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MEDITERRANEAN SYMPOSIUM ON CORALLIGENOUS

United Nations Environment Programme
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PROCEEDINGS OF THE 1ST MEDITERRANEAN SYMPOSIUM ON THE CONSERVATION OF THE CORALLIGENOUS AND OTHER CALCAREOUS BIO-CONCRETIONS

15 – 16 January 2009 – Tabarka

ACTES DU 1ER SYMPOSIUM MEDITERRANEEN SUR LA CONSERVATION DU CORALLIGENE ET AUTRES BIOCONCRETIONS CALCAIRES

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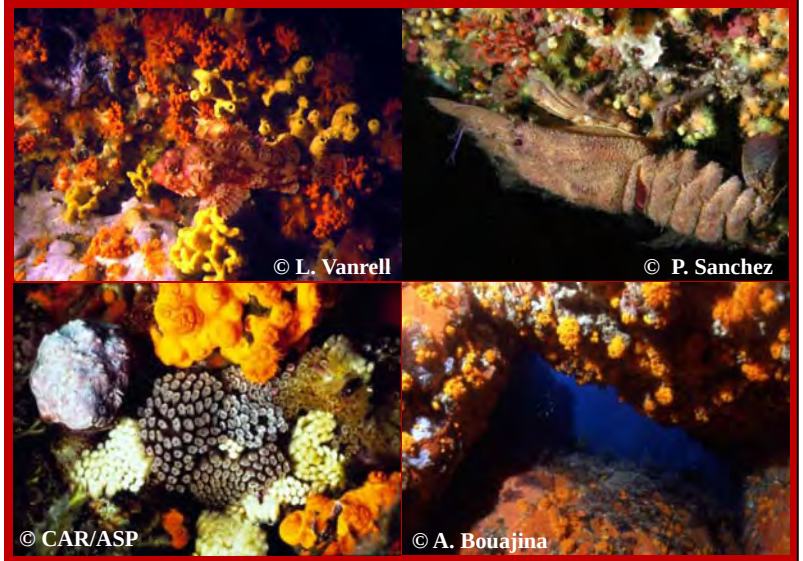

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OVERVIEW ON THE HOMOSCLEROMORPHA SPONGES DIVERSITY IN THE MEDITERRANEAN

ABSTRACT

Sponges are often dominant in marine benthic communities, especially on Mediterranean hard substrates. The Homoscleromorpha group is a poorly known sponge clade, represented by a single family, the Plakinidae, with an unresolved phylogenetic position at the basis of the Metazoan tree. For some of the representatives of this group, the absence of skeleton, main morphological character for sponge taxonomy, explains also the very complicated history of species statut. At present time, 77 species are listed in the World Data Base, with 22 valid species in the Mediterranean and several representatives remaining to be described. All the genera of the family are represented in the Mediterranean: one species from genus Corticium, one species of Pseudocorticium, one species of Placinolopha, one Plakortis, ten species of Plakina and 8 Oscarella species. Most of these sponges only grow sparsely in the Mediterranean with distributions often limited to dark submarine caves. The exceptions are Corticium candelabrum *and several species of the genus Oscarella, who seem to grow only on coralligenous substratum. In some places, Oscarella sp. can be predominant and constitute specific facies. Therefore, they appear as strong competitors for space, overgrowing massive sponges, sea fans and bryozoans. This is especially the case of a new species which seems to be highly dynamic. This strong out-competing ability may be particularly due to an efficient secondary metabolism and the biochemical defense it confers. This hypothesis is also supported by the absence of well-known predator or epibiotic organisms.*

KEY-WORDS: Homoscleromorpha, Oscarella, Mediterranean, distribution, ecology

INTRODUCTION

Sponges represent one of the most ubiquitous and abundant group of metazoans within worldwide hard substrate benthic communities. In the Mediterranean coralligenous community, sponges dominate both in term of biomass and biodiversity on cliffs and overhangs (Sara & Vacelet, 1973; Kefalas *et al.,* 2003; Balata *et al.,* 2005) where in some places, they can cover up to 100% of the substratum surface.

