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Taxonomy of some sponges (Porifera: Demospongiae) collected from the Aegean Sea and description of a new species

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A systematic survey of the sponge fauna of the Aegean Sea has been carried out. Twenty-eight stations located in the Aegean Sea were explored and 59 species of Demospongiae were collected from this particular area, which covers a broader geographical area of the Aegean and Cretan Seas. Some of the species found are poorly known for the Mediterranean fauna, like *Cerbaris curvispiculifera* and *Spongosorites flavens*, which are reported for the first time in the Aegean Sea and generally in the eastern Mediterranean. The species *Axinyssa michaelis* sp. nov. (Halichondriidae: Halichondrida) is new to science. In this paper, a description of the new species is presented along with the description of the first recorded species in the Aegean Sea. In addition to the taxonomic description of the species, some ecological data and a distribution pattern are also presented.

INTRODUCTION

Local benthic taxonomical and ecological studies are important for many reasons such as faunal description and detection and/or assessment of the impact of trawling or pollution. For some areas of the Mediterranean Sea, like those of the Aegean Sea, our knowledge on the composition, diversity and abundance of the sponge fauna is limited due to the minimal research effort carried out in this area. The basis for the description and the study of the sponge fauna composition is primarily the identification of the composing species. Taxonomical papers on the sponges are nowadays scarce and they focus mainly on the areas of northern Aegean and the coastal areas of mainland of Hellas (Voultsiadou & Vafidis, 2004; Voultsiadou, 2005a). The available bibliography on the sponge fauna of the central and North Aegean Sea as well as of the Cretan Sea is rather limited and the available papers refer only to the description of a few new species (Rützler & Broomley, 1981; Pansini, 1996). References have also been made to certain institute and museum collections such as Topsent (1920), Vacelet (1959), Griessinger (1971) and Pulitzer-Finali & Pronzato (1980).

As a consequence, the number of publications on sponges for this area is limited, mainly because of the absence of proper data. The data available are of extreme local interest, i.e. the fauna of Milos Island (Morri et al., 1999), while other refer to a restricted number of species, i.e. commercial sponges (Castritsi-Catharios, 1998) or to the fauna of one restricted bathyal zone, i.e. the circalittoral (Pérèz & Picard, 1958).

Especially for the circalittoral zone, the first research programme which gave adequate and reliable data for a vast area of the central and southern Aegean Sea islands and which contains information that could be broadly used, was conducted in 1995 (Castritsi-Catharios, 1995). The sponge diversity that emerged from the first data analysis, indicated a spatial differentiation between North and South Aegean Sea (Kefalas et al., 2003). The combination and comparison of data from adjacent broad marine areas (Levantine Sea, northern Aegean Sea), or different ecological zones (sublittoral, bathyal) showed that there is a dissimilarity among the North Aegean, the South Aegean and the Levantine Sea, as well as a clear distinction between the sublittoral, circalittoral and bathyal zones of the eastern Mediterranean Sea (Voultsiadou, 2005b).

It is generally accepted that the circallitoral zone of the western Mediterranean is one of the richest areas in number of species and in diversity of forms (Maldonado, 1992), especially in waters deeper than 100 m, where the number of endemic sponge species is rapidly increasing.

In this study, we have attempted to provide both taxonomical (mainly) and ecological (some) information for the sponge fauna of the Aegean Sea islands. In addition, a collection of 59 species of Demospongiae is reported. Among the collected sponges, several well-known Mediterranean species are recorded. Some of the species detected are considered rare for the Mediterranean fauna. Furthermore, the species *Axinyssa michaelis* sp. nov. is new to science and the description of this new species is presented along with that of the rare species, indicating those first recorded in the Aegean Sea.

MATERIALS AND METHODS

Sampling method: all the samplings were carried out using the dredge gear ‘Gagava’. This old traditional fishing gear, which is dragged from the vessel with the help of a rope or a metal chain, is constructed of a truss, which has an aperture of 1 m height and 6–8 m length and a bag-like net set in.

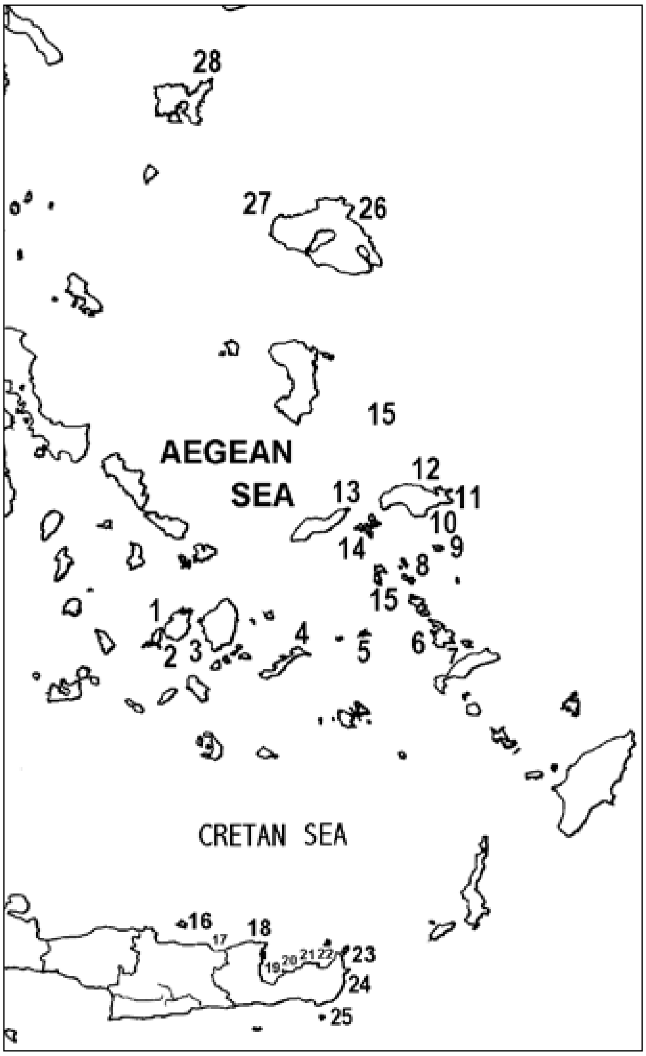

Figure 1. Sampling stations in the islands of the central and southern Aegean Sea. 1, Antiparos; 2, Paros-Antiparos passage; 3, Naxos-Ios passage; 4, Amorgos; 5, Levitha Island; 6, Telendos Island; 7, Vathi of Kalymnos Island; 8, Lipsi; 9, Agathonissi; 10, Pithagorio; 11, Ag. Paraskevi, Samos Island; 12, Vathi Samos; 13, Paleophanaro Cape, Ikaria Island; 14, Phourni Islands; 15, Patmos; 16, Dia; 17, Chersonissos; 18, Ag. Ioannis Cape; 19, Ag. Nicolaos; 20, Psira Island; 21, Sitia Phaneromeni Cape; 22, Sitia; 23, Grantes; 24, Koufonisi passage; 25, Zacros; 26, Channel of Mitilini Lesvos Island; 27, North Lesvos Island; 28, Plaka Cape, Limnos Island.

