

## Census of biodiversity in marine caves of the eastern Mediterranean Sea

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### Abstract

Scientific information on the biodiversity of marine caves in the eastern Mediterranean is limited, especially when considering the extensively studied caves of the north-western and central Mediterranean. Aiming to enhance current knowledge regarding cave communities, this study represents a first assessment of the marine cave biota of the eastern Mediterranean, as defined by the European Union's Marine Strategy Framework Directive (MSFD). Information retrieved from an extensive overview of relevant scientific documents was combined with original data recorded from 23 marine caves in the north-eastern Mediterranean. Our results report a total of 520 taxa recorded in eastern Mediterranean marine caves to date, the majority of which are sponges, polychaetes, rhodophytes, bivalves, fishes, and gastropods. These include several protected, endemic and alien species. However, not all taxonomic groups from different areas have been equally investigated and future studies are expected to increase the number of endemic and alien species. The observed general trend is that the reported species number is generally related to sampling effort and scientific expertise. The most well-studied marine cave communities in the eastern Mediterranean are those of the Aegean Sea (especially its northern sector), which presented the highest number of species, followed by those of the Levantine. Furthermore, our research in Aegean caves revealed numerous new records for the marine cave fauna of the eastern basin, while several species are reported for the first time in a marine cave habitat. The critical need for further scientific research, monitoring, and conservation of this unique ecosystem was highlighted by (i) the presence of certain species endemic to the eastern Mediterranean coupled with a high proportion of alien species, especially in the Levantine Basin, and (ii) marine cave habitat availability in isolated insular areas of the eastern Mediterranean.

**Keywords:** Marine caves, biodiversity, Eastern Mediterranean, Aegean Sea, Levantine, Marine Strategy Framework Directive.

### Introduction

Marine caves constitute a typical feature of the Mediterranean rocky coastline. According to the most recent census, 738 marine caves have been recorded in the eastern Mediterranean to date, representing one fourth of the known Mediterranean marine caves (Giakoumi *et al.*, 2013). However, information regarding their biodiversity and community structure is limited compared to their north-western and central Mediterranean counterparts (Gerovasileiou & Voultsiadou, 2014).

The first scientific data concerning the biota of eastern Mediterranean marine caves were acquired during the "CALYPSO" expedition in the 1950s to Kastelorizo, a Greek island in the Levantine Basin (Laborel, 1961; Vacelet, 1961). Later on, Riedl (1966) provided additional biodiversity data for Aegean caves, while scattered information, focusing mainly on the description of rare and new species, was published in more general faunistic and taxonomic studies from the same area (e.g. Bailey, 1969; Hayward, 1974;

Pulitzer-Finali & Pronzato, 1981; Pulitzer-Finali, 1983; Voultsiadou-Koukoura & van Soest, 1991; Voultsiadou-Koukoura *et al.*, 1991; Voultsiadou & Vafidis, 2004).

Only a limited number of studies concern marine cave biodiversity in the Levantine Basin (e.g. Tournamal, 1969; 1975; Ben-Eliahu & Ten Hove, 1992), mostly including information from the coasts of Lebanon, where a number of new species have been described recently (e.g. Pérez *et al.*, 2004; Vacelet *et al.*, 2007; Harmelin *et al.*, 2009). Additional scattered information on Levantine cave biota is presented in studies on alien species (e.g. Bilecenoğlu & Taškavak, 1999; Bitar *et al.*, 2007; Tsiakiros & Zenetos, 2011; Gewing *et al.*, 2014).

Recently, focused research on the biodiversity and community structure of marine caves in the Aegean Sea has increased our knowledge of this habitat (Gerovasileiou & Voultsiadou, 2012; Gerovasileiou *et al.*, 2012; 2013). Gerovasileiou & Voultsiadou (2012) analysed data obtained from marine cave sponge communities in various Mediter-

anean areas and showed that sponges exhibit clear biogeographic patterns, thus underlining the need to conserve this habitat across the Mediterranean in order to ensure representativeness. Rastorgueff *et al.* (2014) studied cave mysid populations throughout the northern Mediterranean and revealed contrasting patterns of genetic structuring between the western and eastern parts of the basin, which could be attributed to the presence of phylogeographic breaks. Spatial heterogeneity among and within ecoregions is considered a crucial factor that needs to be taken into account in future conservation plans (Giakoumi *et al.*, 2013). However, the lack of scientific data on the biodiversity and community structure of fragmented habitats, such as marine caves, could hamper conservation actions.

Taking into account the high level of individuality of this particular habitat and the need to acquire further knowledge that will ensure its adequate conservation, the aim of this work is to: (i) present new data on the biodiversity of marine caves from the north-eastern Mediterranean, (ii) assess marine cave biodiversity throughout the eastern Mediterranean by combining field data and bibliographic information, and (iii) discuss local patterns and unique features.

## Materials and Methods

Since 2009, several marine caves in north-eastern Mediterranean coastal and insular areas were surveyed within the framework of a broader scientific study focusing on the biodiversity of Aegean Sea caves. Sampling was performed through SCUBA diving. Additional qualitative information provided by recreational divers (through web fora and direct communication) was also considered.

Furthermore, the scientific literature concerning marine caves of the Mediterranean Sea was reviewed and all biodiversity data were incorporated into a single database along with ecological and spatial information (see Methods in Gerovasileiou & Voultsiadou, 2012; 2014). In this database, protected species (including those under regulated exploitation) were identified according to OCEANA (2009 and references therein) as well as the Greek national legislative framework (e.g. Presidential Decree 67/1981; Thessalou-Legaki & Legakis, 2005; Katsanevakis *et al.*, 2011 and references therein). The marine cave biodiversity list was also checked for the presence of alien species (see Methods in Gerovasileiou *et al.*, 2015). The ratio of eastern Mediterranean to total Mediterranean marine cave biodiversity was calculated based on data given in Gerovasileiou & Voultsiadou (2014).

The borders of the eastern Mediterranean were defined according to the European Union's Marine Strategy Framework Directive (MSFD) and encompass the Aegean and Levantine ecoregions as defined by Spalding *et al.* (2007). To facilitate analysis, the eastern Mediterranean was further subdivided into three biogeographic subareas: Northern Aegean (NA), Southern Aegean (SA), and Levantine (LB).

## Results

A total of 62 studies, published during the last 55 years, were found to include data on marine cave biota of the eastern Mediterranean; however, only 14 of them focused exclusively on marine caves, the rest being general ecological, faunistic, and taxonomic studies. Most studies (41) concerned the Aegean ecoregion (20 in the north and 16 in the south Aegean seas), while 35 studies concerned marine caves of the Levantine Basin. Furthermore, this study provided new biodiversity data for 23 marine caves and cave systems (sites with numerous neighbouring marine caves and tunnels), mainly from insular areas of the north-eastern Mediterranean (Fig. 1).

The combined field research and literature review resulted in a total of 520 taxa belonging to 34 groups (Table 1), representing 24% of total Mediterranean marine cave biodiversity. Sponges were the dominant group in terms of species number followed by polychaetes, rhodophytes, bivalves, fishes and gastropods (Table 2 and Figure 2). Concerning the spatial variability of cave biota, a higher number of taxa was reported from the entrance and semidark zones (260 and 265 taxa respectively), compared to the dark zone (116) whereas, for 92 taxa, the cave zone was not specified.

The northern Aegean Sea displayed the highest number of taxa (324 taxa, representing 15% of total Mediterranean marine cave diversity), followed by the Levantine Basin (175 taxa, 8%) and the southern Aegean (157 taxa, 7%). The best studied northern Aegean caves, Fara and Agios Vasilios, hosted 200 and 170 taxa respectively while the best studied Levantine caves were those of Selaata, harbouring 57 taxa. The various taxonomic groups were not equally represented among areas. For instance, northern Aegean caves hosted 100% of the Mediterranean cave Echiura and Phoronida, 50% of the Tanaidacea, approximately 30% of Porifera, Anthozoa, Sipuncula, Cephalopoda, Brachiopoda, Echinodermata and Pisces, and 25% of Polychaeta and Scyphozoa. Respectively, Levantine caves harboured 50% of the Mediterranean cave Bivalvia and 44% of Brachiopoda, while southern Aegean caves hosted 51% of the Mediterranean marine cave Phaeophyceae and 30% of Rhodophyta.

A considerable proportion of taxa recorded in this study are new records for the marine cave biodiversity of the northern Aegean Sea (55.5%), the southern Aegean Sea (25%), and the Levantine Basin (7%). Additionally, 15 species are reported for the first time in marine caves, either as cave-dwellers or occasional visitors (Table 1). A high number of species (88) are protected by national and international legislation (including those under regulated exploitation) (Table 1). It is notable that 46 alien species (Table 1) have been recorded in caves of the eastern basin, covering 9% of its marine cave biodiversity. Most alien species were recorded in the Levantine Basin (43), covering 25% of local marine cave biodiversity (100% of the recorded Tunicata and Echinodermata, 75% of Bryozoa,



**Fig. 1:** Map showing the locations of marine caves for which new data are presented in this study (names of caves are given in the Footnote to Table 1).

67% of Gastropoda, 43% of Pisces, 37% of Hydrozoa, 33% of Decapoda, 28% of Polychaeta and 18% of Bivalvia).

The species encountered in several different marine caves in the eastern Mediterranean were: the chlorophyte *Palmophyllum crassum*; the benthic foraminiferan *Miniacina miniacea*; the sponges *Agelas oroides*, *Spirastrella cunctatrix*, *Phorbas tenacior*, *Axinella damicornis*, *Petrosia ficiformis*, *Chondrosia reniformis*, *Ircinia oros*, *Terpios gelatinosa*, *Axinella verrucosa*, and *Dendroxea lenis*; the anthozoans *Madracis pharensis* and *Leptosammia pruvoti*; the brachiopod *Novocrania anomala*; the tunicate *Halocynthia papillosa*; and the cardinal fish *Apogon imberbis* (Table 1).

