. <u>Chondrosia reniformis</u> aquarium close-up

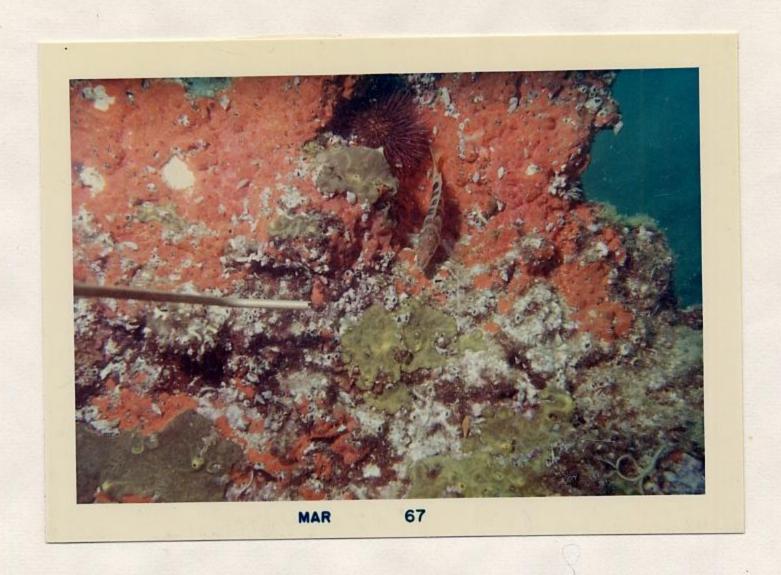


Fig. 3. Cliona viridis (brownish green) and Tylodesma sp. (orange) in situ



Fig. 4. Axinella polypoides aquarium close-up

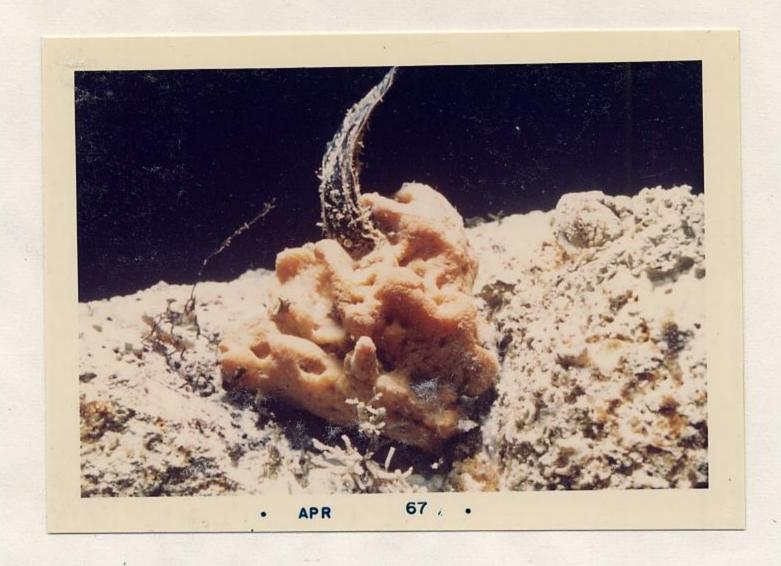


Fig. 5. Agelas oroides aquarium close-up

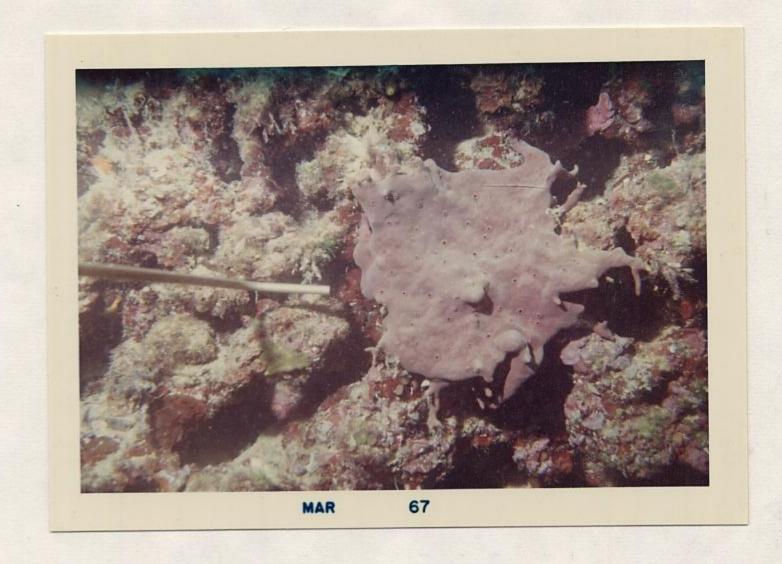


Fig. 6. Petrosia ficiformis in situ



Fig. 7. Ircinia fasciculata (black) and Cliona copiosa (olive green) in situ



Fig. 8. <u>Ircinia fasciculata</u> (another variety)

<u>in situ</u>

Fig. 9. Spicules from Leuconia sp. and Alectona millari

a to d: Leuconia sp.

e to g: Alectona millari

a and b: irregular triradiate spicules

c: regular triradiate spicule

d: oxa with one end enlarged into half a spear head.

e to g: diactinal megascleres studded with conical tubereles.