Sampling stations: all 28 sampling stations are of different substrate type and depth and they extend in a vast area of the Aegean Sea and Cretan Sea (Crete). These stations are shown in Figure 1.

Preservation methods: parts of the specimens are preserved *in situ*, in 5% formaldehyde, buffered (6.5 g Na_2HPO_4 $2H_2O$+4 g NaH_2PO_4). Spicule preparations: hand made sections and spicule preparations were mounted on microscope slides in Canada balsam. The light microscopy was applied using a BX 40 TRI Olympus microscope with incorporated camera.

Material: this collection of the Demospongiae is kept at the laboratory of Zoology and Marine Biology in the University of Athens. A part of the new species has been deposited in the Zoological Museum of the University of Athens (ZMUA) while the other part has been deposited in the Marine Museum of Kalymnos Island (MMK).

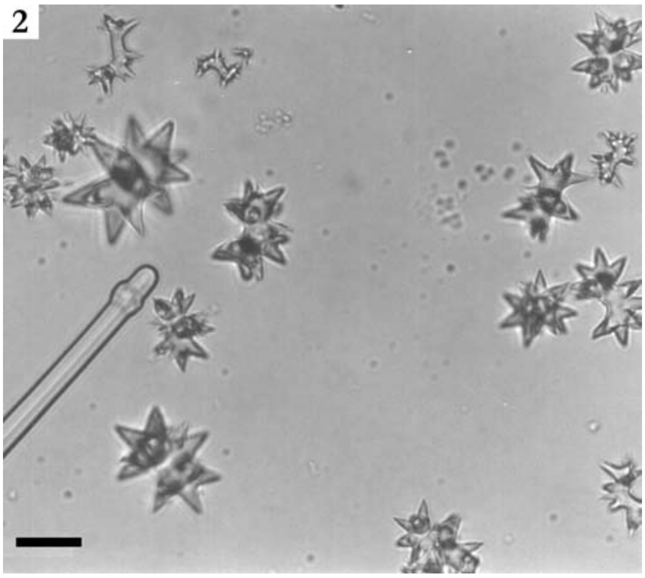

Figure 2. *Spirastrella cunctatrix*, tylostyles, and spirasters. Scale bar: 20 µm.

The classification was based on the *Systema Porifera* (Hooper & van Soest, 2002).

Statistics: four indices were used for the statistical analysis: Margalef's index for the species richness, Simpson's index for the diversity, Shannon's index for the diversity and the index of Pielou which expresses the evenness of the distribution of the species in the sample (Karydis & Tsirtsis, 1996).

Cluster analysis was performed for each index aimed to group the stations. The Bray–Curtis index was used as a measure of the similarity while the group average distance was used as the clustering algorithm.

RESULTS

The depths of sampling and a short description of the composition of the bottoms, for each station, are given in Table 1.

A large area of the Aegean and Cretan Seas was studied and a sponge assemblage of 59 species, listed in Table 2, was identified. For each species described below only one specimen was found, with the exception of *Petrosia clavata* with three specimens detected.

Systematics of sponges

The diagnosis of the most rare species, especially those newly recorded in the Aegean and Cretan Seas, together with the description of the new species *Axinyssa michaelis* are given below.

Genus *Spirastrella* Schmidt, 1868
Spirastrella cunctatrix Schmidt, 1868
Figure 2

Diagnosis

Small smooth incrustation, about 1mm thick with an area of 2 cm^2, on the sponge *Aaptos aaptos*. Colour: pale yellow.

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Table 1. *Sampling stations, depth of sampling, type of subtrate.*

	Stations	Depth (m)	Habitat	Coordinates
1	Antiparos	80–90	Coralligenous bank	37°06'75"N 25°03'40"E
2	Paros-Antiparos passage	20–45	*Posidonia*	36°58'50"N 25°05'10"E
3	Naxos-Ios passage	50–60	Coralligenous, self-edge detritic	36°55'30"N 25°20'60"E
4	Amorgos	90–100	Coralligenous bank	36°55'30"N 25°20'60"E
5	Levitha Island	100–130	Coralligenous bank	36°59'80"N 26°31'30"E
6	Telendos Island, Kalymnos	60–100	Coastal detritic with *Vidalia volubilis*	37°01'00"N 26°55'60"E
7	Vathi, Kalymnos	50–60	Coastal detritic	36°58'70"N 27°03'20"E
8	Lipsi	55–70	Coralligenous bank	37°15'90"N 26°47'46"E
9	Agathonisi, (Gaidouronissi)	60–80	Coralligenous, self-edge detritic	37°25'14"N 26°56'15"E
10	Pithagorio, Samos	20–30	*Posidonia*	37°40'00"N 25°55'00"E
11	Ag. Paraskevi, Samos	65–110	Coralligenous bank	37°46'30"N 27°03'95"E
12	Vathi, Samos	60–80	Coralligenous, coastal detritic	37°46'85"N 26°56'20"E
13	Paleophanaro Cape, Ikaria	90–110	Coralligenous bank	37°42'70"N 26°21'30"E
14	Phourni Islands	50–110	Coralligenous bank	37°30'92"N 26°23'00"E
15	Patmos	30–40	*Posidonia*	37°19'70"N 26°36'70"E
16	Dia Island, Crete	70–120	Coralligenous bank	35°26'00"N 25°16'00"E
17	Chersonissos, Crete	25–50	*Posidonia*, sand	35°19'72"N 25°25'00"E
18	Ag. Ioannis Cape, Crete	70–95	Coralligenous bank	35°22'22"N 25°46'00"E
19	Ag. Nikolaos, Crete	30–80	Rocks, coastal detritic	35°11'70"N 25°53'20"E
20	Psira Island, Crete	80–110	Coastal detritic	35°11'70"N 25°53'20"E
21	Phaneromeni Cape, Sitia, Crete	40–70	Rocks, coastal detritic	35°13'40"N 26°07'50"E
22	Sitia, Crete	30–65	Coastal detritic	35°13'40"N 26°10'00"E
23	Grantes, Crete	40–100	Coralligenous	35°14'90"N 26°19'00"E
24	Zacros, Crete	30–40	*Posidonia*, sand	35°05'97"N 26°16'60"E
25	Koufonisi passage, Crete	30–45	*Posidonia*, sand	35°00'30"N 26°09'10"E
26	Channel of Mytilini, Lesvos	25–35	Sand and *Vidalia volubilis* meadows	39°12'74"N 26°30'70"E
27	Gavatha, North Lesvos	35–75	Coralligenous bank	39°18'00"N 26°00'21"E
28	Plaka Cape, Limnos	40–70	Coralligenous bank	40°04'00"N 25°32'62"E

Skeleton

Ectosome is composed of a cortical layer that seems smooth with no evident oscula, rigid and non-detachable, formed exclusively of spirasters. Choanosome is composed of tylostyles, long and straight, strewn in confusion and in between them numerous spirasters are observed.