Sponges are also well known to provide goods and services to human societies. The coralligenous community can shelter several species of commercial bath sponges (*Spongia officinalis*, *Spongia agaricina* and *Hippospongia communis*), but also species which provide bioactive compounds (the so-called secondary metabolites), with potential cytotoxins, antibiotics, anti-inflammatory and even anti-fouling agents (for a review see Kornprobst 2005). Among these compounds, there is a number of potential candidates for further development in the biomedical and environmental fields.

Among about 660 Mediterranean species (Pansini & Longo 2003), our attention is given to a small sponge group -Homoscleromorpha- which represents only 3 % of the Mediterranean sponge diversity. Over the last years this sponge group has been subject of a special attention because of its peculiar position at the basis of the Metazoa phylogenetic tree (Ereskovsky *et al.,* 2009). Indeed, Homoscleromorph sponges have long been considered as a part of Demospongiae (sub-class Homoscleromorpha, order Homosclerophorida). Their position has been recently challenged by Borchiellini *et al.* (2004). This sponge group appears now as distinct from the other high level sponge clades, namely Demospongiae, Calcispongiae and Hexactinellida. Homoscleromorph sponges display many morphological, cytological, biochemical and embryological features that distinguish them from other sponges and are more evocative of the Eumetazoa (Borchiellini *et al.*, 2004; Ereskovsky *et al.,* 2009). For example, they are the only sponges that possess a basement

membrane made of collagen IV (Boute *et al.*, 1996), this character being presently considered as a synapomorphy of Eumetazoans. We have recently discussed the interest of the Homoscleromorpha reproduction traits for research in Evolutionary Developmental Biology (Ereskovsky *et al.*, 2009). For instance, their cinctoblastula larva has recently been hypothesized as similar to a step in the early evolution of Metazoa (Nielsen, 2008). Finally, Homoscleromorph sponges appear as a promising sponge group in marine natural product research, with several species offering a high secondary metabolite diversity with potential value for the biomedical field (Kornprobst, 2005; Ivanisevic *et al.*, 2008).

Although some information on taxonomy, cytology and reproduction of Homoscleromorphs are available (see for instance Muricy *et al.*, 1996, 1998; Ereskovsky *et al.*, 2009), little is known about their ecology and distribution in the Mediterranean. We are presently conducting several programmes which aims at improving our knowledge on Mediterranean Homoscleromorpha diversity, chemical diversity and phenology in relation to changes in environmental conditions. In this paper, we give a review of Homoscleromorphs distribution in the Mediterranean Sea.

MATERIALS AND METHODS

Data about sponge distribution were obtained from the literature (extensive work by Muricy, PhD thesis) and then through several sampling trips. Homoscleromorph sponges were studied through several national and international programmes (INTAS, PHENOMED, ECIMAR, RFBR) which made us investigate the Mediterranean Sea from Gibraltar Strait to Lebanon. The specimens were collected by SCUBA diving from 1999 to 2008. Most of the time, an *in situ* picture was associated to the sample.

In Homoscleromorpha sponges, the main taxonomic characters are siliceous spicules (*e.g.* diods, triods, calthropes) and in the absence of skeleton, a cytological characters such as mesohyl cell types (vacuolar cells, cells with inclusions) and endosymbiotic bacteria (Muricy & Diaz 2002).

For the study of spicules, the sponge tissue is digested in nitric acid. The dissociated spicules are separated by filtration on a 0.2 μm cyclopore membrane for observation under scanning electron microscope (SEM) or mounted on glass slides for light microscopy. For cytology in light microscopy and transmission electron microscopy (TEM), specimens are fixed in glutaraldehyde 2.5% in a mixture of 0.4 M cacodylate buffer and seawater (4:5 v/v). They are then postfixed for 2 h in 2% osmium tetroxide in seawater, dehydrated through an alcohol series, and embedded in araldite.

