

# The Sponge Population of the Cabrera Archipelago (Balearic Islands): Characteristics, Distribution, and Abundance of the Most Representative Species

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With 7 figures and 3 tables

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**Abstract.** The abundance, distribution, and species richness of the littoral sponges (0-55 m) from the Cabrera Archipelago (Balearic Islands) were studied along light gradients from the surface to the sea bottom and from cave mouths to their inner parts. A total of 98 species (11 *Calcarea* and 87 *Demospongiae*) were recorded, 8 of which are new records for the Spanish coast.

Cluster and correspondence analyses enabled the identification of a sciophilous sponge group including three subgroups: sponges found only in semi-dark cave habitats, a subgroup common to the coralligenous, precoralligenous, and semi-dark cave biocoenoses, and a third subgroup exclusive to the coralligenous biocoenosis. A small number of photophilic species and other species having a wide bathymetric distribution made up another separate group. No species clusters for the different semi-sciophilous (either fleshy or carbonate) or photophilic seaweed communities were discernible. The number of sponge species was negatively correlated with the irradiance level.

## Problem

Although the benthic ecosystems of the Cabrera Archipelago generally correspond to those of the Northwestern Mediterranean and, more particularly, to those of the Balearic Islands, they nevertheless exhibit some peculiarities which render them especially interesting.

The clarity of the water, a sign of oligotrophy, is greater here than in most of the Balearic Islands. As a result, photophilic communities penetrate to considerably greater depths than in the nearby continental areas. The high irradiance, combined with a mean annual temperature 2-3 °C higher than along the Northeastern coast of the Iberian Peninsula (BALLESTEROS, 1989 b), facilitates a relatively sizeable presence of species with sub-tropical affinities, particularly seaweeds. Moreover, the bathymetric distribution of certain

sponges differs from that in nearby areas of the Peninsula: off Cabrera these sponges display photophilic behaviour, while in the continental littoral zone they are usually restricted to dark habitats (personal observation).

The sponge fauna of the Balearic Islands has remained largely unstudied and no systematic examination of the area has been carried out. The literature is restricted to occasional references to certain Cabrera species in a study by LACKSCHEWISCH (1886) on the calcareous sponges of Menorca, and to papers by FERRER HERNÁNDEZ (1916, 1921) and GRIESSINGER (1971).

The aim of the present study was to evaluate the general distribution patterns of the most representative sponges in the various benthic communities around the Cabrera Archipelago. The survey area constitutes an interesting system in the Northwestern Mediterranean, given its singular conditions of irradiance and the low concentrations of nutrients and organic matter (BALLESTEROS, 1989 a, b).

In addition, the authors have attempted to establish whether conventional benthic communities or biocoenoses, defined mainly in terms of botanical criteria (PÉRÈS & PICARD, 1964; BALLESTEROS, 1989 b), apply to sponge taxocoenoses.

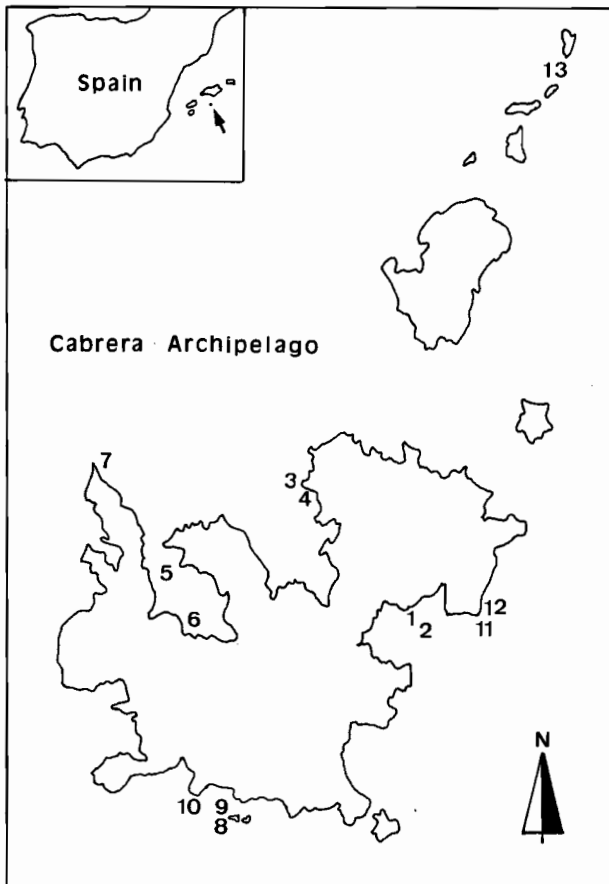


Fig. 1. Sampling stations in the Balearic Islands.

## Material and Methods

### 1. Sampling methods

Samples were taken on three oceanographic cruises: Cabrera-86 (October, 1986), Cabrera-88 (September, 1988) and Pharma Mar-I (October, 1988). The sampling stations, 13 in all (Fig. 1, Table 1), were chosen so that they would cover the largest possible number of different habitats. To this end, sites facing in different directions and with different substrata and bathymetric profiles were selected. At each station, sampling was carried out along a 4 m-wide transect from the surface to the bottom. The succession of seaweed communities (PÉRÈS & PICARD, 1964; BALLESTEROS, 1989 a, b) was recorded *in situ* and in every community the conspicuous sponges were quantified according to an index of relative abundance from 1 to 5 (1 = present; 2 = 1–10% cover; 3 = 10–20% cover; 4 = 20–40% cover; 5 = >40% cover). These indices were preferred to the

Table 1. Location and characteristics of the sampling stations. (Communities: AL, *Arbacia lixula*; CG, *Corallina granifera*; HS, *Halopteris scoparia*; CB, *Cystoseira balearica*; DM, *Dictyopteris membranacea*; CS, *Cystoseira spinosa*; PS, *Peyssonnelia squamaria*; PO, *Posidonia oceanica*; LE, *Lithophyllum expansum*; LP, *Leptopsammia pruvoti*; CP, *Caulerpa prolifera*; VV, *Vidalia volubilis*.)