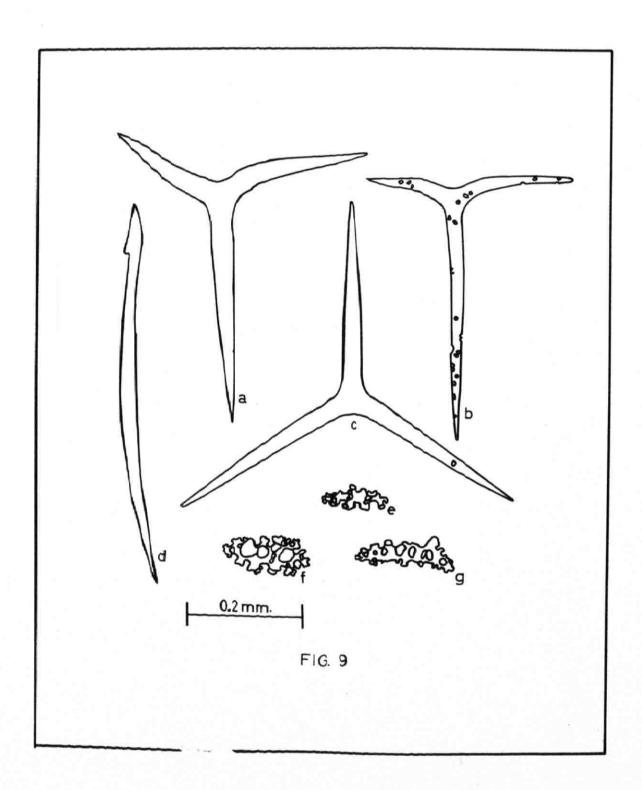


Fig. 10. Chondrilla nucula a to f: euasters

Fig. 11. Cliona viridis

a: straight tylostyle

b: curved tylostyle with axial canal

c to 1: various heads of tylostyles

Fig. 12. Cliona copiosa

a and c: styles

b: tylostyle

Fig. 13. Axinella polypoides

a and b: oxea

c and d: styles

Fig. 14. Crambe crambe

a to f: various deformed desmas

Fig. 15. Agelas oroides

a to c: various acanthostyles

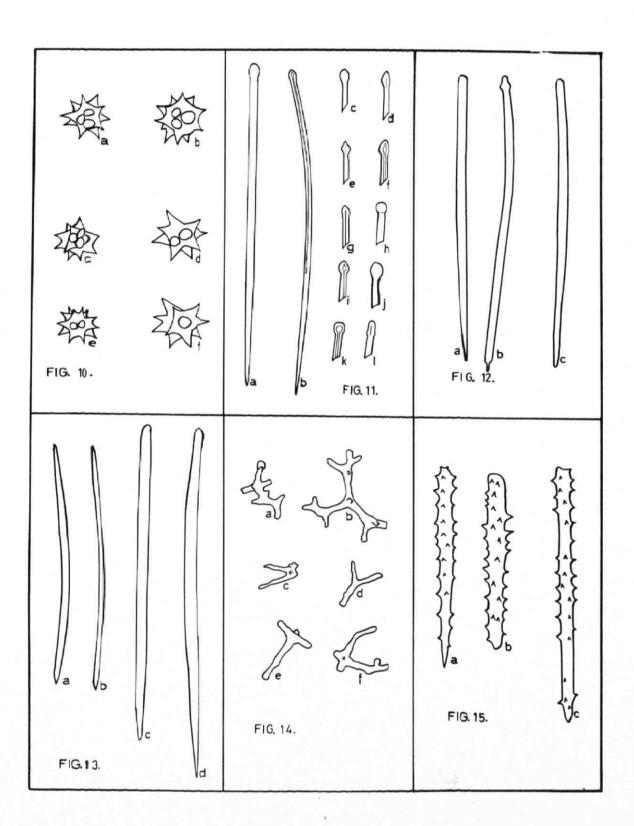
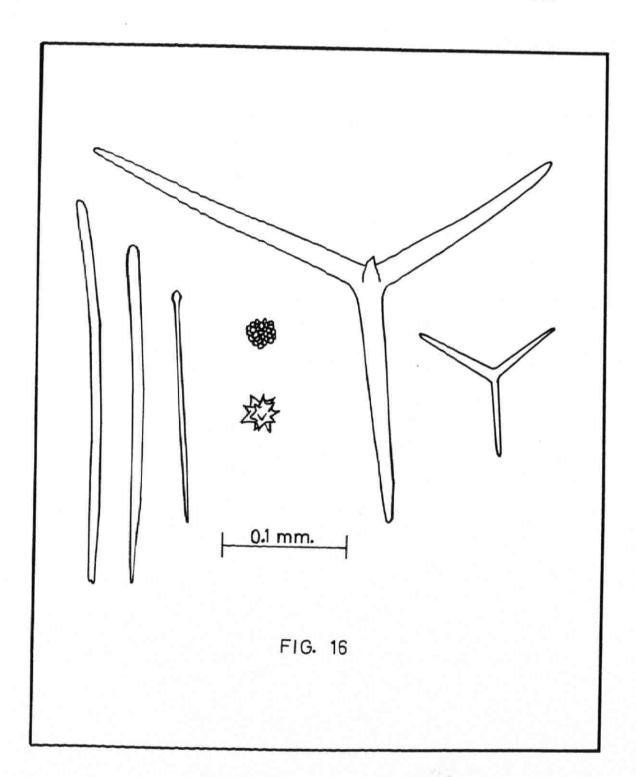


Fig. 16. Dysidea etheria

Miscellaneous spicules observed embedded in secondary fibers.



MAP OF LEBANON