## Discussion

The limited research effort carried out in the marine caves of the eastern Mediterranean, compared to that of the western Mediterranean, is illustrated by the average trend of cave-related publications: approximately 1 study per year for the eastern basin, versus an upward general trend of 5 studies per year for the entire Mediterranean (Gerovasileiou & Voultsiadou, 2012; 2014). A zoogeographical gradient, i.e. a north-west to south-east decrease of species number was observed for sponges, anthozoans, and polychaetes, in accordance with previous studies (Vafidis *et al.*, 1994; Voultsiadou, 2005a; 2009; Gerovasileiou & Voultsiadou, 2012). However, it should be taken into account that geographical patterns of species number generally follow trends in sampling effort and scientific expertise, whereas quantitative information only exists for two marine caves of the northern Aegean Sea (Gerovasileiou *et al.*, 2013; 2014).

The studied eastern Mediterranean cave communi-

ties present certain differences from their western Mediterranean counterparts, such as (i) a scarcity or lack of erect, branching anthozoans (e.g. gorgonian and red coral facies), which often thrive at the entrance and in semidark zones of north-western Mediterranean caves, and (ii) the presence of species endemic to the eastern Mediterranean. This might be related to temperature and trophic differences between the two basins, as suggested by Bibiloni & Gili (1982) and Uriz *et al.* (1993), who compared marine caves of the Balearic Islands (characterized by oligotrophic conditions and higher water temperatures) and the continental north-western Mediterranean coast. Specific characteristics of marine cave communities from the different areas of the eastern Mediterranean are discussed in detail below.

As indicated by the results, the Aegean Sea is the most thoroughly studied area in the eastern Mediterranean regarding its marine cave biodiversity, and hosts some of the richest caves, as far as species number is concerned, studied in the Mediterranean Sea. However, there are marked differences between its northern and southern sectors the northern Aegean is influenced by the brackish cold water input from the Black Sea through the Dardanelles Strait and higher river runoff in contrast to the southern sector, which receives saline warm water flowing northwards from the Levantine (Lykousis *et al.*, 2002). These differences are reflected in the higher productivity and diversity of the northern Aegean (Voultsiadou, 2005a; 2009). In further support of this, Gerovasileiou & Voultsiadou (2012) showed that species composition of the marine cave sponge fauna of the northern Aegean resembled that of the north-western Mediterranean, while the southern Aegean cave sponge fauna displayed closer affinities to that of the Levantine.

In this study, the well-studied northern Aegean marine caves were found to support a rich fauna of sponges, scleractinians, polychaetes, decapods, echinoderms, and fishes, comparable in species number to that of the well-studied north-western Mediterranean caves. They also host endemic eastern Mediterranean species (e.g. the sponges *Axinella cannabina*, *Coscinoderma sporadense*, *Hemiaspiterella aristoteliana*, and *Ircinia paucifilamentosa*, and the bryozoan *Hippaliosina depressa*), as well as species that are not as common in the north-western basin (e.g. *Madracis pharensis*). The fact that several species found in northern Aegean caves are reported for the first time as cave-dwellers may partly be attributed to the recently increased research effort, but may also reflect the presence of occasional visitors. The scleractinian coral *Ceratrotrochus magnaghii* observed on the ceiling of the dark interior zone in two marine caves (10-30 m) is reported for the second time from the eastern Mediterranean. Its present finding in the Aegean Sea constitutes the shallowest record for the species after its recent finding in deep (426-1334 m) *Neopycnodonte-Desmophyllum* framestones, west of Crete (Taviani *et al.*, 2011).

**Table 1.** List of taxa recorded in marine caves of the eastern Mediterranean Sea (NA: Northern Aegean, SA: Southern Aegean, LB: Levantine; CE: cave entrance, SD: semidark zone; D: dark zone, Un: unspecified; † first record as cave-dwellers/occasional visitors, \* first record for local marine cave biodiversity, ‡ alien species, \*\* threatened species or protected by national/international legislation). Numbers represent different marine caves (see Footnote).

Species	NA	SA	LB	Number of caves	Cave zone
<b>Kingdom Chromista</b>					
<b>Phylum Ochrophyta</b>					
<i>Cladostephus spongiosus</i> (Hudson) C. Agardh		14		1	CE
<i>Cutleria chilosa</i> (Falkenberg) P.C.Silva		14		1	CE
<i>Cystoseira amentacea</i> var. <i>stricta</i> Montagne **		15		1	CE
<i>Cystoseira crinita</i> Duby		15		1	CE
<i>Cystoseira spinosa</i> Sauvageau **		15		1	CE
<i>Dictyopteris polypodioides</i> (De Candolle) J.V. Lamouroux		14		1	CE
<i>Dictyota dichotoma</i> (Hudson) J.V. Lamouroux	1*	15, 16		3	CE
<i>Dictyota implexa</i> (Desfontaines) J.V.Lamouroux		15		1	CE
<i>Halopteris filicina</i> (Grateloup) Kützing		14		1	CE
<i>Hinckesia sandriana</i> (Zanardini) P.C.Silva		14		1	CE
<i>Lobophora variegata</i> (J.V. Lamouroux) Womersley ex E.C.Oliveira		14		1	CE
<i>Nereia filiformis</i> (J.Agardh) Zanardini		14		1	CE
<i>Padina pavonica</i> (Linnaeus) Thivy	1*	15		2	CE
<i>Sargassum acinarium</i> (Linnaeus) Setchell **		15		1	CE
<i>Sphacelaria cirrosa</i> (Roth) C. Agardh		14		1	CE
<i>Taonia atomaria</i> (Woodward) J. Agardh		14		1	CE
<i>Zanardinia typus</i> (Nardo) P.C.Silva	1*			1	CE
<i>Zonaria tournefortii</i> (J.V.Lamouroux) Montagne		14		1	CE
<b>Phylum Foraminifera</b>					
<i>Miniacina miniacea</i> (Pallas, 1766)	1, 2, 3, 4*	16, 17, 18, 19, 20*		9	CE, SD, D
<b>Kingdom Plantae</b>					
<b>Phylum Chlorophyta</b>					
<i>Bryopsis duplex</i> De Notaris		15		1	CE
<i>Bryopsis plumosa</i> (Hudson) C. Agardh		15		1	CE
<i>Cladophora echinus</i> (Biasoletto) Kützing		14		1	CE
<i>Codium bursa</i> (Olivi) C.Agardh	2, 4*			2	CE
<i>Flabellia petiolata</i> (Turra) Nizamuddin	1, 2, 4*			3	CE
<i>Palmophyllum crassum</i> (Naccari) Rabenhorst	1, 2, 3, 4	16, 17, 18, 19, 20, 21, 22, 23*	40*	13	CE, SD
<i>Valonia macrophysa</i> Kützing	1, 3*	14, 24		4	CE
<b>Phylum Rhodophyta</b>					
<i>Acrodiscus vidovichii</i> (Meneghini) Zanardini		14		1	CE
<i>Aglaothamnion caudatum</i> (J. Agardh) Feldmann-Mazoyer		14		1	CE
<i>Amphiroa cryptarthrodia</i> Zanardini		14		1	CE
<i>Apoglossum ruscifolium</i> (Turner) J. Agardh		14		1	CE
<i>Asparagopsis taxiformis</i> (Delile) Trevisan de Saint-Léon ‡		25		1	CE
<i>Chrysomenia ventricosa</i> (J.V. Lamouroux) J. Agardh		14		1	CE
<i>Corallina</i> sp.			41	1	CE
<i>Crouania attenuata</i> (C. Agardh) J. Agardh		14		1	CE
<i>Cryptonemia lomation</i> (Bertoloni) J. Agardh		14		1	CE
<i>Digenea simplex</i> (Wulfen) C. Agardh		14		1	CE
<i>Dipterosiphonia rigens</i> (Shousboe ex C.Agardh) Falkenberg		14		1	CE
<i>Eupogodon planus</i> (C.Agardh) Kützing		14		1	CE
<i>Feldmannophycus rayssiae</i> (Feldmann & G.Feldmann) Augier & Boudouresque		14		1	CE
<i>Gelidium bipectinatum</i> Furnari		14		1	CE
<i>Gelidium pusillum</i> (Stackhouse) Le Jolis		14		1	CE

(continued)