st. nr.	site	orientation	depth	substratum	inclination	communities
1	Cala l'Olla (1)	SE	0–22	sand & rocks	subhorizontal	PO
2	Cala l'Olla (2)	E	1–6	rock (boulders)	subhorizontal	HL
3	Blava Cave Point	NW	0–24	rock (wall)	subvertical	CG, CB, CS
			24–30	sand	subhorizontal	PO
			30–47	rock (wall)	vertical	PS
			47–49	rock (wall)	vertical	LE
4	Blava Cave	W	3–14	rock (wall)	every	LP, DCA
5	Cabrera Bay (1)	SW	3–10	rock (boulders)	subhorizontal	HS, DM
				rock (boulders)	vertical	PS
6	Cabrera Bay (2)	SW	10–35	sand	subhorizontal	PO, CP, VV
			1–6	rock (boulders)	subhorizontal	HS
7	Llebeig Cape	N	0–7	rock (wall)	subvertical	HS
			7–35	rock (wall)	subvertical	DM
			35–45	rock (wall)	subvertical	PS
			45–55	rock (wall)	subvertical	LE
8	Estel dos Colls (1)	S	0–6	rock (wall)	subvertical	AL
			6–15	rock (wall)	subvertical	CB
			15–45	rock (wall)	subvertical	DM
			45–55	rock (wall)	subvertical	PS
				rock (crevices)	subvertical	LP
9	Estel dos Colls (2)	N	3–35	rock (wall)	subvertical	AL, CB, DM, PO
			35–40	rock (wall)	every	LP
10	Calamars Cave	SE	8–12	rock (wall)	every	LP
11	Carbassa Point (1)	N	0–27	rock (wall)	vertical	DM
				rock (wall)	overhangs	PS
			27–33	rock (boulders)	subhorizontal	DM
				rock (crevices)	subhorizontal	LP
12	Carbassa Point (2)	E		sand	subhorizontal	PO
			0–20	rock (wall)	subvertical	AL, HS
			20–32	rock (wall)	vertical	DM, PS
13	Illot Na Foradada	NE	0–18	rock (wall)	subvertical	HS
			18–24	rock (wall)	subvertical	CS
			24–35	rock (crevices)	subhorizontal	PS, LE, LP

number of individuals which, in organisms with indeterminate growth like sponges, provides a less accurate estimate of biomass. At the same time, random samples measuring 20 × 20 cm were collected from the different communities (stratified sampling) (ELLIOT, 1977; RÜTZLER, 1978) for later laboratory analysis. These samples furnished information about small, cryptic species with a much more homogeneous distribution than that of the species quantified *in situ*, making a considerable contribution to the qualitative inventory of species, but in no case noticeably affected the quantitative results (index of relative abundance = 1).

In caves the transects were laid out longitudinally, and the entire surface area of each cave was prospected.

Irradiance was measured in every community sampled by means of scalar irradiance sensor (Li-Cor) connected to a datalogger. These measurements were made at noon (GMT) and in summer (July-August). Consequently, they approximate the highest annual irradiance values in the different communities.

## 2. Numerical methods

Numerical analyses were performed on a matrix of species abundance per sample. Only rocky stations (9 in all) and species present in more than one inventory were taken into account in the different analyses. Species present in a unique inventory and those only found on sandy bottoms are included in the general species list.

Qualitative and quantitative cluster analyses were carried out using JACCARD's index of similarity and CZEKANOWSKI's distance index, respectively (LEGENDRE & LEGENDRE, 1979).

As an ordination method, correspondence analysis (LEGENDRE & LEGENDRE, 1979) was used. Species and cave stations which exhibited strong affinity between themselves were not considered in the analysis in order to better understand how the remaining stations and species behaved.

Regression analysis (Statgraphics, Statistical Graphics Corp.) was used to show the relationships between number of species and irradiance in every community sampled. The values were adjusted to a power regression model ( $Y = aX^b$ ).

## Results

### 1. List of species

#### a. Class *Demospongiae*

##### Order *Astrophorida*

###### Family *Geodiidae* GRAY, 1867

*Erylus euastrum* (SCHMIDT, 1870)

*Erylus discophorus* (SCHMIDT, 1862)

*Geodia cydonium* (JAMESON, 1811)

###### Family *Stellettidae* CARTER, 1875

*Stryphnus ponderosus* CARTER, 1875

*Penares helleri* SCHMIDT, 1864

###### Family *Pachastrellidae* CARTER, 1875

*Dercitus plicatus* SCHMIDT, 1868

##### Order *Homosclerophorida*

###### Family *Oscarellidae* LENDENFELD, 1887

*Oscarella lobularis* (SCHMIDT, 1862)

###### Family *Plakinidae* SCHULZE, 1880

*Corticium candelabrum* SCHMIDT, 1862

##### Order *Chondrosiida*

###### Family *Chondrosiidae* SCHULZE, 1877

*Chondrosia reniformis* NARDO, 1833

##### Order *Hadromerida*

###### Family *Tethyidae* GRAY, 1867

*Tethya aurantium* (PALLAS, 1766)

*Aaptos aaptos* (SCHMIDT, 1864)

###### Family *Suberitidae* SCHMIDT, 1870

*Terpios fugax* DUCHASSAING & MICHELOTTI, 1864

*Laxosuberites rugosus* SCHMIDT, 1868

###### Family *Clionidae* TOPSENT, 1887

*Cliona viridis* (SCHMIDT, 1862)

*Cliona celata* GRANT, 1826

*Cliona vastifica* HANCOCK, 1849

*Cliona schmidtii* (RIDLEY, 1881)

###### Family *Spirastrellidae* RIDLEY & DENDY, 1886

*Spirastrella cunctatrix* SCHMIDT, 1868

*Spirastrella minax* (TOPSENT, 1887)

*Diplastrella bistellata* (SCHMIDT, 1862)

Order *Axinellida*

Family *Axinellidae* RIDLEY & DENDY, 1887

*Axinella vacoleti* PANSINI, 1983

*Axinella damicornis* (ESPER, 1794)

*Axinella verrucosa* (ESPER, 1794)

*Acanthella acuta* SCHMIDT, 1862

*Phakellia rugosa* (BOWERBANK, 1866)

Family *Rhabderemiidae* TOPSENT, 1928

*Rhabderemia minutula* (CARTER, 1875)

Family *Raspailiidae* HENTSCHEL, 1923

*Raspaciona aculeata* (JOHNSTON, 1842)

Family *Agelasidae* VERRILL, 1907

*Agelas oroides* (SCHMIDT, 1864)

Order *Poecilosclerida*

Family *Mycalidae* LUNDBECK, 1905

*Mycale tunicata* (SCHMIDT, 1862)

Family *Esperiopsidae* HENTSCHEL, 1923

*Crambe crambe* (SCHMIDT, 1862)

\**Crambe tailliezi*

(VACELET & BOURY-ESNAULT, 1982)

Family *Crellidae* HENTSCHEL, 1923

*Crella elegans* (SCHMIDT, 1862)

*Crella pulvinar* (SCHMIDT, 1982)

Family *Myxillidae* TOPSENT, 1928

*Myxilla rosacea* (LIEBERKÜHN, 1859)

Family *Hymedesmiidae* TOPSENT, 1928

*Hymedesmia versicolor* (TOPSENT, 1893)

*Hymedesmia pansa* BOWERBANK, 1882

*Hymedesmia dujardini* (BOWERBANK, 1866)