Spicules

The tylostyles were 300–360×8–10 µm in length, while the spirasters were in the range of 20–50 µm.

Habitat

The single specimen collected was epibiotic to the sponge *A. aaptos*.

Genus *Clathria* Schmidt, 1862
Subgenus *Clathria* Schmidt, 1862
Clathria (*Clathria*) *toxivaria* (Sarà, 1959).
Microciona toxivaria Sarà, 1959

Diagnosis

Thin hispid encrustation. Colour: light orange.

Skeleton

Perpendicular plumose columns of spicules start from a basic layer of spongin which end up on the surface. From there the edges of big styles are protruded.

Spicules

Megascleres. Principal styles, which are frequently curved near their base: 300–370×10–15 µm (perhaps, due to the minute sample size, only a limited range of sizes is observed). Ectosomal subtylostyles straight or slightly curved, some of them with microspines on base: 140–280×3–6 µm. Acanthostyles: 50–60×6–12 µm. Microscleres. Very thin toxa: 35–450×1–1.5 µm. Isochelas, rarely observed: 15–20 µm.

Genus *Eurypon* Gray, 1867
Eurypon major Sarà & Siribelli, 1960

Diagnosis

Thin hispid encrustation. In most cases it covered quite large areas, extending to a surface of approximately 200 cm^2. Colour: dark brown, when the sponge is alive, turns to black when it is dried.

Skeleton

Ectosome is composed of several types of spicules. The oxeas are tangentially arranged towards the choanosomal skeleton. Between the oxeas few acanthostyles and small styles and subtylostyles are found.

Choanosome is of the microcionid type. Specifically, the long styles and the subtylostyles are forming bundles, which are supported from spongin elevations which extend from the base. The long spicule ends of the columns are directed

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Table 2. *Taxonomic list of species.*

	Distribution	Stations
Phylum PORIFERA		
Class DEMOSPONGIAE		
Order ASTROPHORIDA Sollas, 1888		
Family GEODIIDAE Gray, 1867		
Geodia cydonium (Jameson, 1811)	M-CA	2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 21, 23, 25, 26, 27 and 28
Family ANCORINIDAE Schmidt, 1870		
Penares helleri (Schmidt, 1864)	M-CA	4
Styphnus niger Sollas, 1886	M-CNA	4, 7, 18, 21
Order HADROMERIDA Topsent, 1894		
Family SPIRASTRELLIDAE Ridley & Dendy, 1886		
Spirastrella cunctatrix Schmidt, 1868	M-CAN	21
Family SUBERITIDAE Schmidt, 1870		
Aaptos aaptos (Schmidt, 1864)	M-CAN-RS	21
Aaptos papillatus (Keller, 1880)	M-CNA	12, 13
Suberites carnosus (Johnston, 1812)	M-CNA	9, 27
Suberites domuncula (Olivi, 1792)	M-CNA	4
Suberites syringella (Schmidt, 1868)	ME	12
Order CHONDROSIDA Boury-Esnault & Lopès, 1985		
Family CHONDRILLIDAE Gray, 1872		
Chondrilla nuculla (Nardo, 1833)	M-CNA	11
Chondrosia reniformis Schmidt, 1862	M-CNA	7, 11
Order POECILOSCLERIDA Topsent, 1928		
Suborder MICROCIONINA Hadju, van Soest & Hooper, 1994		
Family MICROCIONIDAE Carter, 1875		
Clathria (*Clathria*) *toxivaria* (Sarà, 1959)	M[1]E	26
Family OPHLITASPONGIINAE De Laubenfels, 1936		
Antho (*Antho*) *involvens* (Schmidt, 1864)	M[1]-CNA	27
Family RASPAILIIDAE Hentschel, 1923		
Subfamily RASPAILIINAE Nardo, 1833		
Eurypon major Sarà & Siribelli, 1960	ME	27
Raspaciona aculeata (Johnston, 1842)	M-CNA	27
Suborder MYCALINA Hadju, van Soest & Hooper, 1994		
Family DESMACELLIDAE Ridley & Dendy, 1886		
Desmacella annexa (Schmidt, 1870)	M-CNA	28
Family MYCALIDAE Lundbeck, 1905		
Mycale (*Aegagropila*) *rotalis* (Bowerbank, 1874)	M-CNA	26
Mycale (*Aegagropila*) *syrinx* (Schmidt, 1862)	ME	26
Mycale (*Mycale*) *massa* (Schmidt, 1862)	M-CNA	9, 26
Suborder MYXILLINA Hadju, van Soest & Hooper, 1994		
Family MIXILLIDAE Dendy, 1922		
Myxilla (*Myxilla*) *rosacea* (Lieberkühn, 1859)	M-CNA	28
Family TEDANIIDAE Ridley & Dendy, 1886		
Tedania (*Tedania*) *anhelans* (Lieberkühn, 1859)	M-CNA	26
Order HALICHONDRIDA Gray, 1867		
Family AXINELLIDAE Carter, 1875		
Axinella cannabina (Esper, 1794)	M-NA	19, 23
Axinella damicornis (Esper, 1794)	M-CNA	1, 4, 8, 14, 13 and 27
Axinella polypoides Schmidt, 1862	M-NA	26
Axinella verrucosa (Esper, 1794)	M-CA	7, 26
Family BUBARIDAE Topsent, 1894		
Cerbaris curvispiculifera (Carter, 1880)	M[1]-CA	27
Family DICTYONELLIDAE van Soest, Diaz & Pomponi, 1990		
Acanthella acuta Schmidt, 1862	ME	1, 9
Dictyonella incisa (Schmidt, 1880)	ME	27
Dictyonella marsilii (Topsent, 1893)	ME	19