Table 1 (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Gymnothamnion elegans</i> (Schousboe ex C. Agardh) J. Agardh		14		1	CE
<i>Herposiphonia tenella</i> (C. Agardh) Ambronn		14		1	CE
<i>Hydrolithon farinosum</i> (J.V. Lamouroux) D. Penrose & Y.M. Chamberlain		14		1	CE
<i>Hypoglossum hypoglossoides</i> (Stackhouse) F.S. Collins & Hervey		14		1	CE
<i>Irvinea boergesenii</i> (Feldmann) R.J. Wilkes, L.M. McIvor & Guiry		14		1	CE
<i>Jania adhaerens</i> J.V. Lamouroux		14		1	CE
<i>Jania rubens</i> (Linnaeus) J.V. Lamouroux		15		1	CE
<i>Jania virgata</i> (Zanardini) Montagne		14		1	CE
<i>Laurencia obtusa</i> (Hudson) J.V. Lamouroux		15		1	CE
<i>Lithophyllum byssoides</i> (J.V. Lamouroux) Foslie **		15, 26		2	CE
<i>Lithophyllum incrustans</i> R.A. Philippi		26		1	CE
<i>Lithophyllum stictaeforme</i> (Areschoug) Hauck		20*	42	2	CE
<i>Mesophyllum alternans</i> (Foslie) Cabioch & M.L. Mendoza **		20*	40, 42	3	CE
<i>Mesophyllum expansum</i> (Philippi) Cabioch & M.L. Mendoza **	5	14, 26		3	CE
<i>Mesophyllum lichenoides</i> (J. Ellis) M. Lemoine		26		1	CE
<i>Monosporus pedicellatus</i> (J.E. Smith) Solier		14		1	CE
<i>Myriogramme distromatica</i> J.J. Rodriguez ex Boudouresque		14		1	CE
<i>Neogoniolithon mamillosum</i> (Hauck) Setchell & L.R. Mason **		26		1	CE
<i>Neurocaulon foliosum</i> (Meneghini) Zanardini		14		1	CE
<i>Nitophyllum punctatum</i> (Stackhouse) Greville		14		1	CE
<i>Osmundea pinnatifida</i> (Hudson) Stackhouse		15		1	CE
<i>Parviphyicus pannosus</i> (Feldmann) G. Furnari		14		1	CE
<i>Peyssonnelia bornetii</i> Boudouresque & Denizot		14, 20		2	CE
<i>Peyssonnelia crispata</i> Boudouresque & Denizot		14		1	CE
<i>Peyssonnelia orientalis</i> (Weber-van Bosse) Cormaci & G. Furnari		14		1	CE
<i>Peyssonnelia rosa-marina</i> Boudouresque & Denizot **	2, 3, 6			3	CE
<i>Peyssonnelia rubra</i> (Greville) J. Agardh		14, 20		2	CE
<i>Peyssonnelia</i> sp.	4		42, 43	3	CE
<i>Peyssonnelia squamaria</i> (S.G. Gmelin) Decaisne		14		1	CE
<i>Phyllophora crispa</i> (Hudson) P.S. Dixon **		14		1	CE
<i>Pleonosporium borneri</i> (Smith) Nägeli		14		1	CE
<i>Pterocladia capillacea</i> (S.G. Gmelin) Santelices & Hommersand		15		1	CE
<i>Pterocladia</i> sp.			41	1	CE
<i>Pterothamnion plumula</i> (J. Ellis) Nägeli		14		1	CE
<i>Ptilothamnion pluma</i> (Dillwyn) Thuret		14		1	CE
<i>Radicilingua reptans</i> (Kyllin) Papenfuss		14		1	CE
<i>Rhodophyllis divaricata</i> (Stackhouse) Papenfuss		14		1	CE
<i>Rhodymenia ardissonae</i> (Kuntze) Feldmann		14		1	CE
<i>Schizymenia dubyi</i> (Chauvin ex Duby) J. Agardh **		26		1	CE
<i>Sphaerococcus coronopifolius</i> Stackhouse		14		1	CE
<b>Kingdom Animalia</b>					
<b>Phylum Porifera</b>					
<i>Aaptos aaptos</i> (Schmidt, 1864)	2, 3, 7			3	CE, SD
<i>Acanthella acuta</i> Schmidt, 1862	1, 2, 3, 7, 8	17, 18	46	8	CE, SD, D
<i>Agelas oroides</i> (Schmidt, 1864)	1, 2, 3, 4, 6, 7, 8, 9, 10	16, 17, 18, 19, 20, 22, 23, 24, 27, 28, 29, 30, 31, 32	40, 42	25	CE, SD, D
<i>Aplysilla rosea</i> (Barrois, 1876)	1, 2, 3, 6, 7, 10	24	40*	8	CE, SD, D
<i>Aplysina aerophoba</i> Nardo, 1843 **	3			1	CE, SD, D
<i>Axinella cannabina</i> (Esper, 1794) **	2, 6, 9			3	CE, SD
<i>Axinella damicornis</i> (Esper, 1794)	1, 2, 3, 4, 6	16, 17, 18, 20, 22, 24, 27, 29, 30	40*	15	CE, SD

(continued)

**Table 1** (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Axinella polypoides</i> Schmidt, 1862 **	8		46, 47, 48	4	SD
<i>Axinella</i> sp.	2, 3			2	SD
<i>Axinella verrucosa</i> (Esper, 1794)	1, 2, 8	22, 23, 24, 28, 30	40*	9	SD
<i>Bubaris</i> sp.	2			1	SD
<i>Cacospongia mollior</i> Schmidt, 1862	7			1	SD
<i>Chondrosia reniformis</i> Nardo, 1847	1, 2, 3, 4, 7, 10	16, 17, 18, 19, 31	42	12	CE, SD, D
<i>Cinachyrella levantinis</i> Vacelet, Bitar, Carteron, Zibrowius & Perez, 2007			47, 49	2	SD
<i>Clathrina clathrus</i> (Schmidt, 1864)	2, 3	20*	45	4	CE, SD, D
<i>Clathrina coriacea</i> (Montagu, 1814)			45	1	CE, SD
<i>Cliona celata</i> Grant, 1826	2, 8			2	CE, SD
<i>Cliona schmidtii</i> (Ridley, 1881)	1, 2, 3	17, 22	50	6	CE, SD
<i>Cliona viridis</i> (Schmidt, 1862)	2*	33		2	CE, SD
<i>Coscinoderma sporadense</i> Voultziadou-Koukoura, van Soest & Koukouras, 1991	2, 3, 4, 8			4	SD
<i>Crambe crambe</i> (Schmidt, 1862)	6, 7, 8, 10	16, 18, 34	46	8	CE, SD
<i>Crella</i> sp.	3			1	SD
<i>Dendrilla</i> sp.	2, 3			2	SD, D
<i>Dendroxea lenis</i> (Topsent, 1892)	2, 3, 4	18, 19, 20, 22, 27*	40*	9	CE, SD, D
<i>Didiscus stylifer</i> Tsuramal, 1969			45	1	CE, SD
<i>Dictyonella incisa</i> (Schmidt, 1880)	1, 2, 3, 7	22*		5	SD
<i>Dictyonella marsilii</i> (Topsent, 1893)	8			1	SD
<i>Dictyonella obtusa</i> (Schmidt, 1862)	3			1	SD
<i>Diplastrella bistellata</i> (Schmidt, 1862)	2, 4, 8	20*		4	SD, D
<i>Diplastrella ornata</i> Rützler & Sará, 1962		33	45	2	D
<i>Discodermia polymorpha</i> Pisera & Vacelet, 2011	8			1	SD
<i>Dysidea avara</i> (Schmidt, 1862)	2			1	SD, D
<i>Dysidea fragilis</i> (Montagu, 1818)	2			1	SD
<i>Erylus discophorus</i> (Schmidt, 1862)	8	33	51	3	SD
<i>Eurypon clavatum</i> (Bowerbank, 1866)	2, 3			2	SD, D
<i>Eurypon</i> sp.	3			1	D
<i>Euryspongia raouchensis</i> Vacelet, Bitar, Carteron, Zibrowius & Perez, 2007			41	1	SD, D
<i>Fasciospongia cavernosa</i> (Schmidt, 1862)	1, 3, 8	17, 20, 22, 24		7	CE, SD
<i>Gastrophanella phoeniciensis</i> Perez, Vacelet, Bitar & Zibrowius, 2004			51	1	D
<i>Geodia cydonium</i> (Jameson, 1811) **	7	33		2	SD
<i>Halichondria</i> sp.1	3			1	SD
<i>Halichondria</i> sp.2	7			1	CE
<i>Halichondrida</i> sp.	2, 3			2	SD, D
<i>Haliclona (Gellius) microsigma</i> (Babic, 1922)	2			1	D
<i>Haliclona (Halichoclona) fulva</i> (Topsent, 1893)	2, 3	24		3	CE, SD, D
<i>Haliclona (Halichoclona) perlucida</i> (Griessinger, 1971)	2			1	SD
<i>Haliclona (Reniera) cratera</i> (Schmidt, 1862)		33		1	Un
<i>Haliclona (Reniera) mediterranea</i> Griessinger, 1971	2			1	CE
<i>Haliclona (Soestella) mucosa</i> (Griessinger, 1971)	1, 2, 3	16, 19, 20, 22		7	CE, SD, D
<i>Haliclona</i> sp.1	1			1	SD, D
<i>Haliclona</i> sp.2	2			1	SD
<i>Haliclona</i> sp.3	2			1	D
<i>Haliclona</i> sp.4	1			1	SD, D
<i>Hamigera hamigera</i> (Schmidt, 1862)			42	1	SD
<i>Hemiasporella aristoteliana</i> Voultziadou-Koukoura & Van Soest, 1991	8			1	SD

(continued)