Family *Phorbasidae* LAUBENFELS, 1936

*Phorbas ficitius* (BOWERBANK, 1866)

*Phorbas coriaceus* (FRISTEDT, 1885)

*Phorbas tenacior* (TOPSENT, 1925)

*Hamigera hamigera* (SCHMIDT, 1862)

Family *Clathriidae* HENTSCHEL, 1923

*Antho involvens* (SCHMIDT, 1864)

Order *Halichondrida*

Family *Halichondriidae* VOSMAER, 1887

\**Spongisorites intricatus* (TOPSENT, 1892)

*Spongisorites genitrix* (SCHMIDT, 1870)

*Ciocalypta penicillus* BOWERBANK, 1864

Family *Hymeniacionidae* LAUBENFELS, 1934

*Hemimycale columella* (BOWERBANK, 1874)

*Batzella inops* (VOSMAER, 1891)

*Ulosa stuposa* (ESPER, 1794)

*Dictyonella obtusa* (SCHMIDT, 1862)

*Dictyonella plicata* (SCHMIDT, 1880)

*Dictyonella marsilli* (TOPSENT, 1893)

*Dictyonella incisa* (SCHMIDT, 1880)

Order *Petrosiida*

Family *Petrosiidae* VAN SOEST, 1986

*Petrosia ficiformis* (POIRET, 1789)

Order *Haplosclerida*

Family *Haliclonidae* LAUBENFELS, 1932

*Haliclona mediterranea* GRIESSINGER, 1971

\**Siphonochalina subcornea* GRIESSINGER, 1971

*Adocia simulans* (JOHNSTON, 1842)

\**Adocia varia* SARÀ 1958

Family *Renieridae* RIDLEY, 1884

*Reniera mucosa* GRIESSINGER, 1971

*Reniera sarai* PULTIZER-FINALI, 1969

*Reniera cratera* SCHMIDT, 1864

\**Reniera aquaeductus* SCHMIDT, 1862

\**Reniera fulva* TOPSENT, 1893

*Dendroxea lenis* (TOPSENT, 1892)

Order *Dictyoceratida*

Family *Dysideidae* GRAY, 1867

*Dysidea avara* (SCHMIDT, 1862)

*Dysidea fragilis* (MONTAGU, 1918)

*Spongionella pulchella* (SOVERBY, 1804)

Family *Spongiidae* GRAY, 1867

*Spongia officinalis* LINNÉ, 1759

*Spongia agaricina* (PALLAS, 1766)

*Spongia virgultosa* (SCHMIDT, 1868)

*Hippospongia communis* (LAMARCK, 1813)

*Oligoceras collectrix* SCHULZE, 1880

Family *Thorectidae* BERGQUIST, 1978

*Ircinia fasciculata* (PALLAS, 1766)

*Ircinia variabilis* (SCHMIDT, 1862)

*Ircinia oros* (SCHMIDT, 1864)

*Ircinia dendroides* (SCHMIDT, 1862)

*Sarcotragus spinosula* (SCHMIDT, 1862)

*Sarcotragus muscarum* (SCHMIDT, 1864)

*Faciospongia cavernosa* (SCHMIDT, 1862)

*Cacospongia scalaris* SCHMIDT, 1862

*Cacospongia mollior* SCHMIDT, 1862

Order *Dendroceratida*

Family *Aplysillidae* VOSMAER, 1883

*Aplysilla sulfurea* SCHULZE, 1878

*Chelonaplysilla noevus* (CARTER, 1876)

*Pteraplysilla spinifera* (SCHULZE, 1879)

*Hexadella racovitzai* TOPSENT, 1896

Family *Halisarcidae* VOSMAER, 1885

*Halisarca dujardini* JOHNSTON, 1842

Order *Verongida*

Family *Aplysinidae* HYATT, 1877

*Aplysina cavernicola* (VACELET, 1958)

*Aplysina aerophoba* SCHMIDT, 1862

b. Class *Calcarea*Order *Calcinea*Family *Clathrinidae* MINCHIN, 1900*Clathrina coriacea* (MONTAGU, 1812)*Clathrina clathrus* (SCHMIDT, 1864)\**Clathrina rubra* SARÀ, 1958*Clathrina cerebrum* (HAECKEL, 1872)Order *Calcaronea*Family *Leucosoleniidae* MINCHIN, 1900*Leucosolenia variabilis* HAECKEL, 1870*Leucosolenia botryoides*

(ELLIS &amp; SOLANDER, 1786)

Family *Grantiidae* DENDY, 1892*Leuconia solida* (SCHMIDT, 1862)\**Leuconia crambessa* (HAECKEL, 1870)Family *Sycettidae* DENDY, 1892*Sycon ciliatum* (FABRICIUS, 1780)*Sycon raphanus* SCHMIDT, 1862*Sycon elegans* (BOWERBANK, 1866)

\* new records for the Spanish littoral.

## 2. Field description of sponge distribution along a light gradient

The noon irradiance values in summer ranged between  $700 \mu\text{E} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$  and  $2 \mu\text{E} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$  from the most photophilic to the most sciophilous community (Table 2). A negative correlation was found between the mean percentage of surface irradiance and the number of sponge species. The values fit on a power regression model ( $r^2 = 0.93$ ,  $P < 0.01$ ) (Fig. 2 A).

In all the photophilic communities of the Archipelago, *I. variabilis*, *I. fasciculata*, *S. spinosula*, *C. crambe*, *C. viridis*, *C. celata*, and *H. hamigera* were the most conspicuous sponges. Among seaweeds rhizoids *A. varia*, *I. dendroides*, *S. virgulosa*, *S. intricatus*, *S. subcornea* and certain seasonal calcareous sponges, particularly *S. raphanus*, *S. ciliatum*, and *L. variabilis*, were also found. Occasional vestigial specimens of *D. avara*, *H. columella*, and *A. aerophoba* were recorded only in the case of a dense community of the seaweed *Halopteris scoparia* below 5 m. In these communities, *C. crambe* grew on vertical and steep sloping rock faces, *I. variabilis*, with an abundance of symbiotic cyanophytes, presented branched, creeping forms among the seaweeds, while *H. hamigera*

Table 2. Absolute irradiance values (at noon) and percentage of the surface irradiance in every community sampled (BALLESTEROS & ZABALA, unpublished data).

community	irradiance ( $\mu\text{E} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ )	% of surface irradiance
<i>Arbacia lixula</i>	700–1300	30–60
<i>Corallina granifera</i>	700–900	30–40
<i>Cystoseira balearica</i>	400–700	15–30
<i>Halopteris scoparia</i>	400–700	15–30
<i>Cystoseira spinosa</i>	150–430	7–20
<i>Dictyopteris membranacea</i>	150–430	7–20
<i>Peyssonnelia squamaria</i>	100–200	4–10
<i>Lithophyllum expansum</i>	55–110	2–5
<i>Leptopsammia pruvoti</i>	5	0.5–2