RESULTS

Homoscleromorpha consists presently of one family – Plakinidae - with 7 genera and 77 species, including 22 Mediterranean species (Tab. 1). This represents about 29 % of the Homoscleromorphs biodiversity reported so far in the World Porifera Database.

The species *Oscarella lobularis*, *Plakina monolopha* and *P. trilopha* are reported to be cosmopolitan, but most records from outside the Mediterranean were probably misidentified (Boury-Esnauly *et al.*, 1992; Muricy *et al.*, 1998). Homoscleromorph sponges are generally located in shallow waters from 4 to 35 m, but some species, such as *O. tuberculata, P. monolopha, P. trilopha* and *Plakortis simplex* have been already found at more than 100 meters depth. All species are dwellers of sciaphilic hard substratum communities often in semi dark or dark conditions. *Corticium candelabrum* and several species of the genus Oscarella homoscleromorphs seem to be only growing on coralligenous substratum. In some places, Oscarella sp. can be predominant and constitute particular facies. They seem to be strong competitors for space, overgrowing massive sponges, sea fans and erect bryozoans. This high out competing ability may be particularly due to their efficient secondary metabolism and the biochemical defenses it confers. This hypothesis is also supported by the absence of well-known predator or epibiotic organisms.

Tab. 1: Checklist of Mediterranean species of Homoscleromorpha

Corticium candelabrum Schmidt, 1862
Oscarella imperialis Muricy, Boury-Esnault, Bézac & Vacelet, 1996
Oscarella lobularis (Schmidt, 1862)
Oscarella microlobata Muricy, Boury-Esnault, Bézac & Vacelet, 1996
Oscarella tuberculata (Schmidt, 1868)
Oscarella viridis Muricy, Boury-Esnault, Bézac & Vacelet, 1996
Placinolopha moncharmonti (Sarà, 1960)
Plakina bowerbanki (Sarà, 1960)
Plakina crypta Muricy, Boury-Esnault, Bézac & Vacelet, 1998
Plakina dilopha Schulze, 1880
Plakina endoumensis Muricy, Boury-Esnault, Bézac & Vacelet, 1998
Plakina jani Muricy, Boury-Esnault, Bézac & Vacelet, 1998
Plakina monolopha Schulze, 1880
Plakina reducta (Pulitzer-Finali, 1983)
Plakina tetralophoides Muricy, Boury-Esnault, Bézac & Vacelet, 1998
Plakina topsenti (Pouliquen, 1972)
Plakina trilopha Schulze, 1880
Plakina weinbergi Muricy, Boury-Esnault, Bézac & Vacelet, 1998
Plakinastrella copiosa Schulze, 1880
Plakinastrella mixta Maldonado, 1992
Plakortis simplex Schulze, 1880
Pseudocorticium jarrei Boury-Esnault, Muricy, Gallissian & Vacelet, 1995