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Table 2 *(Continued.)*

Family HALICHONDRIIDAE Gray, 1867		
Axinyssa aurantiaca (Schmidt, 1862)	ME	19, 26
Axinyssa michaelis sp. nov.	ME	27
Hymeniacidon perlevis (Montague, 1818)	M-CNA	8, 24
Halichondria sp.		19
Spongosorites intricatus (Topsent, 1892)	M[1]E	27
Spongosorites flavens Pulitzer-Finali, 1983	M[1]E	13
Topsentia contorta Sarà, 1961	ME	27
Order AGELASIDA Hartman, 1980		
Family AGELASIDAE Verill, 1907		
Agelas oroides (Schmidt, 1864)	ME	1, 2, 3, 4, 5, 8, 10, 11, 12, 13, 14, 16 18, 19, 20, 21, 22, 23, 27 and 28
Order HAPLOSCLERIDA Topsent, 1928		
Suborder HAPLOSCLERINA Topsent, 1928		
Family CHALINIDAE Gray, 1867		
Dendroxea lenis (Topsent, 1892)	M-CNA	21
Haliclona (*Haliclona*) *simulans* (Johnston, 1842)	M-CNA	9, 13, 14, 26 and 27
Haliclona (*Halichclona*) *fulva* (Topsent, 1893)	M[1]-CA	27
Haliclona (*Soestella*) *implexa* (Schmidt, 1868)	M-CA	27
Haliclona (*Rhizoniera*) *sarai* (Pulitzer-Finali, 1969)	M[1]E	27
Suborder PETROSINA Boury-Esnault & Van Beveren, 1982		
Family PHLOEODICTYIDAE Carter, 1882		
Calyx nicaeensis (Risso, 1826)	ME	26, 27
Family PETROSIIDAE van Soest, 1980		
Petrosia (*Petrosia*) *clavata* (Esper, 1794)	M[1]E	4, 14 and 23
Petrosia (*Petrosia*) *ficiformis* (Nardo, 1833)	M-CAN-IP	7
Order DICTYOCERATIDA Minchin, 1900		
Family IRCINIIDAE Gray, 1867		
Ircinia dendroides (Schmidt, 1862)	ME	9
Ircinia oros (Schmidt, 1864)	M-CA	12, 19
Sarcotragus foetida (Schmidt, 1862)	ME	12, 27
Family THORECTIDAE Bergquist, 1978		
Cacospongia scalaris Schmidt, 1862	M-CA	2, 3, 4, 7, 8, 9, 15, 17, 19, 22, 23, 25 27 and 28
Family SPONGIIDAE Gray, 1867		
Hippospongia communis (Lamarck, 1813)	ME	2, 3, 10 and 26
Spongia (*Spongia*) *agaricina* Pallas, 1766	ME	1, 4, 9, 11, 12, 13 and 14
Spongia (*Spongia*) *officinalis* var. *adriatica* (Schmidt, 1862)	ME	1, 3, 4, 6, 7, 8, 9, 11, 12, 13, 14, 18, 21, 23, 24 and 27
Spongia (*Spongia*) *officinalis* var. *mollissima* (Schmidt, 1862)	ME	4, 5
Spongia (*Spongia*) *virgultosa* (Schmidt, 1868)	M-CA	18
Spongia (*Spongia*) *zimocca* Schmidt, 1862	ME	3, 6, 7, 9, 11 and 12
Family DYSISEIDAE Gray, 1867		
Dysidea avara (Schmidt, 1862)	M-CAN	1, 3, 4, 7, 9 and 14
Order DENDROCERATIDA Minchin, 1900		
Family DICTYODENDRILLIDAE Bergquist, 1980		
Spongionella gracilis (Vosmaer, 1886)	ME	27
Order VERONGIDA Bergquist, 1978		
Family APLYSINIDAE Carter, 1875		
Aplysina aerophoba Schmidt, 1862	M-CNA	2, 15, 17, 25 and 26
Aplysina cavernicola (Vacelet, 1959)	ME	7, 8, 9, 17, 19, 22, 23, 27 and 28

ME, Mediterranean endemic; M[1], first record for the Aegean Sea and eastern Mediterranean; M-CAN, widely distributed; M-CA, Mediterranean–Central Atlantic; CA, central Atlantic (European and African coasts, Azores and Canary Islands); CAN, central and North Atlantic; NA, northern Atlantic-Boreal distribution; RS, Red Sea; IP, Indo-Pacific.

outwards while they protrude from the ectosomal layer and extend over it. The acanthostyles echinate the columns. In addition, several acanthostyles and subtylostyles (a smaller form from the ones previously mentioned) are strewn in confusion with each other.

Spicules

Ectosomal oxeas are in the range of 300–500×3–6 µm. Larger styles or subtylostyles are curved near the base and in the range of 800–2000×14–25 µm. Acanthostyles size ranges from 80–150×7–12 µm.

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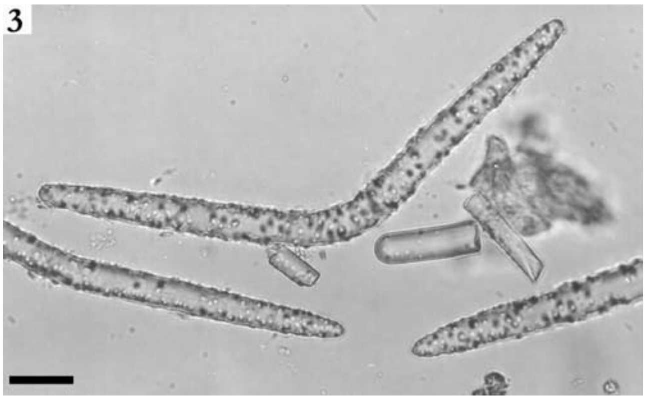

Figure 3. *Cerbaris curvispiculifera*, acanthoxeas. Scale bar: 15 μm.

Genus *Cerbaris* Topsent, 1898
Cerbaris curvispiculifera (Carter, 1880)
(Figure 3)
Microciona curvispiculifera Carter, 1880

Diagnosis

Thin hispid encrustation with small dimensions (it covers only 2–3 cm^2). Colour: dark-yellow.

Skeleton

Basic layer of spongin attached on the substrate. The large styles start perpendicularly from the basal layer and are surrounded by branches of acanthostyles. Acanthostyles and acanthoxeas are distributed within the choanosome with no particular order.

Spicules

Megascleres. Styles slightly curved near the base with dimensions 150–2000×6–20 μm. Acanthostyles are curved in a variable fashion near the base with dimensions of 130–210×7–8 μm. Acanthoxeas exhibited a pronounced bent in their middle: 180–300×10–15 μm.

Remarks

Cerbaris curvispiculifera, is a rare species recorded only twice in the Mediterranean Sea (Vacelet, 1969; Bibiloni, 1993). In general, the morphology and the size of the acanthostyles and the acanthoxeas recorded by the two researchers are similar to those of our specimen. All three specimens appear to have important differences concerning the size of their styles, while the smallest one was recorded by Bibiloni (966–1000×12–15 μm), compared to our specimen (150–2000×6–20 μm). Vacelet recorded a size between those two (300–1600×10–20 μm).

Genus *Dictyonella* Schmidt, 1868
Dictyonella marsillii (Topsent, 1893)
Stylotella marsillii Topsent 1893

Diagnosis

Massive sponge, about 22 cm long. Consistency: soft, delicate and can be easily torn. Colour: the living sponge has a chocolate brown colour, darker at its surface and a little lighter inside.

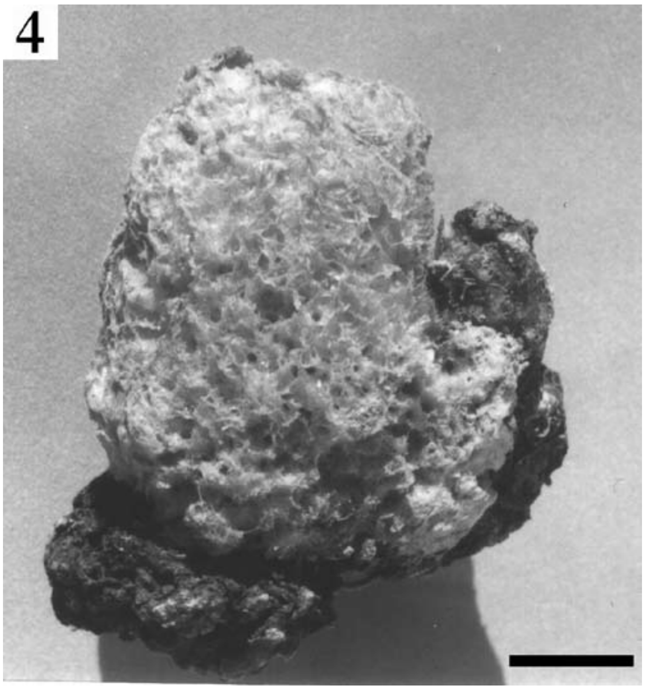

Figure 4. *Axinyssa michaelis* sp. nov., habit. Scale bar: 2.2 cm.