Table 1 (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Hemimycale columella</i> (Bowerbank, 1874)		16*		1	CE, SD
<i>Hexadella</i> sp.	2, 3			2	SD, D
<i>Hexadella pruvoti</i> Topsent, 1896	1, 2, 3, 4	18, 20, 30		7	CE, SD, D
<i>Hexadella racovitzae</i> Topsent, 1896	2, 3			2	CE, SD, D
<i>Hyrtios collectrix</i> (Schulze, 1880)	2			1	CE
<i>Ircinia dendroides</i> (Schmidt, 1862)		33		1	SD
<i>Ircinia oros</i> (Schmidt, 1864)	1, 2, 4, 6, 7, 10	16, 18, 19, 20, 29		11	CE, SD
<i>Ircinia paucifilamentosa</i> Vacelet, 1961	1, 2, 3, 4, 8		42	6	CE, SD, D
<i>Ircinia variabilis</i> (Schmidt, 1862)	1, 2, 7, 8, 10	18, 24	48	8	CE, SD
<i>Jaspis johnstonii</i> (Schmidt, 1862)	1, 2, 3, 7, 8	17, 18	46	8	CE, SD
<i>Jaspis</i> sp.	3			1	D
<i>Leucetta solida</i> (Schmidt, 1862)			45	1	D
<i>Merlia normani</i> Kirkpatrick, 1908		33	42	2	SD
<i>Microscleroderma lamina</i> Perez, Vacelet, Bitar & Zibrowius, 2004			51	1	D
<i>Myrmekioderma spelaum</i> (Pulitzer-Finali, 1983)	1, 2, 8	18, 19, 20	46, 48	8	SD, D
Lithistida sp.	1*			1	SD
<i>Oceanapia</i> sp.	2			1	SD
<i>Oscarella balibalo</i> Pérez, Ivanisevic, Dubois, Pedel, Thomas, Tokina & Ereskovsky, 2011	2, 3			2	CE, SD
<i>Oscarella lobularis</i> (Schmidt, 1862)	4, 8	30*		3	CE, SD
<i>Oscarella microlobata</i> Muricy, Boury-Esnault, Bézac & Vacelet, 1996	2		50	2	D
<i>Oscarella tuberculata</i> (Schmidt, 1868)	2, 3			2	CE, SD
<i>Penares euastrum</i> (Schmidt, 1868)	2, 3, 8	20*	47	5	CE, SD, D
<i>Penares helleri</i> (Schmidt, 1864)	2, 8		46	3	SD
<i>Petrobiona massiliana</i> Vacelet & Lévi, 1958 **		31		1	SD
<i>Petrosia (Petrosia) ficiformis</i> (Poiret, 1789) **	1, 2, 4, 5, 7, 8, 10	18, 20, 22, 24, 27, 33, 34	42	15	CE, SD, D
<i>Petrosia (Strongylophora) vansoesti</i> Boury-Esnault, Pansini & Uriz, 1994	1, 8			2	SD, D
<i>Petrosia pulitzeri</i> Pansini, 1996		33		1	Un
<i>Phorbas tenacior</i> (Topsent, 1925)	1, 2, 3, 4, 6, 7, 8, 10	16, 17, 18, 19, 24, 28, 30, 33	40*	17	CE, SD
<i>Phorbas topsenti</i> Vacelet & Perez, 2008	3	17		2	CE
<i>Placospongia decorticans</i> (Hanitsch, 1895)			48	1	Un
<i>Plakina bowerbanki</i> (Sarà, 1960)	2, 3			2	CE, SD, D
<i>Plakina monolopha</i> Schulze, 1880	3, 8			2	SD, D
<i>Plakina reducta</i> (Pulitzer-Finali, 1983)			46, 48	2	Un
<i>Plakina</i> sp.1	2, 3			2	SD, D
<i>Plakina trilopha</i> Schulze, 1880	3			1	CE, SD, D
<i>Plakina weinbergi</i> Muricy, Boury-Esnault, Bézac & Vacelet, 1998		19	52, 53	3	Un
<i>Plakinastrella copiosa</i> Schulze, 1880	8			1	SD
Plakinidae sp.1	2			1	D
<i>Plakortis simplex</i> Schulze, 1880			51	2	Un
<i>Pleraplysilla spinifera</i> (Schulze, 1879)	1, 2, 3, 10	16, 22		6	CE, SD
<i>Protosuberites rugosus</i> (Topsent, 1893)	2			1	D
<i>Pseudocorticium jarrei</i> Boury-Esnault, Muricy, Gallissian & Vacelet, 1995	2, 3	18*	53	4	CE, SD, D
<i>Raspaciona aculeata</i> (Johnston, 1842)	2, 3*			3	CE, SD

(continued)

**Table 1** (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Sarcotragus foetidus</i> Schmidt, 1862 **	1, 2, 3, 8, 10			5	CE, SD
<i>Sarcotragus spinosulus</i> Schmidt, 1862	7			1	SD
<i>Spirastrella cunctatrix</i> Schmidt, 1868	1, 2, 3, 4, 5, 6, 7, 9, 10	16, 17, 18, 19, 20, 22, 23, 24, 27, 28, 29, 30, 32, 33	40, 42	25	CE, SD, D
<i>Spongia (Spongia) nitens</i> (Schmidt, 1862)	2, 3			2	SD
<i>Spongia (Spongia) officinalis</i> Linnaeus, 1759 **	1, 2, 7			3	CE, SD
<i>Spongia (Spongia) virgultosa</i> (Schmidt, 1868)	2, 3			2	CE, SD, D
<i>Spongionella pulchella</i> (Sowerby, 1804)	2			1	SD
<i>Spongosorites</i> sp.1	2			1	CE, SD
<i>Stryphnus mucronatus</i> (Schmidt, 1868)	4			1	SD
<i>Sycon elegans</i> (Bowerbank, 1845)	3*			1	SD, D
<i>Sycon humboldti</i> Risso, 1826			45	1	D
<i>Terpios gelatinosa</i> (Bowerbank, 1866)	1, 2, 3, 4, 6, 7, 10	16, 17, 23, 24		11	CE, SD, D
<i>Tethya aurantium</i> (Pallas, 1766) **	2			1	CE
<i>Thyrosiopsis cuticulatus</i> Vacelet & Perez, 1998	1, 2, 4, 6	17, 18, 19, 20		8	CE, SD, D
<i>Timea geministellata</i> Pulitzer-Finali, 1978	7			1	CE
<i>Timea</i> sp.1	3			1	D
<i>Timea unistellata</i> (Topsent, 1892)	2, 3	22*		3	CE, SD, D
<i>Topsentia lacazei</i> (Schmidt, 1868)			45	1	D
<b>Phylum Cnidaria</b>					
<i>Actinia equina</i> (Linnaeus, 1758)	10*		40*	2	CE, SD
<i>Actinia prasina</i> Gosse, 1860 †	7*			1	SD
<i>Aglaophenia octodonta</i> Heller, 1868			54	1	CE
<i>Aglaophenia picardi</i> Svoboda, 1979			54	1	CE
<i>Bimeria vestita</i> Wright, 1859			54	1	CE
<i>Calliactis parasitica</i> (Couch, 1842)	1*	29, 35		3	SD
<i>Campanularia hincksii</i> Alder, 1856			54	1	CE
<i>Caryophyllia inornata</i> (Duncan, 1878) **	2, 3, 4, 6*	16, 18, 24, 36		8	CE, SD, D
<i>Ceratotrochus magnaghii</i> Cecchini, 1914 **	2, 3*			2	D
<i>Cerianthus membranaceus</i> (Spallanzani, 1784)	2, 5	23, 30, 34		5	CE, SD, D
<i>Cladocora caespitosa</i> (Linnaeus, 1758) **	9			1	Un
<i>Clytia gracilis</i> (Sars, 1850)			54	1	CE
<i>Clytia hemisphaerica</i> (Linnaeus, 1767)			54	1	CE
<i>Clytia linearis</i> (Thorneley, 1900) ‡			54	1	CE
<i>Corallium rubrum</i> (Linnaeus, 1758) **	11			1	CE, SD
<i>Dynamena quadridentata</i> (Ellis & Solander, 1786) ‡			54	1	CE
<i>Eudendrium carneum</i> Clarke, 1882 ‡			54	1	CE
<i>Eudendrium merulum</i> Watson, 1985 ‡			54	1	CE
<i>Eudendrium racemosum</i> (Cavolini, 1785)			54	1	CE
<i>Eudendrium</i> sp.	2, 3			2	CE
<i>Filellum serratum</i> (Clarke, 1879) ‡			54	1	CE
<i>Guynia annulata</i> Duncan, 1872 **		36		1	D
<i>Halopteris diaphana</i> (Heller, 1868) **			54	1	CE
<i>Hoplangia durotrix</i> Gosse, 1860	1, 2, 3, 6	36	55	6	CE, SD, D
<i>Laomedea</i> sp.			54	1	CE
<i>Lafoeina tenuis</i> Sars, 1874			54	1	CE
<i>Leptopsammia pruvoti</i> Lacaze-Duthiers, 1897 **	1, 2, 3, 4	18, 20, 21, 22, 23, 24, 27, 29, 31*	40*	14	CE, SD, D

(continued)



Table 1 (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Madracis pharensis</i> (Heller, 1868) **	1, 2, 3, 4, 6, 10	16, 20, 22, 24, 27, 28, 30, 31, 32*	40, 42, 47	18	CE, SD, D
<i>Obelia dichotoma</i> (Linnaeus, 1758)			54	1	CE
<i>Oculina patagonica</i> de Angelis 1908 †**		25	54	1	CE, SD
<i>Paracyathus pulchellus</i> (Philippi, 1842) **	2, 3*	20*		3	SD, D
<i>Parazoanthus axinellae</i> (Schmidt, 1862) **	5, 9	16, 21, 24, 28*	40*	7	SD
<i>Pennaria disticha</i> (Goldfuss, 1820)			54	1	CE
<i>Phyllangia americana mouchezii</i> (Lacaze-Duthiers, 1897) **	2*	24*	55	3	CE, SD, D
<i>Polycyathus muelleriae</i> (Abel, 1959) **	1, 2, 4, 6*		40, 55	6	SD, D
<i>Rhizostoma pulmo</i> (Macri, 1778) †	1*			1	SD
<i>Sertularia marginata</i> (Kirchenpauer, 1864) ‡			54	1	CE
<i>Sertularia tongensis</i> (Stechow, 1919) ‡			54	1	CE
<b>Phylum Ctenophora</b>					
Ctenophora spp.	1*			1	SD
<b>Phylum Platyhelminthes</b>					
<i>Stylochus</i> sp.	2			1	SD
<b>Phylum Nemertea</b>					
Nemertea spp.	2, 3*			2	SD, D
<b>Phylum Nematoda</b>					
Nematoda spp.	2, 3*			2	SD, D
<b>Phylum Arthropoda</b>					
<b>Subphylum Crustacea</b>					
Anomura sp.1	2, 3*			2	SD
<i>Athanas nitescens</i> (Leach, 1814)	2, 3*			2	SD
<i>Carupa tenuipes</i> Dana, 1852 ‡		37		1	Un
<i>Charybdis (Charybdis) hellerii</i> (A. Milne-Edwards, 1867) ‡			54	1	SD
<i>Chthamalus</i> sp.	1, 10*			2	CE, SD
<i>Colomastix pusilla</i> Grube, 1861	2, 3*			2	CE, SD, D
Copepoda sp.1	3*			1	SD
Copepoda sp.2	3*			1	SD
Cumacea sp.	2, 3*			2	SD, D
<i>Dardanus arrosor</i> (Herbst, 1796)		35		1	Un
<i>Dardanus calidus</i> (Risso, 1827)	1*	29*		2	SD
<i>Dromia personata</i> (Linnaeus, 1758)	2*	18*		2	D
<i>Eualus occultus</i> (Lebour, 1936)	2, 3*			2	SD
<i>Eurynome aspera</i> (Pennant, 1777)	2*			1	CE
<i>Galathea strigosa</i> (Linnaeus, 1761)	2			1	SD
<i>Gammarus subtypicus</i> Stock, 1966 †	3*			1	SD
<i>Gnathia vorax</i> (Lucas, 1849)	2*			1	CE, SD, D
<i>Hemimysis margalefi sensu lato</i> Alcaraz, Riera & Gili, 1986		18, 19, 38	56	4	Un
<i>Herbstia condyliata</i> (Fabricius, 1787)	2, 3*			2	CE, SD
<i>Janira maculosa</i> Leach, 1814	2, 3*			2	CE, SD, D
<i>Leptocheirus bispinosus</i> Norman, 1908	2, 3*			2	SD, D
<i>Leptochelia savignyi</i> (Kroyer, 1842)	2, 3*			2	SD, D
<i>Leucothoe spinicarpa</i> (Abildgaard, 1789)	2, 3*			2	SD, D
<i>Liljeborgia dellavallei</i> Stebbing, 1906	2, 3*			2	CE, SD
<i>Lysianassa caesarea</i> Ruffo, 1987	2*			1	CE, SD
Mysida spp.	1, 2, 3, 4, 7*			5	SD, D
<i>Palaemon serratus</i> (Pennant, 1777) **	1, 4, 7*			3	SD, D
<i>Palinurus elephas</i> (Fabricius, 1787) **	1, 2, 3*		42	4	CE, SD, D
<i>Paradoxapseudes intermedius</i> (Hansen, 1895) †	2, 3*			2	SD, D