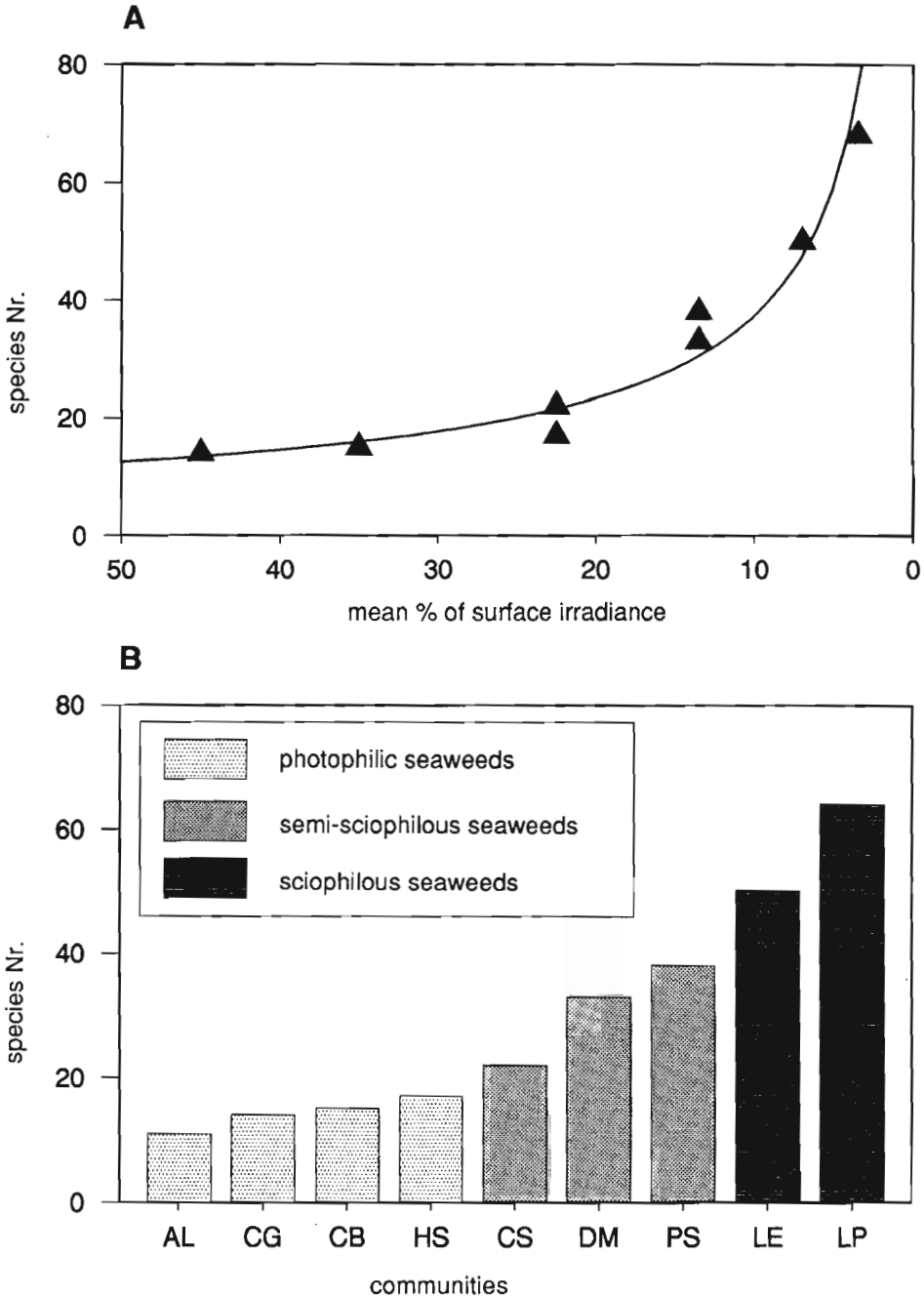


Fig. 2. A. Power regression analysis between number of sponge species and irradiance in rocky communities ( $r^2 = 0.93$ ;  $P < 0.01$ ). B. Variation in the number of sponge species from the most photophilic to the most sciophilous community. (Communities: AL, *Arbacia lixula*; CG, *Corallina granifera*; CB, *Cystoseira balearica*; HS, *Halopteris scoparia*; CS, *Cystoseira spinosa*; DM, *Dictyopteris membranacea*; PS, *Peyssonelia squamaria*; LE, *Lithophyllum expansum*; LP, *Leptopsammia pruvoti*.)

Table 3. Matrix of species abundance per sample used in numerical analysis; arrangement according to the groups resulting from the quantitative cluster analyses.

	community sample number	P2		P1										S																											
		LP	LP	LE	LE	LE	LE	LE	PS	PS	PS	PS	PS	PS	PS	PS	DM	DM	DM	DM	DM	DM	DM	DM	CS	CS	HS	HS	HS	HS	CBC	CB	AL	AL	AL	AL					
P2	57 <i>A. varia</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
	46 <i>H. columella</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
	85 <i>H. dujardini</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	34 <i>M. rosacea</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	96 <i>S. ciliatum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	55 <i>S. subcornea</i>	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
P1	30 <i>C. crambe</i>	2	1	1	1	.	.	1	.	3	2	1	.	4	.	2	3	3	4	3	3	3	4	3	3	5	2	2	4	4	.	.	.	.	.	.	.				
	15 <i>C. celata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	16 <i>C. vastifica</i>	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	14 <i>C. viridis</i>	1	3	2	1	.	1	2	2	2	2	2	.	1	.	1	2	2	3	2	2	2	3	3	3	2	2	3	3	3	4	.	.	.	.	.	.	.	.		
	41 <i>H. hamigera</i>	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2	.	.	1	2	3	.	1	.	2	2	.	.	.	.	.	.		
	72 <i>I. fasciculata</i>	.	1	.	.	1	.	1	2	2	.	1	2	.	2	.	1	2	2	3	2	2	3	3	4	4	4	2	3	3	3	4	.	.	.	.	.	.	.		
	74 <i>I. spinosula</i>	.	.	1	.	.	.	.	3	2	.	1	1	2	.	1	2	3	2	1	2	3	.	.	3	2	4	4	3	5	.	.	.	.	.	.	.	.	.		
	73 <i>I. variabilis</i>	2	2	.	.	.	.	.	.	1	.	1	1	.	.	.	2	.	.	4	.	2	2	2	4	2	3	5	.	3	4	.	.	.	.	.	.	.			
	92 <i>L. variabilis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	1	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	
	69 <i>S. virgultosa</i>	1	2	1	2	1	1	1	.	.	3	2	.	3	.	2	.	.	.	.	.	3	2	3	3	2	.	2	.	.	.	.	.	.	.	.	.	.	.		
S3	42 <i>A. involvens</i>	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
	47 <i>B. inops</i>	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	65 <i>D. fragilis</i>	.	.	1	.	2	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	98 <i>S. elegans</i>	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
19 <i>S. minax</i>	.	.	1	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
S2	52 <i>D. incisa</i>	1	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	50 <i>D. plicata</i>	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	6 <i>D. plicatus</i>	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	35 <i>H. versicolor</i>	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	59 <i>R. sarai</i>	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	4 <i>S. ponderosus</i>	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	20 <i>D. bistellata</i>	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	63 <i>D. lenix</i>	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	51 <i>D. marshilli</i>	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	3 <i>G. cydonium</i>	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	77 <i>I. dendroides</i>	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	25 <i>Ph. rugosa</i>	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	60 <i>R. cratera</i>	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	62 <i>R. fulva</i>	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	11 <i>A. aaptos</i>	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	*86 <i>A. cavernicola</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	*39 <i>A. coriaceus</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	*38 <i>A. fictitius</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	*81 <i>A. sulphurea</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	*82 <i>Ch. noevus</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
*90 <i>C. rubra</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
*80 <i>C. mollior</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
*37 <i>H. dujardini</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
*71 <i>O. collectrix</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
* 5 <i>P. helleri</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
*26 <i>Rh. minutula</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
*61 <i>R. aqueductus</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
*12 <i>T. fugax</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
44 <i>S. genitrix</i>	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
33 <i>C. pulvinar</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
8 <i>C. candelabrum</i>	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
75 <i>I. muscarum</i>	.	2	.	.	.	.	2	.	.																																