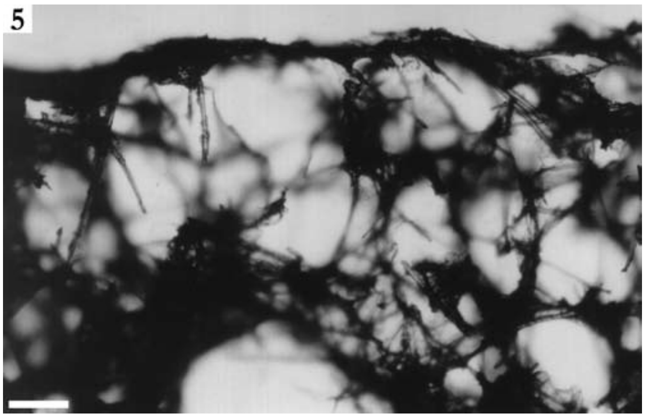

Figure 5. *Axinyssa michaelis* sp. nov., cross-section of peripheral skeleton. Ascending tracts of spicules with scarce spongin. Scale bar: 150 μm.

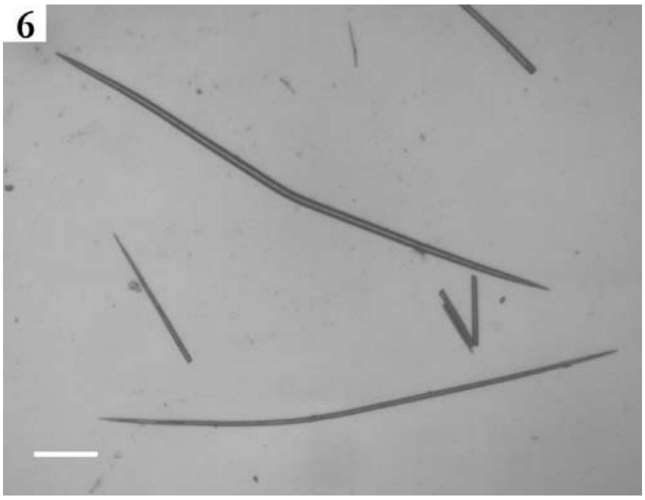

Figure 6. *Axinyssa michaelis* sp. nov., oxeas. Scale bar: 200 μm.

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Table 3. *Comparative features of* Axinyssa michaelis *and related species of the genus:* A. topsenti *(type species of the genus);* A. digitata *(eastern Atlantic species);* A. aurantiaca *and* A. luteus *(Mediterranean species).*

	A. aurantiaca (Schmidt, 1864)	*A. luteus* Lendelfeld, 1897	*A. digitata* (Cabioch, 1968)	*A. topsenti* Lendelfeld, 1897	*A. michaelis*
Form	Massive, cushion shape	Massive	Massive body, vertical projections	Lobate mass of tubes	Massive
Colour	Intense yellow	Intense yellow	Lemon yellow	Dark-green	Grey
Type of spicules	Oxeas (no clear size categories)	Oxeas (no clear size categories)	Oxeas (one size)	Oxeas (two sizes)	Oxeas (no clear size categories)
Spicule min-max size	300–990×3–14 µm (Mean 617.0 µm; SD 226.6 µm)	300–1000×8–13 µm	450–920×3.8–17.5 µm	550–740×14–18 µm & 165–250×4–5 µm	550–1810×12–26 µm (Mean 1428 µm; SD 218.3 µm)
Distribution	Mediterranean	Mediterranean	East Atlantic (European coasts)	Zanzibar	Mediterranean

min, minimum; max, maximum.

Skeleton

Ectosome. No dermal specialization.

Choanosome. Very cavernous, with the smooth-lined canals often reaching a 3 mm diameter. The styles are strewn abundantly within the choanosome and they are generally arranged in bundles with no specific directions.

Spicules

Styles, half of them bent at the upper 1/3 towards the base (the round edge) and their dimensions are 700–1400×5–14 µm.

Genus *Axinyssa* Lendenfeld, 1897
Axinyssa michaelis sp. nov.
Figures 4–6

Type material

Holotype: North Aegean Sea, Lesvos Island (Gavathas), 8 October 1998 (ZMUA 40004 and MMK75).

Etymology

The name of the species is derived from the Greek first name *Michalis*, which stands for Michael. Archangel Michael is considered as the patron saint of Lesvos Island, where the new species was found.

Diagnosis

Massive, sub-spherical sponge with a maximum diameter of 8 cm and a minimum diameter of 6 cm. The surface is characteristically conulose, with conules sometimes arranged into parallel lines of 4–5, reaching a height of 2–2.5 mm. The oscula are simple, relatively small in size, with diameter 0.5–3 mm.

Consistency: the sponge is moderately compressible and is fragile when alive. Tough and non-compressible, when it has dried out.

Colour: the living sponge is light grey, with no evident differences between the ectosome and the choanosome. The colour changes to dark-grey when the sponge is dried out, especially the colour of the ectosome which is darker than the choanosome.

Skeleton

Ectosome. The surface is totally covered with a transparent organic dermal membrane. The dermal membrane is detachable with a very extensive net of sub-dermal cavities and channels, which run parallel to the surface, extending subsequently to the choanosome. A distinct ectosomal skeleton is absent.

Choanosome. The choanosomal skeleton is totally disorganized. It contains scattered spicules of all sizes. Interspicular collagen is scarce, covering especially those spicules which are organized to form radial ascending tracts towards the surface. The dermal membrane receives the terminal tufts of radial spicule tracts, causing the intense conulation of the specimen. The choanosome is of low density near the surface and in the interior skeleton, with many large open spaces 200–600 µm in diameter, where a few scattered spicules might protrude in the loom of these spaces.

Spicules

Megascleres. Oxeas hardly divided in size-classes. The dominant larger oxeas are slightly bent in the middle, 1100–(Mean 1428, SD 218.3) 1850×6–26 µm. Very often thinner and smaller oxeas can be observed, double bent or twisted to the same or opposite direction, 980–(mean 1092.2, SD 82.4) 1240×4–6 µm (Table 3).

Habitat

Depth and substrate. The only specimen was recovered from a coralligenous seabed at a depth of 45–60 m. It was found attached to the sponge *Spongosorites intricans*, sharing the same stone.