(continued)

Table 1 (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Phtisica marina</i> Slabber, 1769	3*			1	SD
<i>Pilumnus minutus</i> De Haan, 1835 ‡	2			1	CE
<i>Plesionika narval</i> (Fabricius, 1787)	2, 3	24, 31*		4	D
<i>Scyllarides latus</i> (Latreille, 1802) **	2*	29*	42	3	D
<i>Scyllarus arctus</i> (Linnaeus, 1758)**	3*			1	D
<i>Stenopus spinosus</i> Risso, 1826	2, 3, 7			3	SD, D
<i>Stenothoe</i> sp.	3*			1	SD
<i>Tanais dulongii</i> (Audouin, 1826)	2*			1	D
<b>Phylum Annelida</b>					
<b>Class Polychaeta</b>					
<i>Amphiglena mediterranea</i> (Leydig, 1851)	2*			1	SD
<i>Amphinome</i> sp.	3*			1	CE
<i>Amphitrite</i> sp.	2*			1	CE
<i>Boccardia polybranchia</i> (Haswell, 1885) †	2, 3*			2	SD, D
<i>Branchiomma bombyx</i> (Dalyell, 1853)	3*			1	SD
<i>Branchiosyllis exilis</i> (Gravier, 1900)			46, 48, 50	3	Un
<i>Ceratonereis (Composetia) costae</i> (Grube, 1840)	3*			1	SD
<i>Chone collaris</i> Langerhans, 1881	2, 3*			2	SD, D
<i>Chrysopetalum debile</i> (Grube, 1855)	3*			1	SD
<i>Dipolydora armata</i> (Langerhans, 1880)	2*			1	SD
<i>Dodecaceria concharum</i> Örsted, 1843	3*			1	SD
<i>Eupolymnia nebulosa</i> (Montagu, 1818)	2*	16*		2	SD
<i>Eupolymnia nesidensis</i> (Delle Chiaje, 1828)	2*			1	D
<i>Eusyllis kupfferi</i> Langerhans, 1879 ‡			46, 50	2	Un
<i>Exogone (Exogone) naidina</i> Örsted, 1845	2*			1	SD
<i>Exogone</i> sp.	2*			1	CE
<i>Filograna</i> sp.	3*	16, 24*		3	SD
<i>Filigranula annulata</i> (O. G. Costa, 1861)		36		1	Un
<i>Glycera tridactyla</i> Schmarda, 1861 †	2, 3*			2	SD
<i>Harmothoe spinifera</i> (Ehlers, 1864)	2, 3*			2	SD
<i>Hermodice carunculata</i> (Pallas, 1766)	1, 2, 3, 4	17, 20*		6	CE, SD, D
<i>Hydroides heterocerus</i> (Grube, 1868) ‡			45	1	Un
<i>Hydroides minax</i> (Grube, 1878) ‡			45	1	Un
<i>Janua (Dexiospira) pagenstecheri</i> (de Quatrefages, 1865)	5			1	Un
<i>Leodice torquata</i> (Quatrefages, 1866)	2*			1	SD
<i>Lumbrineris funchalensis</i> (Kinberg, 1865)	3*			1	SD
<i>Lysidice ninetta</i> Audouin & Milne-Edwards, 1833	2*			1	SD
<i>Myrianida prolifera</i> (O.F. Müller, 1788)			46	1	Un
<i>Myrianida</i> sp.	3*			1	CE
<i>Neanthes caudata</i> (Delle Chiaje, 1827) †	3*			1	SD
<i>Nereis zonata</i> Malmgren, 1867	2, 3*			2	SD, D
<i>Neodexiospira pseudocorrugata</i> (Bush, 1905)	5			1	Un
<i>Nidificaria clavus</i> (Harris, 1968)	5			1	Un
<i>Notomastus latericeus</i> Sars, 1851	2*			1	SD
<i>Odontosyllis fulgurans</i> (Audouin & Milne Edwards, 1833)			50	1	Un
<i>Oxydromus</i> sp.	3*			1	SD
<i>Palola siciliensis</i> (Grube, 1840)	2*			1	SD
<i>Perinereis</i> sp.	2, 3*			2	CE
<i>Phyllochaetopterus socialis</i> Claparède, 1869	4*			1	D
<i>Phyllodoce</i> sp.	3*			1	CE
<i>Phyllodocidae</i> sp.	2*			1	CE
<i>Pileolaria heteropoma</i> (Zibrowius, 1968)	5			1	Un
<i>Placostegus tridentatus</i> (Fabricius, 1779)	2, 3*			2	SD

(continued)

Table 1 (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Platynereis dumerilii</i> (Audouin & Milne Edwards, 1834)	2*			1	SD
<i>Polychaeta</i> sp.	3*			1	CE
<i>Polydora hoplura</i> Claparède, 1869 †	2, 3*			2	SD
<i>Polyophthalmus pictus</i> (Dujardin, 1839)	2*			1	SD
<i>Pontogenia chrysocoma</i> (Baird, 1865)	3*			1	SD
<i>Potamilla torelli</i> (Malmgren, 1866)	2*			1	SD
<i>Prionospio malmgreni</i> Claparède, 1869 †	2*			1	SD
<i>Proceraea aurantiaca</i> (Claparède, 1868)			46	1	Un
<i>Protolaeospira striata</i> (Quievreux, 1963)	5			1	Un
<i>Protula intestinum</i> (Lamarck, 1818)			42	1	SD
<i>Protula tubularia</i> (Montagu, 1803)	2, 3, 4*			3	CE, SD, D
<i>Pseudopotamilla reniformis</i> (Bruguière, 1789)	2, 3*			2	SD, D
<i>Sabella spallanzanii</i> (Gmelin, 1791)	3, 6*	27, 29*		4	CE, SD
<i>Salvatoria</i> sp.	3*			1	CE
<i>Serpula vermicularis</i> Linnaeus, 1767	4*			1	CE, SD
<i>Sphaerosyllis bulbosa</i> Southern, 1914	3*			1	SD
<i>Sphaerosyllis hystrix</i> Claparède, 1863	2, 3*			2	SD
<i>Sphaerosyllis pirifera</i> Claparède, 1868			46, 50	2	Un
<i>Spio filicornis</i> (Müller, 1776)	2*			1	SD
<i>Spiophanes</i> sp.	3*			1	CE
<i>Spirobranchus kraussii</i> (Baird, 1865) ‡			41	1	SD, D
<i>Spirobranchus polytrema</i> (Philippi, 1844)	2, 3*			2	SD
<i>Spirorbis cuneatus</i> Gee, 1964	5			1	Un
<i>Spirorbis</i> sp.	2, 3*			2	CE
<i>Subadyte pellucida</i> (Ehlers, 1864)	3*			1	SD
<i>Syllidia armata</i> Quatrefages, 1866	2*			1	SD
<i>Syllis amica</i> Quatrefages, 1866	2, 3*			2	SD, D
<i>Syllis armillaris</i> (O.F. Müller, 1776)	2*		46, 50	3	SD
<i>Syllis cf. mayeri</i> Musco & Giangrande, 2005 ‡			46, 48	2	Un
<i>Syllis corallicola</i> Verrill, 1900			46, 50	2	Un
<i>Syllis gracilis</i> Grube, 1840	3*		46, 51	3	SD
<i>Syllis hyalina</i> Grube, 1863	2, 3*		46, 50	4	SD
<i>Syllis jorgei</i> San Martín & López, 2000			50	1	Un
<i>Syllis variegata</i> Grube, 1860	2*			1	SD, D
<i>Trypanosyllis zebra</i> (Grube, 1840)			46, 50	2	Un
<i>Vermiliopsis infundibulum</i> (Philippi, 1844)	2*		45	2	SD
<i>Vermiliopsis labiata</i> (O. G. Costa, 1861)	3*			1	SD
<i>Vermiliopsis monodiscus</i> Zibrowius, 1968	2, 3*			2	SD
<i>Vinaria koehleri</i> (Caullery & Mesnil, 1897)	5			1	Un
<b>Phylum Sipuncula</b>					
<i>Aspidosiphon (Aspidosiphon) muelleri muelleri</i> Diesing, 1851	2, 3*			2	SD
<i>Phascolosoma (Phascolosoma) granulatum</i> Leuckart, 1828	2*			1	SD
<b>Phylum Echiura</b>					
<i>Bonellia viridis</i> Rolando, 1821	2*			1	D
<b>Phylum Mollusca</b>					
<i>Acar clathrata</i> (Defrance, 1816)	3*			1	CE
<i>Abra alba</i> (W. Wood, 1802)			46, 48, 58	3	Un
<i>Acteocina mucronata</i> (Philippi, 1849) ‡			46	1	Un
<i>Afrocardium richardi</i> (Audouin, 1826) ‡			46	1	Un
<i>Aplysia dactylomela</i> Rang, 1828 ‡			44	1	Un
<i>Arca noae</i> Linnaeus, 1758 **			58	1	Un
<i>Arcopagia balaustina</i> (Linnaeus, 1758)			58	1	Un
<i>Barbatia barbata</i> (Linnaeus, 1758) **	2*		48	2	CE, SD