Table 3. Continued.

	P2		P1										S																
	LP 22	LP 5	LE 13	LE 21	LE 30	LE 4	LE 17	PS 25	PS 24	PS 29	PS 12	PS 8	PS 3	DM 20	DM 19	DM 15	DM 7	DM 16	DM 11	CS 2	CS 28	HS 27	HS 6	HS 10	CB 1	CB 14	AL 23	AL 18	
24 <i>A. acuta</i>	2	3	2	.	4	1	.	1	2	4	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
22 <i>A. damicornis</i>	1	3	2	.	2	2	3	4	.	2	2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
28 <i>A. oroides</i>	3	3	4	.	1	2	.	.	.	.	3	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
40 <i>P. tenacior</i>	2	1	1	3	4	3	3	4	4	4	3	1	2	2	1	.	.	.	2	1	.	2	.	.	.	.	.	.	
9 <i>Ch. reniformis</i>	2	3	.	2	2	2	3	2	.	1	3	1	1	1	.	1	.	2	3	.	.	.	.	.	.	.	.	.	
89 <i>C. clathrus</i>	1	3	2	1	3	3	2	.	2	3	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
88 <i>C. coriacea</i>	1	2	2	1	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
79 <i>C. scalaris</i>	2	2	1	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
64 <i>D. avara</i>	2	2	2	.	4	2	.	4	4	4	3	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	
49 <i>D. obtusa</i>	2	1	1	.	1	1	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
1 <i>E. euastrum</i>	3	4	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
78 <i>F. cavernosa</i>	3	2	2	2	4	4	2	2	1	3	1	2	.	1	.	2	2	.	.	2	.	3	.	.	.	.	.	.	
70 <i>H. communis</i>	1	1	2	2	1	3	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
84 <i>H. racovitzae</i>	1	1	2	1	1	1	.	.	1	2	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	
76 <i>I. oros</i>	3	3	.	3	.	.	.	3	.	1	.	1	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	
7 <i>O. lobularis</i>	2	2	2	1	3	2	1	3	4	3	3	.	2	1	.	1	.	1	2	.	2	.	.	.	.	.	.	.	
83 <i>P. spinifera</i>	3	3	1	2	1	1	.	.	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
53 <i>P. ficiformis</i>	3	3	1	.	.	.	.	.	1	.	1	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	
27 <i>R. aculeata</i>	1	1	.	1	1	.	1	1	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
58 <i>R. mucosa</i>	2	1	3	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
18 <i>S. cunctatrix</i>	3	4	4	2	2	.	2	.	2	4	2	.	2	.	.	1	2	3	.	.	.	2	.	.	.	.	.	.	
43 <i>S. intricatus</i>	2	2	1	.	1	3	1	1	.	1	.	1	.	.	.	1	.	.	1	.	1	.	.	.	2	.	.	.	
67 <i>S. officinalis</i>	.	1	1	1	.	1	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
56 <i>A. simulans</i>	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
17 <i>C. schmidti</i>	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	
54 <i>H. mediterranea</i>	2	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
97 <i>S. raphanus</i>	1	.	.	.	.	1	.	1	1	1	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	

grew only in small patches in the somewhat darker enclaves. *C. viridis* and *C. celata*, always in the form of growth stage  $\alpha$ , proliferated where the seaweeds were sparse. These last two species were particularly abundant in the *Arbacia lixula* community. *S. spinosula*, *I. fasciculata*, and *I. variabilis* attained the highest abundance in the above community, especially on horizontal surfaces; some specimens of *S. spinosula* were up to 50 cm diameter. Observations of these three species growing together in contact suggested that *S. spinosula* grows faster, as it often surrounded the other two species.

Two types of semi-sciophilous communities predominated in the Archipelago's broad infralittoral zone: the *Dictyopteris membranacea* community at depths between 10 m and 35 m, and that of *Cystoseira spinosa* between 7 m and 25 m in more sheltered areas. The associated sponges varied both quantitatively and qualitatively according to depth. The highest species diversity was recorded on vertical rock faces below 20 m. *S. spinosula* and *C. crambe* were also abundant there, and *O. lobularis* – less sciophilous than in the adjoining continental littoral (personal observation) – was rather common and frequently found growing on the bryozoan *Myriapora truncata*. *D. avara*, *I. muscarum*, *P. ficiformis*, *P. tenacior*, *F. cavernosa*, *S. subcornea*, and *S. virgultosa* were abundant on vertical or slightly overhanging rock faces or in the deepest parts of the *Dictyopteris membranacea* community. *A. varia*, *H. hamigera*, *I. dendroides*,

and *L. botryoides* occasionally recorded among the seaweed rhizoids. Most of these species were not found at similar depths in the *Cystoseira spinosa* community.