Remarks

Fifteen species are assigned to the genus *Axinyssa*, distributed mainly in tropical world oceans. Only one species has been reported in the Mediterranean Sea, *Axinyssa aurantiaca* (Schmidt, 1864). *Axinyssa michaelis* is the second species of the genus recorded in the Mediterranean Sea to date. Erpenberck & van Soest (2002), in the latest revision of the genus, have also examined the holotype of

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the species *Axinyssa luteus* (Lendenfeld, 1897 as *Astromimus*), which is reported in the list of Pulitzer-Finali (1983). They concluded that *Axinyssa luteus* and the very common Mediterranean species *Halichondria aurantiaca* (Schmidt, 1864) are very similar, so they must be considered as synonymous (Table 3).

Genus *Spongosorites* Topsent, 1896
Spongosorites flavens Pulitzer-Finali, 1983

Diagnosis

Massive sponge, about 20 cm long and 8–10 cm tall. A large number of epibiots, vermetids tubes, bryozoans and corals grow inside and over the sponge. Consistency: soft and extremely fragile. Colour: yellow when alive, chocolate brown in formalin.

Skeleton

Ectosome. A tangential crust of spicules normally arranged in one direction. Some sparse spicules, perpendicular to the surface, were observed.

Choanosome. Halichondroid with the spicules in total confusion.

Spicules

Oxeas, usually straight: 75–360×3–5 μm.

Genus *Spongosorites* Topsent, 1896
Spongosorites intricatus (Topsent, 1892)
Halichondria intricata Topsent, 1892

Diagnosis

Massive sponges. Oscula are small and circular, randomly distributed. It has a smooth surface, covered with numerous epibiotic organisms. Consistency: tough, non-compressible sponge. Colour: two specimens have a dark brown colour and one has dark green.

Skeleton

The ectosomal skeleton consists of a very dense layer of spicules, in a tangential-paratangential arrangement. The choanosome skeleton consists of a dense network of spicules, randomly scattered. The spongin is abundant.

Spicules

Oxeas slightly curved throughout their length, covering a wide spectrum of sizes: 55–730×2.5–20 μm.

Genus *Topsentia* Berg, 1899
Topsentia contorta Sarà, 1961

Diagnosis

Massive sponge. Depending on the sponge size, sizeable lobes with apical oscula (1–8 mm wide) exist. Few flat oscula exist in some cases, with elevated rims, 1–4 mm wide.

Consistency: relatively tough sponge, but moderately compressible when alive. When the sponge dries out it turns hard and non-compressible. Colour: when the sponge was alive it was grey, and got slightly darker when it dried out.

Spicules

Megascleres. Oxeas hardly distinguishable in two types: (a) bent in the middle: 400–950×10–18 μm; (b) thinner oxeas found in all sizes, which sometimes have two bents of the same or opposite direction: 400–1050×6–13 μm.

Genus *Dendroxea* Griessinger, 1971
Dendroxea lenis (Topsent, 1892)
Reniera lenis Topsent, 1892

Diagnosis

A thin encrustation which completely covers the stone on which it is attached. Consistency: soft. When trying to detach it from the substrate, it splits into small sticky pieces. Colour: brown.

Skeleton

Ectosome non-differentiable from the choanosome. Choanosome. Ascending tracts of spicules, more easily distinguishable near the surface. The skeleton near the base is totally confused.

Spicules

Oxeas, slightly curved: 100–150×3–6 μm.

Genus *Haliclona* Grant, 1836
Subgenus *Halichoclona* De Laubenfels, 1932
Haliclona (*Halichoclona*) *fulva* (Topsent, 1893)
Reniera fulva Topsent, 1893

Diagnosis

Both specimens are massive with small lobes. The surface is irregular, forming grooves of varying depths, which end up to the lobe surface. Few oscula, 2–4 mm, which in some instances are found with their rims slightly elevated. No mucous secreted. Colour: dark orange. Consistency: hard but fragile.

Skeleton

Ectosome. The ectosome skeleton forms a network that covers the sponge surface. The multispicular flat fibres are 40–250 μm thick, forming meshes with sizes ranging from 100 up to 800 μm. The sponge ostia are evident only in the lumen of reticulation.

Choanosome. The choanosome is formed from primary ascending paucispicular lines and transverse almost perpendicular spicules. The primary lines are covered by large quantities of spongin and thus are very difficult to distinguish.

Spicules

Oxeas of different shapes. Some of them are straight with different grades of central bending. Additionally, differences exist in the size of the spicules but more characteristic is the big fluctuation of their length, which ranged from 135 to 285×6–9 μm. Some thinner oxeas exist with a thickness of 2.5–4 μm.

Subgenus *Soestella* de Weerdt, 2000
Haliclona (*Soestella*) *implexa* (Schmidt, 1868)
Reniera implexa Schmidt, 1868

Diagnosis

It appears in the shape of branches or small rounded tubules that grow from a common stalk forming an amorphous base and proceeding in all directions. Dimensions. The tubules are 1–3 cm long and their diameter is 0.5 cm. The oscula are small and round and are located sideways or at the top of the branches. Under normal pressure or when cut into pieces while it is still alive, the sponge secretes a small quantity of mucous. Consistency: soft and flexible. Colour: white–cream.

Skeleton

Ectosome. A regular reticulation unispicular or bispicular. Choanosome. Ill-defined paucispicular lines with single transverse spicules. Some nodal spongin.

Spicules

Oxeas, slightly curved, uniform in size: 130–157×3–9 μm.

Subgenus *Rhizoniera* Griessinger, 1971
Haliclona (*Rhizoniera*) *sarai* (Pulitzer-Finali, 1969)
Reniera sarai Pulitzer-Finali, 1969

Diagnosis

The first specimen is conical with a height of 4 cm, a wide base of 6×3 cm and an apical osculum, 1cm wide. The second specimen is almost a perfect sphere of 7 cm diameter. In this species, the oscula are much more in number; seven in total, but smaller, 3 mm wide. Abundant mucous when the sponge was alive. The surface has a characteristic crumbling feeling. Consistency: non-compressible sponge. Colour: orange to orange-red when the sponge is alive. It turns into a light brown in alcohol or when the sponge is dry.

Skeleton

Ectosome. Covered from an aspicular membrane. Not clearly separable from the choanosome. Choanosome. Primary multispicular lines consisting of a large number of transverse spicules, which are situated randomly towards all directions. The spongin is abundant.

Spicules

Oxeas, which can be subdivided into two groups: (a) 115–132×3–4 μm and (b) 145–175×7–8 μm.

Genus *Petrosia* Vosmaer, 1885
Subgenus *Petrosia* Vosmaer, 1885
Petrosia (*Petrosia*) *clavata* (Esper, 1794)
(Figure 7)
Spongia clavata Esper, 1794

Diagnosis

The specimen from Station 4 is a vacuous ball 10 cm in diameter with thick walls, the specimen from Station 23 has the shape of a funnel also with a thick wall (about 1cm) and the specimen from Station 14 is a massive sponge with a diameter of 15.5 cm. Consistency: rocky, non-compressible. Colour: cream.