(continued)

Table 1 (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Berthella aurantiaca</i> (Risso, 1818)			47	1	Un
<i>Bittium reticulatum</i> (da Costa, 1778)	2*			1	SD
<i>Bornia sebetia</i> (O. G. Costa, 1830)			46, 48, 50, 58	1	Un
<i>Brachidontes pharaonis</i> (P. Fischer, 1870) ‡				4	Un
<i>Bryopa melitensis</i> (Broderip, 1834) †	2, 3*			2	CE, SD
<i>Cardita calyculata</i> (Linnaeus, 1758)			48, 50	2	Un
<i>Chama asperella</i> Lamarck, 1819 ‡			58	1	Un
<i>Chama gryphoides</i> Linnaeus, 1758	2*			1	SD
<i>Chama pacifica</i> Broderip, 1835 ‡			46, 47, 48, 50, 51, 58	6	Un
<i>Chamelea gallina</i> (Linnaeus, 1758) **			46	1	Un
<i>Charonia variegata</i> (Lamarck, 1816) †**		32*		1	SD
<i>Chelidonura fulvipunctata</i> Baba, 1938 ‡			57	1	Un
<i>Conomurex decorus</i> (Röding, 1798) ‡			54	1	SD
<i>Corbula gibba</i> (Olivi, 1792)			46, 48	2	Un
<i>Coripia corbis</i> (Philippi, 1836)			46	1	Un
<i>Coripia jozinae</i> (Van Aartsen, 1985)			46, 48	2	Un
<i>Ctena decussata</i> (O. G. Costa, 1829)			46, 48, 58	3	Un
<i>Diodora</i> sp.	2, 3*			2	SD, D
<i>Dosinia lupinus</i> (Linnaeus, 1758)			58	1	Un
<i>Eledone moschata</i> (Lamarck, 1798)	9			1	CE
<i>Elysia viridis</i> (Montagu, 1804)	9			1	CE
<i>Felimare picta</i> (Schultz in Philippi, 1836)	3*			1	CE
<i>Flabellina affinis</i> (Gmelin, 1791)	1*			1	CE
<i>Flabellina pedata</i> (Montagu, 1815)		16*		1	SD
<i>Fusinus pulchellus</i> (Philippi, 1844)	12			1	Un
<i>Glans trapezia</i> (Linnaeus, 1767)			46, 48	2	Un
<i>Glycymeris</i> sp. (juveniles of <i>G. bimaculata</i> and/or <i>G. pilosa</i> )			46	1	Un
<i>Gonilia calliglypta</i> (Dall, 1903)			46	1	Un
<i>Goniobranchus annulatus</i> (Eliot, 1904) ‡			48	1	CE
<i>Goodallia triangularis</i> (Montagu, 1803)			46	1	Un
<i>Gouldia minima</i> (Montagu, 1803)			46, 48	2	Un
<i>Hiatella arctica</i> (Linnaeus, 1767)	2, 3*			2	CE, SD
<i>Hypselodoris infucata</i> (Rüppell & Leuckart, 1830) ‡			54	1	SD, D
<i>Irus irus</i> (Linnaeus, 1758)			58	1	Un
<i>Lima lima</i> (Linnaeus, 1758)			48, 50	2	Un
<i>Lithophaga lithophaga</i> (Linnaeus, 1758) **	2, 3, 4*		46, 47, 48, 50, 58	8	CE, SD, D
<i>Loripes lucinalis</i> (Lamarck, 1818)			46, 58	2	Un
<i>Loripinus fragilis</i> (Philippi, 1836)			46, 48	2	Un
<i>Lucinella divaricata</i> (Linnaeus, 1758)			46	1	Un
<i>Luria lurida</i> (Linnaeus, 1758) **	2*		46, 47, 48, 50, 51, 58	1	D
<i>Malleus regula</i> (Forsskål in Niebuhr, 1775) ‡				6	Un
<i>Manupecten pesfelis</i> (Linnaeus, 1758)	2			1	SD

(continued)

Table 1 (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Megaxinus unguiculinus</i> Pallary, 1904			46	1	Un
<i>Mimachlamys varia</i> (Linnaeus, 1758)			46	1	Un
<i>Mitra</i> sp.	2			1	SD
<i>Modiolus barbatus</i> (Linnaeus, 1758) **	3*		48	2	CE
<i>Musculus costulatus</i> (Risso, 1826)			46	1	Un
<i>Musculus subpictus</i> (Cantraine, 1835)			58	1	Un
<i>Neopycnodonte cochlear</i> (Poli, 1795)	2, 3*			2	CE, SD
<i>Nucula nucleus</i> (Linnaeus, 1758)			46, 48, 58	3	Un
<i>Nuculana pella</i> (Linnaeus, 1767)			48	1	Un
<i>Papillicardium papillosum</i> (Poli, 1791)			58	1	Un
<i>Parvicardium scriptum</i> (Bucquoy, Dautzenberg & Dollfus, 1892)			46, 48, 58	3	Un
<i>Peltodoris atromaculata</i> Bergh, 1880	1, 2, 5, 12	20, 21, 34		7	CE, SD
<i>Pinctada imbricata radiata</i> (Leach, 1814) ‡			54	1	SD
<i>Pinna nobilis</i> Linnaeus, 1758 **	2*			1	SD
<i>Pleurobranchus forskalii</i> Rüppell & Leuckart, 1828 ‡			51	1	Un
<i>Pygunculus fourierii</i> (Audouin, 1826) ‡			58	1	Un
<i>Raphitoma</i> sp.	2*			1	CE
<i>Ringicula auriculata</i> (Ménard de la Groye, 1811)			46, 48, 58	3	Un
<i>Rocellaria dubia</i> Pennant, 1777	2, 3*			2	CE, SD
<i>Sandalia triticea</i> (Lamarck, 1810)	12			1	Un
<i>Semicassis granulata</i> (Born, 1778)			40*	1	Un
<i>Sphenia rueppellii</i> A. Adams, 1851 ‡			47	1	Un
<i>Spisula subtruncata</i> (da Costa, 1778) **			58	1	Un
<i>Spondylus spinosus</i> Schreibers, 1793 ‡			46, 46, 48, 50, 51, 58	1	Un
<i>Striarca lactea</i> (Linnaeus, 1758)			50, 51, 58	5	Un
<i>Thracia phaseolina</i> (Lamarck, 1818)			58	1	Un
<i>Thuridilla hopei</i> (Vérany, 1853)	2*			1	CE
<i>Tylodina perversa</i> (Gmelin, 1791)	3*			1	CE, SD
<i>Umbraculum umbraculum</i> (Lightfoot, 1786)	1*		41	2	CE, SD
<i>Venerupis geographica</i> (Gmelin, 1791) **			46	1	Un
<i>Venus verrucosa</i> Linnaeus, 1758 **			46	1	Un
Vermetidae	3*			1	SD
<b>Phylum Bryozoa</b>					
<i>Adeonella pallasii</i> (Heller, 1867)	1, 2, 3*			3	CE, SD
<i>Bugula</i> sp.	1, 2, 3*			3	CE, SD
<i>Crisia</i> sp.	1, 2, 3*			3	CE, SD
<i>Fron dipora verrucosa</i> (Lamouroux, 1821)	3*			1	CE, SD
<i>Hippaliosina depressa</i> (Busk, 1854)	1, 2, 3			3	CE, SD, D
<i>Microporella coronata</i> (Audouin, 1826) ‡			50, 51	2	Un
<i>Microporella harmeri</i> Hayward, 1988 ‡			46	1	Un
<i>Myriapora truncata</i> (Pallas, 1766)	3, 5	17, 22, 23, 24*		6	CE, SD
<i>Onychocella marioni</i> (Jullien, 1882)	2			1	D
<i>Parasmittina egyptiaca</i> (Waters, 1909) ‡			46, 47, 50, 51, 58	5	Un

(continued)