In the somewhat more sciophilous community of *Peyssonnelia squamaria* (precoralligenous), mainly at depths from 25 m to 55 m but also established in cracks and on overhanging rock faces at lesser depths, few new species were recorded (*P. fictitius*, *S. raphanus*, *H. racovitzai*, and *S. cunctatrix*); however, the most sciophilous species in all the above-mentioned communities presented substantial biomass levels. The sponge population exhibited affinities either with that of the *Dictyopteris membranacea* community or with that of the *Lithophyllum expansum* (coralligenous) community, depending on the depth.

The two communities richest in sponges (semi-dark caves: *Leptopsammia pruvoti* community, and coralligenous: *Lithophyllum expansum* community) presented a high percentage of different species (30%). Species richness and abundance were higher in semi-dark caves, with 21 exclusive species (Table 3).

The sponge biomass in the *Leptopsammia pruvoti* community decreased progressively from the cave mouths towards the inner parts, as previously reported for caves (SARÀ, 1961; POULIQUEN, 1972; PANSINI & PRONZATO, 1982; HARMELIN, 1985; BIBILONI *et al.*, 1989). The number of species, on the other hand, increased after a certain distance from the cave mouth but then fell off again further inside. The most characteristic species in the darkest zones were *P. rugosa*, *D. bistellata*, *D. lenis*, *R. mucosa*, *R. minutula*, and *P. ficiformis*.

In summary, the number of sponges on rocky bottoms increased considerably from the most photophilic communities to the most sciophilous ones (Figs. 2A and B), while sponge biomass was higher in certain photophilic communities (*e.g.*, *Arbacia lixula*) than in certain sciophilous ones (*e.g.*, *Peyssonnelia squamaria*) (Table 3).

As expected, there was a distinct paucity of sponges in soft bottom communities, both in the infralittoral (*Posidonia oceanica*, *Caulerpa prolifera*) and circalittoral (*Vidalia volubilis*). Nevertheless it should be noted that, in Cabrera, some species (*e.g.*, *C. elegans* and *H. columella*) were common on soft bottoms with greater sedimentation and probably more organic matter than on the rock faces, while they were scarce on rocky bottoms. Curiously, these species are among the most abundant in rocky areas on the nearby continental littoral (BOURY-ESNAULT, 1971; personal observations).

*C. penicillum* and *A. simulans* were other species present on and characteristic of soft bottoms.

### 3. Numerical results on sponge distribution

Species clustering using JACCARD'S similarity index (Fig. 3) yielded two main groups of sponges segregated at a similarity level of about 0.1. Group S included all the sciophilous species, corresponding to the communities of *Leptopsammia pruvoti* (semi-dark caves), *Lithophyllum expansum* (coralligenous) and *Peyssonnelia squamaria* (precoralligenous). Within this group three subgroups can be differentiated: (S1) formed by species common to the communities of *Leptopsammia pruvoti*, *Lithophyllum expansum*, and *Peyssonnelia squamaria*;

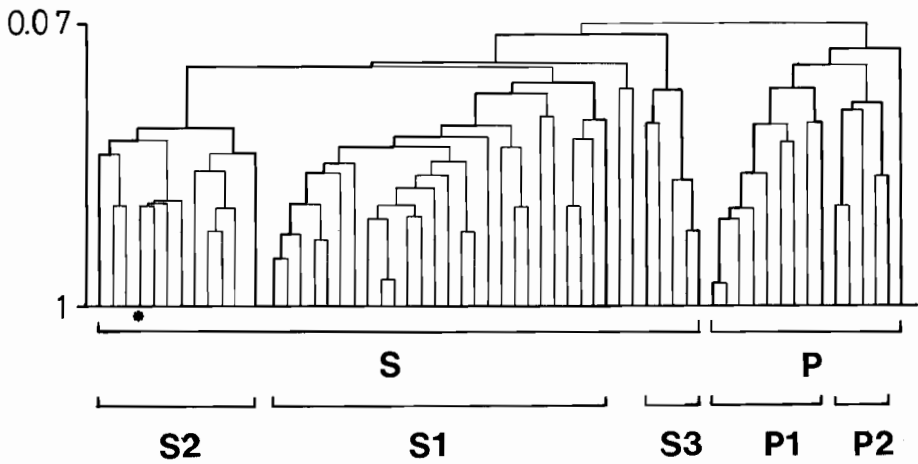


Fig. 3. Qualitative cluster of species based on the presence/absence data from the matrix of Table 3. (S) sciophilous species; (S1) species common to the coralligenous, precoralligenous, and semi-dark caves communities; (S2) species exclusive to caves; (S3) species exclusive to the coralligenous biocoenosis; (P1) photophilic species; (P2) broadly distributed species. (\*) corresponds to those species exhibiting the same behaviour in the analysis, see Table 3)

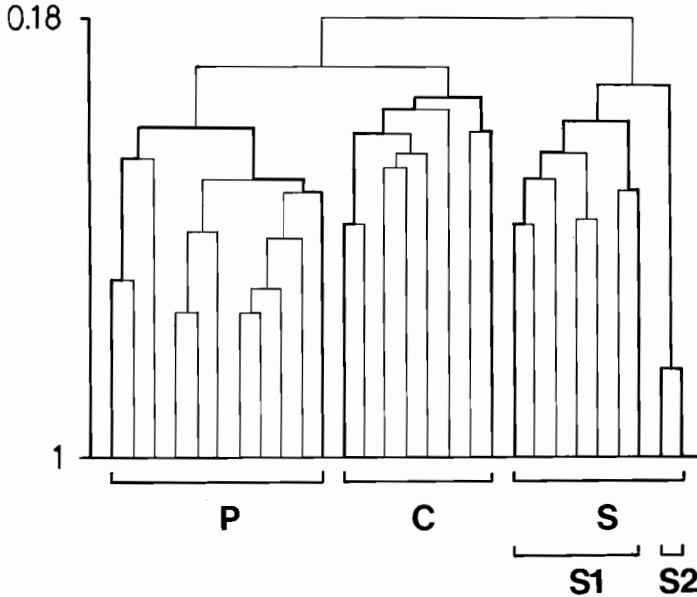


Fig. 4. Qualitative cluster of samples based on the presence/absence data from the matrix of Table 3. (S) samples from sciophilous communities; (S2) samples from caves; (S1) samples from the remaining sciophilous communities; (P) samples from the photophilic communities together with those of the *Cystoseira spinosa* community; (C) samples from semi-sciophilous communities.

(S2) species dwelling almost exclusively in caves; and (S3) species present only in the *Lithophyllum expansum* community. Photophilic (P1) species and those with a broad bathymetric distribution (P2) were aggregated in group P, without further differentiation into subgroups pertaining to the various photophilic and semi-sciophilous communities sampled.