Among the 22 Mediterranean species the most widely distributed are *Corticium candelabrum, O. lobularis, O. tuberculata, P. monolopha, P. trilopha* and *P. simplex* (Tab. 2). These species inhabit predominantly coralligenous substrates at the depth from 10 to more than 100 m, but also in caves. The highest number of reports belong to the Northern coastal regions of Mediterranean.
Corticium candelabrum (Fig. 1) is a tiny thinly encrusting to cushion-shaped sponge, sometimes lobate, with a colour from light brown to brown and sometimes reddish. Its consistency is firm to cartilaginous, and its skeleton is dominated by clathrops of several types. This species is quite common in shallow coralligenous community.
Oscarella lobularis (Fig. 1) was long considered as the only species of the genus *Oscarella*, with different chromotypes and consistencies. This sponge is thinly encrusting to lobate, from white to deep purple and sometimes blue. This sponge is devoid of skeleton and its consistency is rather soft. This species is one of the most common and abundant Homoscleromorpha in the Mediterranean, conditioning specific facies in some places. It is distributed from shallow waters down to 300 m, in the coralligenous community and at the entrance of caves. This species is regularly found growing on the sea-fan *Paramuricea clavata*.
Oscarella tuberculata (Fig. 1) is one of the "sister species" of *O. lobularis*, which is also common in shallow coralligenous community. This sponge is also thinly encrusting to lobate, but its color is highly variable (yellow, green, blue and sometimes pink). Its consistency is more cartilaginous than *O. lobularis*, it harbors a particular type of vacuolar cell which also allow distinguishing both "sister" species.
We recently found a new *Oscarella* species (Fig. 1, sp. 1) which has quite the same consistency of *O. lobularis*, but microlobate, with a color from white to orange. This species is able to out-compete many other invertebrates dwelling in the coralligenous (gorgonians, bryozoans and other sponges), probably due to a very efficient secondary metabolism.