Table 1 (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Parasmittina raigii</i> (Audouin, 1826)			47	1	Un
<i>Parasmittina serruloides</i> Harmelin, Bitar & Zibrowius, 2009 ‡			46, 51	2	Un
<i>Reteporella</i> sp.	3*	18, 24*	40*	4	CE, SD, D
<i>Reteporellina delicatula</i> Hayward, 1974	5			1	Un
<i>Rhynchozoon neapolitanum</i> Gautier, 1962	2, 3*	23, 24*		4	CE, SD
<i>Schizoretepora hassi</i> Harmelin, Bitar & Zibrowius, 2007 ‡			46, 47, 48, 50, 58	5	SD
<i>Schizomavella</i> sp.	3*			1	CE, SD
<i>Smittina nitidissima</i> (Hincks, 1880) ‡			46, 48, 50	3	Un
<i>Turbicellepora coronopus</i> (Wood, 1844) †	2, 3*			2	CE, SD
<b>Phylum Brachiopoda</b>					
<i>Argyrotheca cistellula</i> (Searles-Wood, 1841)			58, 60	2	Un
<i>Argyrotheca cuneata</i> (Risso, 1826)			46, 47, 48, 50, 51, 58, 59, 60	8	Un
<i>Joania cordata</i> (Risso, 1826)	13		46, 47, 48, 51, 58	6	Un
<i>Novocrania anomala</i> (Müller, 1776)	2, 3*	20*	46, 47, 48, 50, 51, 58, 60, 61, 62	12	SD, D
<i>Megathiris detruncata</i> (Gmelin, 1790)	13			1	Un
<b>Phylum Phoronida</b>					
<i>Phoronis australis</i> Haswell, 1883 †	2*			1	CE
<b>Phylum Echinodermata</b>					
<i>Amphipholis squamata</i> (Delle Chiaje, 1828)	2*			1	D
<i>Arbacia lixula</i> (Linnaeus, 1758)	1, 2, 3, 4, 7, 10*	30*		7	CE, SD, D
<i>Centrostephanus longispinus</i> (Philippi, 1845) **	2, 3	22*		3	CE, SD, D
<i>Hacelia attenuata</i> Gray, 1840 **	1, 2, 3	27*		4	CE, SD
<i>Holothuria (Panningothuria) forskali</i> Delle Chiaje, 1823 **	4*			1	CE, SD
<i>Holothuria (Platyperona) sanctori</i> Delle Chiaje, 1823 **	1, 2, 3*			3	CE, SD, D
<i>Marthasterias glacialis</i> (Linnaeus, 1758)	3*	34		2	CE
<i>Ophidiaster ophidianus</i> (Lamarck, 1816) **	1, 3*			2	CE
<i>Ophiothrix fragilis</i> (Abildgaard, 1789)	1, 2, 3, 4*			4	CE, SD
<i>Peltaster placenta</i> (Müller & Troschel, 1842) †	3*			1	D
<i>Sphaerechinus granularis</i> (de Lamarck, 1816)	3*			1	CE
<i>Synaptula reciprocans</i> (Forskål, 1775) ‡			54	1	SD

(continued)

Table 1 (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<b>Phylum Chordata</b>					
<b>Subphylum Tunicata</b>					
<i>Didemnum</i> sp.	1*			1	CE, SD
<i>Halocynthia papillosa</i> (Linnaeus, 1767) **	2, 3, 4, 6, 9	16, 23, 24, 27*		9	CE, SD
<i>Herdmania momus</i> (Savigny, 1816) ‡			40, 45, 63	3	SD
<i>Microcosmus vulgaris</i> Heller, 1877	2, 3, 6, 9			4	CE, SD
<i>Phallusia nigra</i> Savigny, 1816 ‡			54	1	SD, D
Salpidae	1*			1	SD
<i>Symplegma brakenhielmi</i> (Michaelsen, 1904) ‡			54	1	SD
Tunicata sp.1	3*			1	D
Tunicata sp.2	3*			1	CE, SD
<b>Subphylum Vertebrata</b>					
<b>Superclass Pisces</b>					
<i>Anthias anthias</i> (Linnaeus, 1758) **	2, 3, 4			3	CE, SD
<i>Apogon (Apogon) imberbis</i> (Linnaeus, 1758) **	1, 2, 3, 4, 5, 7	16, 27*	40*	9	CE, SD, D
<i>Boops boops</i> (Linnaeus, 1758) **	3			1	CE
<i>Bothus podas</i> (Delaroche, 1809) **	2*			1	SD
<i>Chromis chromis</i> (Linnaeus, 1758) **	1, 2, 3	16*		4	CE, SD, D
<i>Conger conger</i> (Linnaeus, 1758) **	1, 3*			2	CE, SD
<i>Coris julis</i> (Linnaeus, 1758) **	1, 3			2	CE, SD
<i>Diplodus annularis</i> (Linnaeus, 1758) **	1*			1	CE, SD
<i>Diplodus sargus sargus</i> (Linnaeus, 1758) **	1, 2, 9			3	CE, SD
<i>Diplodus vulgaris</i> (Geoffroy Saint-Hilaire, 1817) **	1, 2, 4*			3	CE, SD, D
<i>Enchelycore anatina</i> (Lowe, 1838)			51	1	CE
<i>Epinephelus costae</i> (Steindachner, 1878) **	2*			1	D
<i>Epinephelus marginatus</i> (Lowe, 1834) **	2*		42	2	CE
<i>Gobius auratus</i> Risso, 1810 †**	2, 3*			2	CE, SD
<i>Lepadogaster candolii</i> Risso, 1810 **	3*			1	SD
<i>Mugil</i> sp. **	1, 7*			2	CE
<i>Mullus surmuletus</i> Linnaeus, 1758 **	1, 2*			2	CE, SD
<i>Muraena helena</i> Linnaeus, 1758 **	1, 3, 4*			3	CE, SD
<i>Oblada melanura</i> (Linnaeus, 1758) **	1, 7, 9			3	CE, SD
<i>Parablennius gattorugine</i> (Linnaeus, 1758) **	7*			1	CE, SD
<i>Parablennius rouxi</i> (Cocco, 1833) **	2*			1	SD
<i>Pempheris vanicolensis</i> Cuvier, 1831 ‡		39	40, 64, 65	4	CE, SD
<i>Phycis phycis</i> (Linnaeus, 1766) **	2, 3, 7			3	CE, SD, D
<i>Sargocentron rubrum</i> (Forsskål, 1775) ‡		31, 39	40, 64, 66	5	CE, SD
<i>Sarpa salpa</i> (Linnaeus, 1758) **	2*			1	CE
<i>Sciaena umbra</i> Linnaeus, 1758 **	1, 2, 4		42	4	SD, D
<i>Scorpaena maderensis</i> Valenciennes, 1833 **	2*			1	CE, SD
<i>Scorpaena porcus</i> Linnaeus, 1758 **	2, 7*			2	CE, SD
<i>Scorpaena scrofa</i> Linnaeus, 1758 **	3*			1	CE, SD
<i>Seriola dumerili</i> (Risso, 1810) **		29*		1	CE, SD
<i>Serranus cabrilla</i> (Linnaeus, 1758) **	1, 2, 3			3	CE, SD, D
<i>Serranus scriba</i> (Linnaeus, 1758) **	1, 2, 4*			3	CE, SD, D
<i>Siganus luridus</i> (Rüppell, 1829) ‡			40	1	CE
<i>Sparisoma cretense</i> (Linnaeus, 1758) **	1*			1	CE

(continued)

**Table 1** (continued)

Species	NA	SA	LB	Number of caves	Cave zone
<i>Spicara maena</i> (Linnaeus, 1758) **	3*			1	CE
<i>Symphodus mediterraneus</i> (Linnaeus, 1758) **	1*			1	SD
<i>Tripterygion delaisi</i> Cadenat & Blache, 1970 **	7*			1	CE
<b>Class Aves</b>					
<i>Alcedo atthis</i> (Linnaeus, 1758) **	1*			1	
<b>Class Mammalia</b>					
<i>Monachus monachus</i> (Hermann, 1779) **	+	+	+		CE, SD, D

**Northern Aegean caves**

1. Trypia Spilia, Agios Efstratios Island, Greece (Gerovasileiou & Voultsiadou, 2012; this study)
2. Fara Bay Islet, Lesvos Island, Greece (Gerovasileiou *et al.*, 2009; 2012; 2013; Gerovasileiou & Voultsiadou, 2012; this study)
3. Agios Vasilios Islet, Lesvos Island, Greece (Gerovasileiou *et al.*, 2009; 2012; 2014; Gerovasileiou & Voultsiadou, 2012; this study)
4. Cape Drepanon, Chalkidiki Peninsula, Greece (Voultsiadou-Koukoura & van Soest, 1991; Voultsiadou-Koukoura *et al.*, 1991; Voultsiadou-Koukoura & Koukouras, 1993; this study)
5. Emborios cave, Chios Island, Greece (Jones *et al.*, 1968; Bailey, 1969; Hayward, 1974)
6. Avlaki, Chalkidiki Peninsula, Greece (this study)
7. Ftelio cave, Agios Efstratios Island, Greece (Gerovasileiou & Voultsiadou, 2012; this study)
8. Youra Island caves, Sporades Islands, Greece (Voultsiadou, 1986; Voultsiadou-Koukoura & van Soest, 1991; Voultsiadou-Koukoura *et al.*, 1991; Voultsiadou-Koukoura & Koukouras, 1993; Voultsiadou & Vafidis, 2004; Voultsiadou, 2005b)
9. Marmaras, Chalkidiki Peninsula, Greece (Riedl, 1966)
10. Red caves, Chalkidiki Peninsula, Greece (this study)
11. Northern Aegean Sea, Greece (Dounas *et al.*, 2009)
12. Chalkidiki Peninsula, Greece (Antoniadou & Chintiroglou, 2005)
13. Northern Evoikos, Greece (Logan *et al.*, 2002)