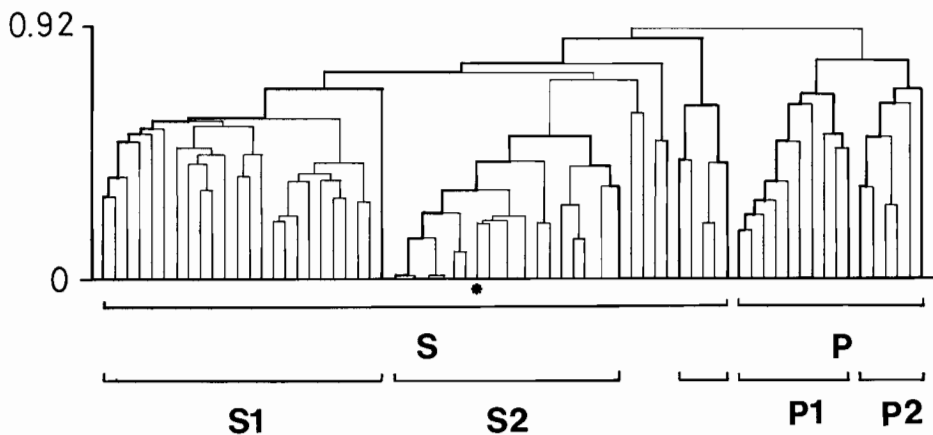


Fig. 5. Quantitative cluster of species based on the abundance data matrix presented in Table 3. Abbreviations of groups as in Figure 3. (\* corresponds to those species showing the same behaviour in the analysis, marked with asterisks in Table 3.)

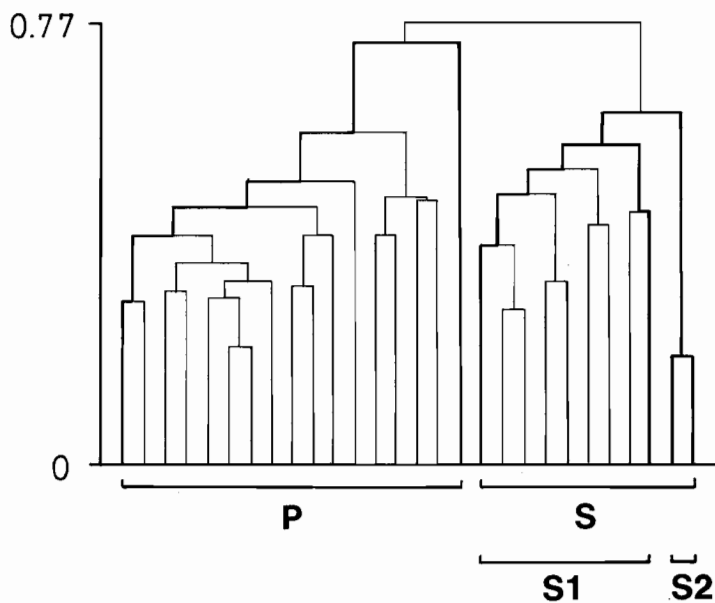


Fig. 6. Quantitative cluster of samples based on the data matrix presented in Table 3. (S1) samples from the sciophilous biocoenoses: coralligenous, precoralligenous and semi-dark caves; (S2) samples from caves.

The qualitative clustering of samples (Fig. 4) indicated three groups (S, P, and C) differentiated at a similarity level of 0.2. Group S contained the samples of the sciophilous communities (PS, LE, and LP). Within this group, the cave samples (S1) were clearly separate from the rest (S2). Group P included all samples from the photophilic seaweeds communities (CB, AL, and HS), those of the *Cystoseira spinosa* community (CS), and two samples of the *Dictyopteris membranacea* community (DM). Group C encompassed samples from the middle depths, corresponding to communities of semi-sciophilous fleshy and calcified seaweeds (DM and PS).

The pattern from the qualitative classification was basically repeated in the quantitative clustering of species (Fig. 5). The quantitative clustering of samples (Fig. 6) differentiated only two groups (S and P), with the samples of the photophilic and semi-sciophilous fleshy seaweed communities (CB, HS, AL, DM, and CS) being grouped together. Here again the precoralligenous biocoenosis behaved like an intermediate group; it formed part of group S or group P according to the level of irradiance at the sampling site, although it exhibited a stronger tendency to be grouped with the sciophilous communities.

The distribution of species and samples along the first axis of the correspondence analysis (26% of the explained variance) (Fig. 7) is ascribable to an irradiance gradient: the species and the samples of the most sciophilous communities (*i. e.*, the coralligenous) were located in the negative sector, while those of the most photophilic communities (photophilic seaweeds) fell in the positive sector. Although these two groups were clearly discriminated, the rest of the species and samples – belonging to the semi-sciophilous communities – were distributed between the two without any clear pattern. The second axis (11% of the variance) appears to be related, to a certain extent, to the bearing of the sampling transect and, indirectly, to light intensity. Samples from the transects facing North were located in the positive sector, and those bearing South and East in the negative sector. The direction only seems significant in the case of the deepest communities (PS and LE), whose species helped to define this axis; in the shallow levels the light intensity was in all cases sufficient so that the orientation did not affect the presence and/or the abundance of species. The resulting ordination supported the results obtained with the cluster analyses.

## Discussion

The level of irradiance exerts a decisive, though indirect, effect on the presence and abundance of sponge species in the first 55 m of the littoral zone (Figs. 2 A and B) by influencing the seaweed production (BALLESTEROS, 1989 a) and, thus, the ability of the seaweeds to compete with sponges for the substratum.

A large number of species (67) was a feature of the strongly sciophilous communities, whereas no species were present exclusively in photophilic communities.

The horny sponges (Orders *Dendroceratida* and *Dictyoceratida*) were most abundant in the study area. *I. fasciculata*, *I. variabilis*, *S. spinosula*, and *F. cavernosa* were distributed along practically the entire bathymetric profile between 0 m and 55 m. These species, together with *I. oros*, *S. muscarum*, *S. agaricina*,