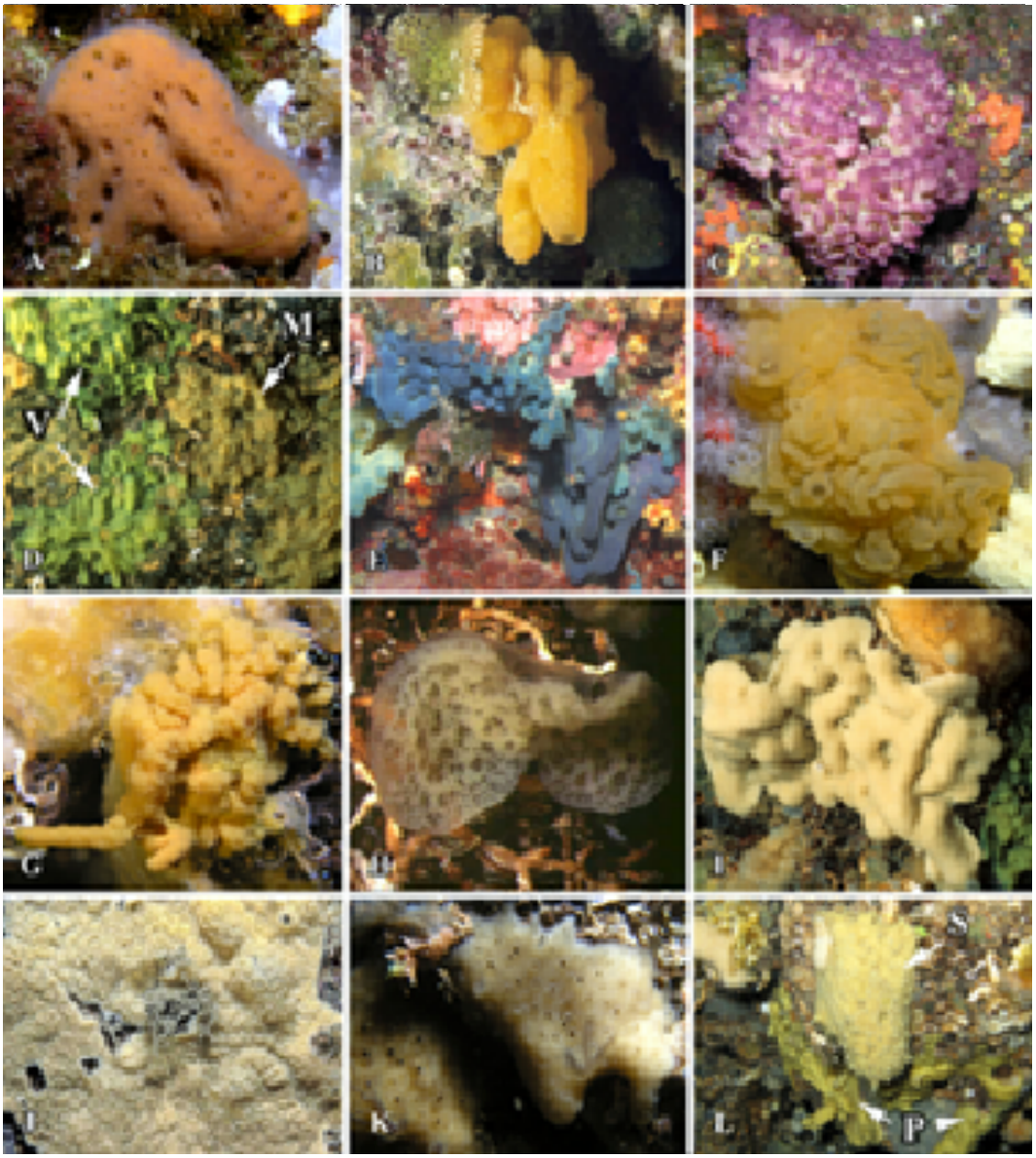

Fig. 1: Some Mediterranean Homoscleromorpha species. A – *Corticium candelabrum* ; B - *Oscarella imperialis*; C - *Oscarella lobularis*; D - *Oscarella microlobata* (M) and *Oscarella viridis* (V); E - *Oscarella tuberculata*; F – *Oscarella* sp. 1; G - *Oscarella* sp. 2; H - *Plakina crypta*; I - *Plakina trilopha*; J - *Plakina monolopha*; K - *Plakina weinbergi*; L - *Plakortis simplex* (S) and *Plakina jani* (P).

Species dwelling in submarine cave remain poorly known. 82% of Mediterranean Homoscleromorph species can be cave dwellers and 41% are only found in semi dark and dark caves (Table 2). Several new homoscleromorph species were recently described in some Mediterranean caves: *O. microlobata, O. viridis, P. crypta, P. endoumensis, P. jani, P. topsenti, P. trilopha, P. weinbergi* and *Pseudocorticium jarrei* (Tab 2). Some of these species were only registered in one or two Mediterranean locations. Moreover, within these sites, we have also found out some potential new species which will be described soon.
Among the Mediterranean species, one remains rather puzzling: *Placinolopha moncharmonti,* which has been found only once – near Naples (Italy) at the depth 90 m.