7

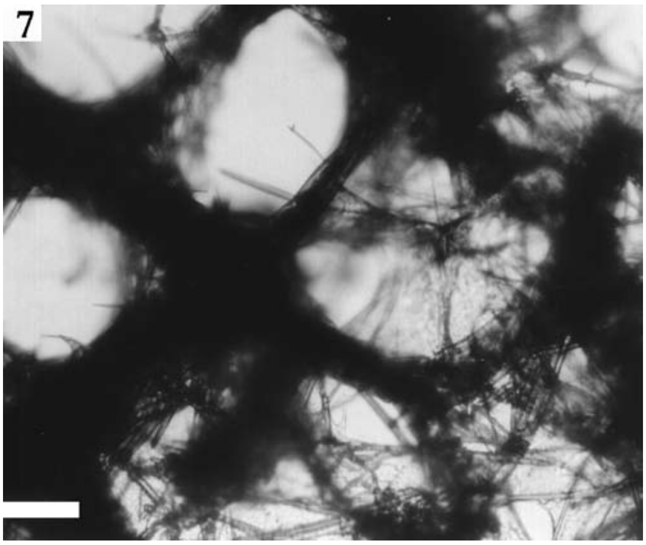

Figure 7. *Petrosia clavata*, fibres and free spicules attached on the interconnecting membrane. Scale bar: 220 μm.

Skeleton

Ectosome. It consists of multispicular fibres that form a rather geometrical, polygonal or circular reticulation, with meshes 30–180 μm in diameter. A transparent membrane with some sparse spicules on it covers partially or totally the meshes which are formed from the fibres' reticulation. Choanosome. The reticulation of the fibres here is more dense and confused. Free spicules are frequent.

Spicules

Oxeas slightly curved of uniform shape: 190–210×3–4 μm.

Habitat: always found at depths greater than 40 m, preferably on coralligenous banks.

Remarks

Petrosia clavata seems to be a well-differentiated species. Differs from the other species *P. ficiformis* through the size and the shape of its spicules, which are only thin oxeas, and through the total lack of the short and thick oxeas or strongyls (Pulitzer-Finali, 1983). In addition, essential habitat differences seem to exist between the two species. *Petrosia ficiformis* is a very common species in shallow waters (<30 m) of the Mediterranean Sea in comparison to *P. clavata* which is an extremely rare species and hitherto is only recorded in deeper waters (>40 m) (Pulitzer-Finali, 1983).

Genus *Spongionella* Bowerbank, 1862
Spongionella gracilis (Vosmaer, 1886)
Velinea gracilis Vosmaer, 1886

Diagnosis

All three specimens, collected at the station of north Lesvos Island, have the shape of creeping branches. Their length reaches 15 cm but their thickness does not exceed 1 cm. The surface is smooth and the conules are small. Few small oscula (0.5–1 mm diameter) are usually found on short

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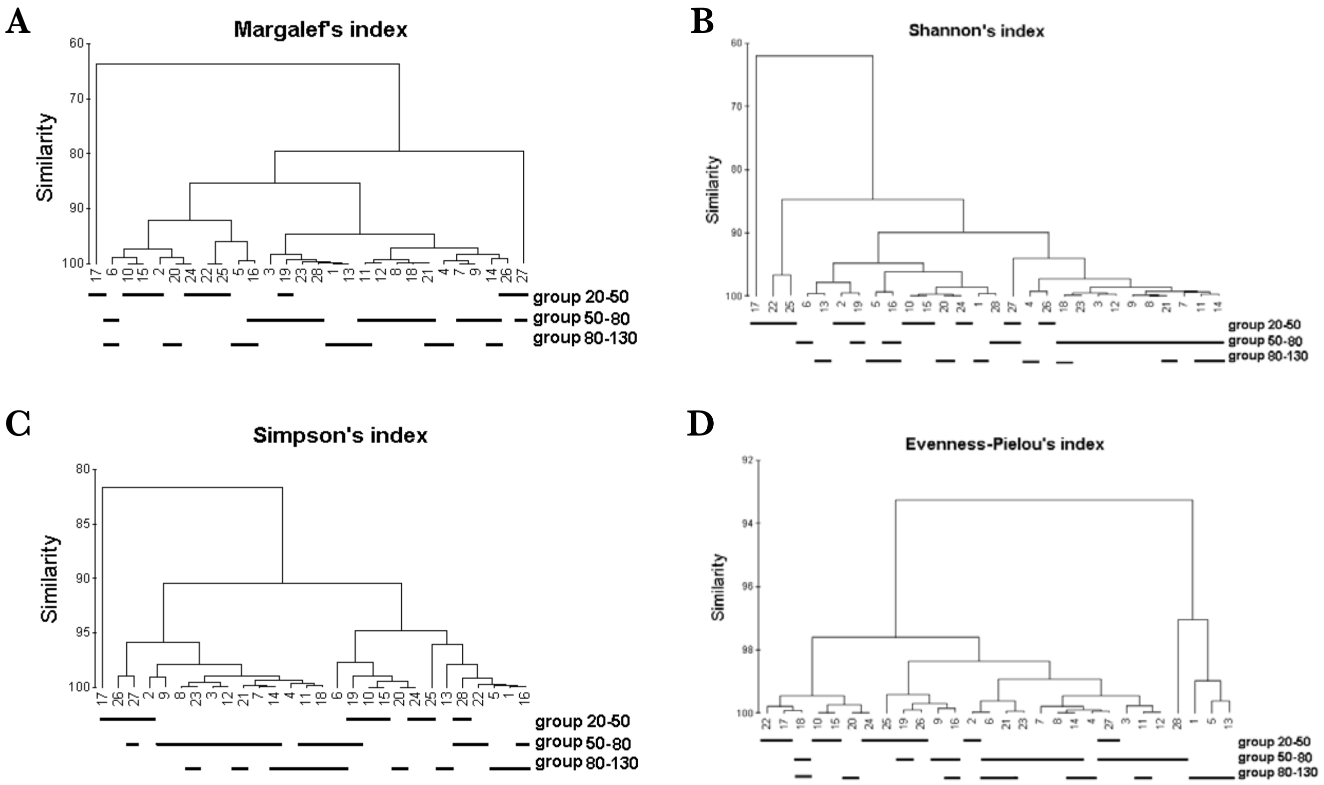

Figure 8. A–D, Graphical presentation of the grouping of the four geographical regions of the Aegean Sea, using cluster analysis on Margalef's index, on Shannon–Wiener's index, on Simpson's index and on evenness (Pielou) index. Depth range: group 20–50 m, 50–80 m and 80–130 m.

elevations. Consistency: flexible with moderate elasticity. Colour: black and brown–yellow near their base. Dark-grey internally.

Skeleton

Primary fibres with pith covering 60–70% of the fibres' diameter (40–50 µm). The secondary fibres are short without ramifications and are almost perpendicular to the primary fibres while pith does not exist (10–20 µm).

Habitat

The branching specimens were usually found as epibiotic on the species *Spongosorites intricatus*.