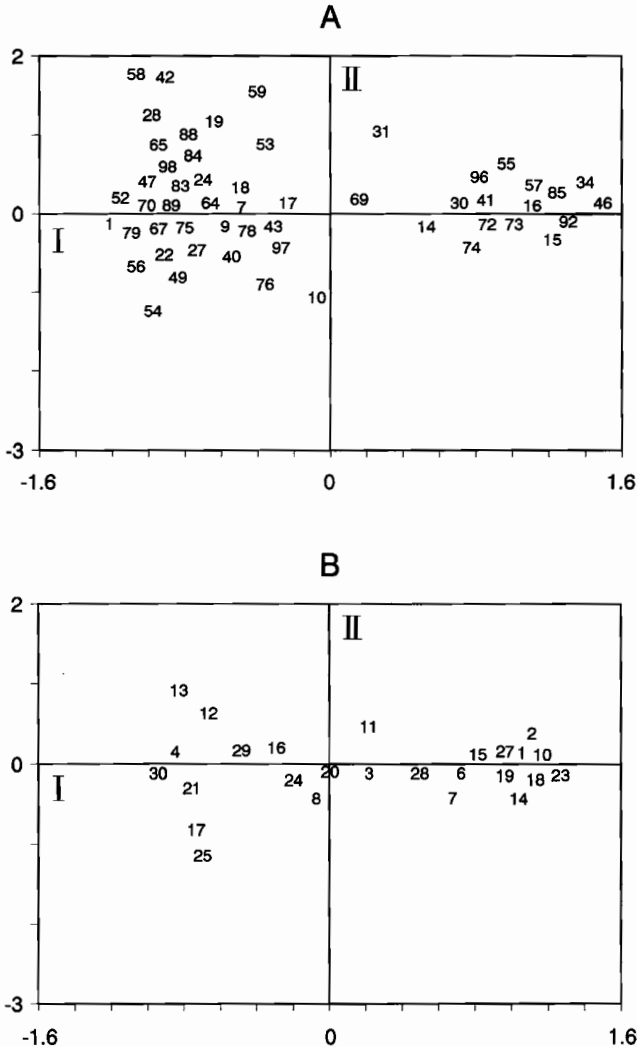


Fig. 7. A. Distribution of species in the space generated by the first two axes of the correspondence analysis. B. Distribution of samples in the same space.

and *D. avara*, accounted for the largest sponge biomass around the Archipelago. Among the commercial horny sponges, only *S. agaricina* and *H. communis* were more abundant than on the continental littoral, whereas *S. officinalis* was less frequent (personal observation).

*S. spinosula* appears to exhibit distinct subtropical affinities: in the photophilic habitats of Cabrera, its growth rates enabled substratum competition even with fleshy seaweeds, while in the northeastern Iberian littoral it is relegated to sciophilous zones (semi-dark caves and coralligenous biocoenoses) by other, faster-growing photophilic organisms (VACELET, 1959). Field observations in which this species surrounded *I. fasciculata* and *I. variabilis* indicate that the adaptation of the species to the oligotrophic waters of Cabrera is efficient

enough to surpass the growth rates of the other two species, which have developed symbiotic relationships with cyanobacteria (SARÀ, 1964, 1971).

The distributional pattern of *S. spinosula* could be compared with that of the sponge *S. officinalis* and the cnidarian *Madracis farenensis*, both much more sciophilous in the Western Mediterranean than in the warmer Eastern Mediterranean (VACELET, 1964). The photophilic behaviour of all these species is therefore a good indicator of warm and oligotrophic conditions.

The sponge groups or taxocoenoses in the Cabrera Archipelago do not exactly match conventional Mediterranean benthic communities (PÉRÈS & PICARD, 1964; VACELET, 1959; GILI & ROS, 1982; BALLESTEROS, 1989 a, b). The clear separation between the coralligenous and semi-dark caves communities discernible in cluster and correspondence analyses is hardly marked in the adjoining continental littoral (BOURY-ESNAULT, 1971; HARMELIN *et al.*, 1985; personal observations). This could be due to insufficient darkness in the Cabrera coralligenous biocoenoses despite their depth; the result is a relative paucity of species compared to what would be expected in coralligenous biocoenoses under optimal conditions.

The clustering of the semi-sciophilous *Cystoseira spinosa* community with the photophilic communities was probably due to the thallus arrangement of the seaweeds; it is not dense enough to produce the sciophilous conditions required by the sponges in the basal stratum of the community.

No species clusters pertaining to the different communities of semi-sciophilous or photophilic seaweeds were identifiable from either the qualitative or the quantitative analyses. The growth rates of the seaweeds in all these communities are high (BALLESTEROS, 1989 a, b) and, in consequence, only those sponges displaying special adaptations can survive. Four types of adaptive strategies have been developed by such sponges to compete successfully with seaweeds for the substratum: (1) chemical defenses (AMADE *et al.*, 1987; URIZ *et al.*, 1991) as *C. crambe*, (2) boring into and growing under the substratum, typical of *Cliona* species, (3) creeping (*I. dendroides*, *S. subcornea*, *A. varia*, *S. virgultosa*, *F. cavernosa*) or epiphytic (*L. variabilis*, *L. botryoides*, *S. ciliatum*) habits, exhibited by usually small, cryptic species and, (4) symbiosis with zooxanthellae (as *C. viridis*), cyanobacteria (SARÀ, 1964, 1971) or bacteria (VACELET *et al.*, 1989), which increases sponge growth rates, enabling them to attain a high biomass, particularly in communities perturbed by the predation of sea urchin, *Arbacia lixula*. This last strategy was mainly exhibited by horny sponges.

Due to the differences in sampling effort and methods in previous works, comparisons of the sponge distribution in Cabrera with that from other Mediterranean areas remain approximate. Moreover, quantitative, statistically usable data on littoral sponges are scarce in the Mediterranean, except in the case of very concrete habitats such as the *Posidonia* meadows (PANSINI & PRONZATO, 1985) or the caves (RUSS & RÜTZLER, 1959; PANSINI & PRONZATO, 1982; BALDUZZI *et al.*, 1989). Only the methodology employed in the latter work (BALDUZZI *et al.*, 1989) is comparable with that of the present study; consequently, certain differences between caves from Naples and Cabrera can be pointed out.

The total number of species was similar in both localities (72 and 64, respectively), but only 32 % of the species were common to both localities. This

could be attributed both to the double isolation of caves on islands (HARMELIN, 1985) and to the different structure of the caves from the two localities; those of Cabrera are more photophilic and, as a consequence, their semi-dark cave biocoenosis is much more extensive.

## Summary

A total of 98 sponge species (11 *Calcarea* and 87 *Demospongiae*) were identified around the Cabrera Archipelago; 8 were new records for the Iberian Peninsula. Cluster and correspondence analyses differentiated a group of sciophilous species from another group made up of two subgroups (photophilic species and those with a broad bathymetric distribution). Within the sciophilous group three subgroups were distinguishable: species from caves, species exclusively dwelling in the coralligenous biocoenosis, and species common to caves, coralligenous, and precoralligenous biocoenoses. There were no groups of species distinctly characteristic of the different photophilic or semi-sciophilous communities. Regarding the sponge population, the *Dictyopteris membranacea* community was qualitatively closer to that of the precoralligenous biocoenosis, although quantitatively it was included in the group of photophilic seaweeds.

Irradiance was the main factor determining the number of species of the sponge population; its action is presumably indirect, positively influencing seaweed growth and, therefore, competition with sponges for the substratum. On the other hand, sponge abundance was higher in some photophilic communities than in certain sciophilous ones.

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