Tab 2: Distribution of Homoscleromorpha sponges in the Mediterranean Sea

Species	Regions and sectors of Mediterranean	Habitat	Depth (m)	References
Corticium candelabrum	WR*, septentrional sector; ASR* middle, lower sectors; ER*: septentrional, central, meridional (Aegean, Levantine Seas) sectors	Coralligenous/cave	1 - 60	Pulitzer-Finali, 1983; Uriz, Bibiloni, 1984; Voultsiadou, 2005;
Oscarella imperialis	WR, septentrional sector	Coralligenous	15 - 25	Muricy et al. 1996
O. lobularis	WR, septentrional; ASR, high sector	Coralligenous	5 - 35	Boury-Esnault *et al.* 1992
O. microlobata	WR, septentrional sector; ER: meridional (Liban, Levantine Seas) sector	Cave	15 (6-34)	Muricy *et al.* 1996; Voultsiadou, 2005
O. tuberculata	WR, septentrional, central (Spain, Italy, Corse) sectors; Gibraltar; ASR high (Limski Kanal), middle sector; ER: central, meridional (Aegean, Levantine Seas) sectors	Coralligenous/cave	1 – 40 - 350	Pulitzer-Finali, 1983; Carballo, 1994; Uriz, Bibiloni, 1984; Boury-Esnault *et al.* 1992; Voultsiadou, 2005
O. viridis	WR, septentrional sector	Cave	15	Muricy *et al.* 1996
Oscarella sp. nov.	WE, septentrional, central (Corse) sectors, ASR middle sector	Coralligenous/cave	8 - 30	Unpubl.
Placinolopha moncharmonti	WR, central sector (Italy - Naples)	Coralligenous	90	Sara, 1960
Plakina bowerbanki	WE, central (Italy) sector; ASR middle, lower sectors (Trimiti isl),	Deep sea	1 - 15	Sara, 1961a; Pulitzer-Finali, 1983
P. crypta	WR, septentrional sector (3PP Cave - La Ciotat, France)	Cave	22	Muricy *et al.* 1998
P. dilopha	WE, septentrional, central (Italy) sectors; ASR high sector; ER: septentrional, central sectors	Cave	4	Voultsiadou, 2005
P. endoumensis	WR, septentrional sector	Cave	3 - 5	Muricy *et al.* 1998
P. jani	WR, septentrional sector	Cave	15-20	Muricy *et al.* 1998
P. monolopha	WR, septentrional, central sectors (Spain, Italy); Gibraltar; ASR, high, middle sectors; ER: septentrional, sector	Coralligenous/cave	2 – 40 (1 – 370)	Sara, 1961a; Pulitzer-Finali, 1983; Carballo, 1994; Uriz, Bibiloni, 1984; Voultsiadou, 2005
P. reducta	ASR: middle sector; ER: meridional (Liban, Levantine Sea) sector	Cave	5 – 30	Pulitzer-Finali, 1983; Voultsiadou, 2005
P. topsenti	WR, septentrional, central sectors	Coralligenous/cave	12	Pouliquen, 1972; Pulitzer-Finali, 1983
P. trilopha	WR, septentrional, central (Italy, Spain) sectors; ASR: middle, (i. Tremiti, Bari), lower sectors. ER: septentrional, sector	Cave	1 – 40 (570)	Sara, 1961a,b; 1962; Pulitzer-Finali, 1983; Uriz, Bibiloni, 1984; Muricy *et al.* 1998; Voultsiadou, 2005
P. weinbergi	ER, central (Crete), meridional (Liban, Levantine Sea) sectors	Cave	9 - 20	Muricy *et al.* 1998; Vacelet unpubl.
Plakinastrella copiosa	WR, septentrional, central sectors; ER: septentrional, sector;	Coralligenous/cave	10 - 20	Uriz, Bibiloni, 1984; Voultsiadou, 2005
P. mixta	WR, central sector (Spain – Alboran; Italy - Naples)	Deep sea	70 - 120	Maldonado, 1992
Plakortis simplex	WR, septentrional, central sectors (France, Spain, Italy - Naples); ASR: middle, lower sectors (i. Tremiti, Bari); ER: central (Crete), septentrional (Aegean Sea), meridional (Liban, Levantine Sea) sectors;	Coralligenous/cave	1 - 110	Sara, 1961a, b; 1962; Pulitzer-Finali, 1983; Uriz, Bibiloni, 1984; Voultsiadou, 2005;
Pseudocorticium jarrei	WR, septentrional sector; ER: meridional (Liban) sector	Cave	14-16	Boury-Esnault *et al.* 1995; Vacelet unpubl.

* Subdivision of Mediterranean on biogeographical region accepted in this work according Fredj (1972). WR - western region, ER – estern region, ASR – Adriatic Sea region.

CONCLUSION

Complementary tools are necessary for the investigation of Homoscleromorpha sponge diversity in the Mediterranean. For example, a chemical fingerprint approach giving an indication of the sponge metabolome is now applied to most Mediterranean Homoscleromorpha species (Ivanisevic *et al.*, 2008) in order to contribute to a phylogenetic analysis using a combination of morphological, cytological, chemical and molecular characters. Homoscleromorph sponges display many features that distinguish them from other sponges and are more evocative of the Eumetazoa. That made this group very important for evolutionary development studies. That is the reason why we have also just proposed *O. lobularis* as a new sponge model for this research field (Ereskovsky *et al.*, 2009).

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