The community of sponges

Species richness refers to the number of species found in each of the 28 stations, in relation to the depth profile of the bottom. Coralligenous banks over 60 m in depth and especially those of the eastern Aegean exhibit great diversity among species (more than ten different species per station). Extremely rich substrata are found in Stations 26 and 27 of the north Aegean with 11 and 19 species respectively, although the bottoms differ in structure and depth profiles (Table 1) while poor substrata were those of Stations 17 (3 species), 15 (2 species), 16 (1 species), 24 (2 species) and 6 (3 species). These differences are due to several factors. One such factor is the sampling method. It is probable that the sampling method was not effective for substrates dominated by *Posidonia* beds (Stations 17 and 24). It should be noted that it was really hard to detach enough species from the roots of those plants. It is also possible that some bottoms, although coralligenous, were poor substrates, i.e. Stations 20, 15 and 16, while Stations 27 and 4 exhibited a high species richness.

The grouping has been done by using the most common indices, i.e. those of: Margalef for the species richness (Figure 8A), Simpson (Figure 8C), and the most popular among the ecologists that of Shannon (Figure 8B), both for the expression of the diversity, and finally that of Pielou for the evenness (Figure 8D).

In addition, cluster analysis was performed for each index separately targeting the study of the station grouping and the probable relation of the groups of species and the groups of depths (Figure 8A–D). Three groups of depths were selected for this purpose. The group 30–50 m which is dominated by *Posidonia* beds or bottoms covered by sand. The group 50–80 m where the bottom is mainly coastal detritic.

The last depth group is that of 80–130 m which is dominated by coralligenous bottoms. We must mention here that one station may participate in two depth groups, and therefore its depth is included in both groups at a satisfactory percentage of around 40–50%.

The results of this grouping show that the diversity indices of Margalef and Shannon give a satisfactory grouping for the range 50–80 m. The indices of Margalef and Pielou give a satisfactory grouping for the range 50–80 m as well as for the range 20–50 m. All indices fail in grouping the range 80–130 m, which includes stations dispersed in all groups.

DISCUSSION

This collection of Demospongiae is a contribution of our knowledge to this particular region of Aegean Sea islands since the systematic, faunistic and biogeographical data for this area are considerably poor. In this paper one new species and 14 rare species have been described.

Axynissa michaelis is the second species of the genus *Axynissa* reported in the Mediterranean Sea, in addition to the very common species, generally known as *Halichondria aurantiaca* (Schmidt, 1864) (van Soest R.W.M. et al., 1990). From the proximities of the Mediterranean there is only one species known so far, *Axinyssa digitata* (Cabioch, 1968 as *Pseudaxinyssa*), which was retrieved from the English Channel and Gibraltar (Carballo et al., 1996). Carballo et al. (1994) had re-described the Atlantic species *A. digitata* and they conclude that some species do not perfectly fit the original description of the genus *Axinyssa*. They suggested that this species could be included in the genus *Pseudoaxinyssa*, as erected by Burton, 1931, possessing a single category of spicules and could be distinguished from *Axinyssa* which possesses two categories of spicules (see also Table 3, *A. topsenti*, type species of the genus *Axynissa*). They also suggest that the general characteristics, (conule formation, subectosomal skeletal arrangement and organic skin), seem to fit more with Axinellidae than with the Halichondridae. Furthermore, this hypothesis is reinforced because of the existence of a primitive radial architecture of the choanosomal skeleton, as in *Axinyssa topsenti* Lendenfeld, 1987 and which was also noticed in *A. michaelis*. On the contrary, Erpenberck & van Soest, (2002) in the latest revision of the book (Hooper & van Soest, 2002), mentioned that the genus *Axinyssa* Lendenfeld, 1897, should be placed in the family Halichondriidae. This is because *Axinyssa* possesses a large complement of loose and irregularly scattered oxeas in the choanosome, although the surface characters are atypical in the family. Additionally, in the genus *Axinyssa* Lendenfeld, 1897, they concluded the existence of some important transition species, sharing important features of the greater groups Axinellidae and the Halichondridae.

Most of the species of our collection, recorded in Table 2, showed a widespread distribution in the Aegean Sea. These were also found in the fauna of the western Mediterranean (Pulitzer-Finali, 1983) with the exception of the two species: *Halichondria* sp. and *Axinyssa michaelis* sp. nov. Some of the species included in our collection are rare and poorly known as these were found only once or twice in the Mediterranean, like *Eurypon major*, *Clathria toxivaria*, *Antho involvens*, *Dictyonella incisa*, *Haliclona fulva*, *Haliclona sarai* and *Dendroxea lenis*. Some poorly known species, such as *Cerbaris curvispiculifera* which was reported only twice in the Mediterranean Sea (Vacelet, 1969; Bibiloni, 1993), *Petrsia clavata* known from the collection of Pulitzer-Finali (1983) and Topsent (1928) and *Spongosorites flavens* which has also been described by Maldonado (1992) are reported in this study for the first time in the eastern Mediterranean.

The 59 species reported in this paper represent a considerable part of the Mediterranean fauna of Porifera. Two of them, *Aaptos aaptos* and *Petrosia fisiformis*, are widely distributed in the seas of the world. A large number (25 or 43.1%) are endemic to the Mediterranean. Also a large number (33 or 56.9%), more than half of the 59, are distributed in both the Mediterranean and the Atlantic. It must be noted that some of these species were considered a few years ago as typically endemic to the Mediterranean (or having their distribution centres in the Mediterranean) and only recently we have few records of their presence in the Atlantic such as *Cacospongia scalaris*, *Axinella verrucosa* and *Haliclona fulva*. Endemic Aegean sponge research is fairly recent (Voultsiadou, 2005a). The last two decades research has been realized in specific habitats such as deep circallitoral zones with depths much bigger than 100 m or caves, where the possibility of finding endemic species is increased (Pansini, 1996; Voultsiadou, 2005b).

In the paper of Kefalas et al. (2003), which targeted the investigation of the circalittoral zone of the Aegean Sea, a clear differentiation in the composition of Demosponges' populations, mainly in relation to the type of the substrate, is pointed out. Some differences may appear in the bathymetric spreading of the species of the Aegean Sea related to the western Mediterranean (Uriz et al., 1992; Kefalas et al., 2003), but it is a known phenomenon which is caused by the clearness of the waters, an impact of the oligotrophic situation, but also by the increased average temperature (Castritsi-Catharios, 1998).

We can observe that there is a trend in forming two groups of Porifera through the bathymetric spreading. The group of species found in depths 20–50 m and the group of species found in depths 50–80 m. The physical and biological differences of these two depth ranges may be responsible for the differentiation of species found in each of these two groups.

The spreading which is observed in the greater depth group of 80–130 m, is probably due to the existence in this depth of species normally found in smaller depths and which finally survive because these species find conditions favouring their survival. Such an example is *Spongia officinalis*, a species which in the western Mediterranean does not survive in depths greater than 40–50 m while in the eastern Mediterranean survives in much greater depths, as is shown in the results of this study (Table 2). This is probably due to the increased water transparency in the area and more specifically in the Aegean Sea.

In summary, the sponge fauna of the Aegean composes a typical Mediterranean fauna, with great interest due to the presence of endemic species.

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