**Southern Aegean caves**

14. Sykia cave, Milos Island, Greece (Lazaridou & Charitonidis, 1993)
15. Lindos caves, Rhodes Island, Greece (Tsekos & Haritonidis, 1974)
16. Vouliagmeni pit, Attica, Greece (Gerovasileiou & Voultsiadou, 2012; this study)
17. Madhes cave, Crete, Greece (Gerovasileiou & Voultsiadou, 2012; this study)
18. Alykes cave, Crete, Greece (Gerovasileiou & Voultsiadou, 2012; Rastorgueff *et al.*, 2014 as "Blue Cave"; this study)
19. Stavros cave, Crete, Greece (Gerovasileiou & Voultsiadou, 2012; this study)
20. Kalathas cave, Crete, Greece (this study)
21. Amorgos Island, Greece (this study)
22. Fourni Island, Greece (this study)
23. Polyaiagos Island, Greece (this study)
24. Andros Island, Greece (Gerovasileiou & Voultsiadou, 2012; this study)
25. Saronikos Gulf, Greece (Salomidi *et al.*, 2013)
26. Kallithea caves, Rhodes Island, Greece (Tsekos & Haritonidis, 1974)
27. Syros Island, Greece (this study)
28. Gyaros Island, Greece (this study)
29. Pandieronisi Islet, Cyclades, Greece (this study)
30. Porto Rafti, Attica, Greece (this study)
31. Rhodes Island, Greece (André *et al.*, 2009; this study)
32. Kolymbari, Crete, Greece (this study)
33. Gourmia, Agios Nikolaos, Crete, Greece (Pulitzer-Finali & Pronzato, 1981; Pulitzer-Finali, 1983; Pansini, 1996)
34. Aegina Island, Greece (Riedl, 1966)
35. Cape Sounion, Greece (Riedl, 1966)
36. Kali Limines, Crete, Greece (Zibrowius, 1968; 1971; 1978; Bitar & Zibrowius, 1997)
37. Dalyan, Muğla, Turkey (Yokes & Galil, 2006)

38. Schinaria Bay, Crete, Greece (Rastorgueff *et al.*, 2014)
39. Southern Aegean coasts of Turkey (Bilecenoglu, 2010)

**Levantine Sea caves**

40. Blue Cave, Kastelorizo Island, Greece (Katsanevakis *et al.*, 2014; this study)
41. Raoucheh cave, Lebanon (Zibrowius & Bitar, 2003; Vacelet *et al.*, 2007; Bitar, 2010; Crocetta *et al.*, 2013b)
42. Cape Greco, Cyprus (Ramos-Esplá *et al.*, 2007)
43. Cape Matapan, Kastelorizo Island, Greece (Laborel, 1961; Vacelet, 1961)
44. Saadiyat, Lebanon (Crocetta *et al.*, 2013b)
45. Rosh-HaNiqra, Israel (Tsumamal, 1969; 1975; Ben-Eliahu & Ten Hove, 1992; Gewing *et al.*, 2014)
46. Selaata caves, Lebanon (Logan & Long, 2001; Carteron, 2002; Logan *et al.*, 2002; Aguado & San Martin, 2007; Harmelin *et al.*, 2007; 2009; 2011; Crocetta *et al.*, 2013a,b)
47. Kafar Abida, Lebanon (Carteron, 2002; Logan *et al.*, 2002; Aguado & San Martin, 2007; Bitar & Zibrowius, 1997; Harmelin *et al.*, 2007; Vacelet *et al.*, 2007; Harmelin *et al.*, 2009; Crocetta *et al.*, 2013a,b)
48. Ras El Chakaa, Lebanon (Carteron, 2002; Logan *et al.*, 2002; Aguado & San Martin, 2007; Harmelin *et al.*, 2007; 2009; Crocetta *et al.*, 2013a,b)
49. Sdot Yam, Israel (Meroz-Fine *et al.*, 2005)
50. Ramkine Island, Lebanon (Logan & Long, 2001; Carteron, 2002; Logan *et al.*, 2002; Aguado & San Martin, 2007; Harmelin *et al.*, 2007; 2009; 2011; Crocetta *et al.*, 2013a; Crocetta & Russo, 2013)
51. Chak El Hatab caves, Lebanon (Carteron, 2002; Logan *et al.*, 2002; Perez *et al.*, 2004; Aguado & San Martin, 2007; Harmelin *et al.*, 2007; 2009; 2011; Bitar, 2013; Crocetta *et al.*, 2013a,b; Crocetta & Russo, 2013)
52. Cape Arnaoutis, Agios Georgios Island, Cyprus (Muricy *et al.*, 1998)
53. Lebanon (Ereskovsky *et al.*, 2009)
54. Lebanese caves and tunnels (Bitar *et al.*, 2007; Morri *et al.*, 2009; Bitar, 2010)
55. Tabarja, Lebanon (Bitar & Zibrowius, 1997)
56. Kas, Turkey (Rastorgueff *et al.*, 2014)
57. Cyclops Cave, Protaras, Cyprus (Tsiakkios & Zenetos, 2011)
58. Jbail – Tablieh cave, Lebanon (Logan & Long, 2001; Logan *et al.*, 2002; Harmelin *et al.*, 2009; Crocetta *et al.*, 2013a,b; Crocetta & Russo, 2013)
59. Termik Santral (east of Keryneia/Girne), Cyprus (Logan *et al.*, 2002)
60. Rizokarpason/Dipkarpas, Cyprus (Logan *et al.*, 2002)
61. El Kassmieh, Lebanon (Logan & Long, 2001)
62. Cape Shikmona, Haifa, Israel (Logan & Long, 2001)
63. Lebanese caves (Harmelin *et al.*, 2007)
64. Levantine and coasts of Turkey (Bilecenoglu, 2010)
65. Antalya Bay, Turkey (Bilecenoglu & Taskavak, 2009)
66. Beirut, Lebanon (Riedl, 1966)



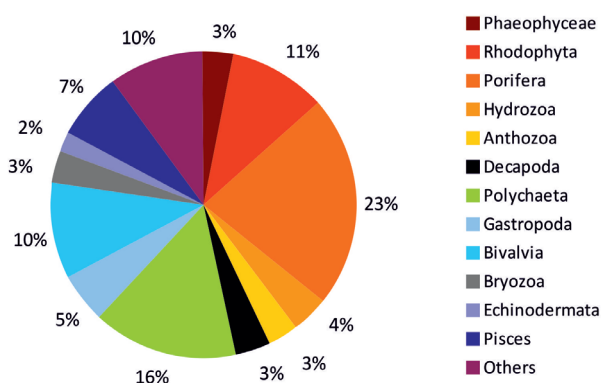
**Table 2.** Number of taxa per taxonomic group recorded in marine caves of the eastern Mediterranean (NA: Northern Aegean, SA: Southern Aegean, LB: Levantine). The percent contribution of each group to the total Mediterranean marine cave diversity was calculated based on data given in Gerovasileiou & Voultsiadou (2014).

Taxonomic group	NA	SA	LB	Total number of taxa	% contribution to total Mediterranean marine cave diversity
Phaeophyceae	3	17		18	54.5
Foraminifera	1	1		1	7.1
Chlorophyta	4	5	1	7	25.9
Rhodophyta	3	51	5	53	31.4
Porifera	95	42	39	116	36.5
Hydrozoa	1		19	19	17.6
Anthozoa	15	11	8	17	34.7
Scyphozoa	1			1	25
Ctenophora	1			1	100
Platyhelminthes	1			1	2.8
Nemertea	1			1	11.1
Nematoda	1			1	2.7
Copepoda	2			2	1.8
Cirripedia	1			1	14.3
Decapoda	15	6	3	18	24.7
Mysida	1	1	1	1	4.8
Tanaidacea	3			3	50
Isopoda	2			2	13.3
Amphipoda	8			8	9.6
Cumacea	1			1	16.7
Polychaeta	67	5	18	79	30.3
Sipuncula	2			2	33.3
Echiura	1			1	100
Gastropoda	15	3	12	28	20.9
Bivalvia	11		45	53	58.9
Cephalopoda	1			1	33.3
Bryozoa	12	3	8	18	8.2
Brachiopoda	3	1	4	5	55.6
Phoronida	1			1	100
Echinodermata	11	4	1	12	35.3
Tunicata	6	1	3	9	22
Pisces	32	5	7	37	38.5
Aves	1			1	
Mammalia	1	1	1	1	
<b>Total</b>	<b>324</b>	<b>157</b>	<b>175</b>	<b>520</b>	<b>24</b>

In the rest of the Mediterranean, this anthozoan was found in semidark and dark caves of Marseille (7-37 m) and Croatia (40 m), as well as on coralligenous beds and in deeper waters, down to 400 m (Zibrowius, 1978). Interestingly, along the southern coasts of Crete, 2 rare benthic species were recorded, not yet found in other eastern Mediterranean caves, namely, the polychaete *Filogranula annulata* (Zibrowius, 1968; 1971) and the deep-sea scleractinian *Guynia annulata* reported from a dark cave with freshwater infiltrations (Zibrowius, 1971; 1978).

The detailed study of the macroalgal assemblages in a semi-submerged cave in Milos Island, southern Aegean Sea (Lazaridou & Charitonidis, 1993), yielded 68 species (11 phaeophytes, 6 chlorophytes, and 51 rhodophytes). The majority of the species recorded were sciaphilic (62%), but several photophilic species were also found in well-lit sectors due to the shallow depth and complex cave morphology. The macroalgal diversity within this cave is

considered high compared to other well studied Mediterranean caves, where a range of 34-56 macroalgal species per cave have been recorded (e.g. Martí *et al.*, 2004; Alongi *et al.*, 2012). This fact could possibly be attributed to the cave geomorphology and climatic factors of the southern Aegean resulting in higher levels of sunlight locally. It should be taken into account that there are still major knowledge gaps with regard to Aegean marine flora, and particularly understudied habitats, such as caves, and that future studies are expected to increase the number of species in this region (Tsiamis *et al.*, 2013; 2014). Furthermore, the known sponge diversity from southern Aegean marine caves is two times lower than that of the well-studied caves of the more eutrophic northern Aegean Sea. However, *in situ* observations by the authors showed that the cave communities of the southern Aegean islands were richer in sessile biota than those of the adjacent, well-lit infralittoral beds, where sciaphilic species (e.g.



**Fig. 2:** Taxonomic composition of marine cave biota in the eastern Mediterranean.

rhodophytes, sponges, and anthozoans) were rare or even absent. This fact highlights the significant role of marine caves in the southern Aegean marine ecosystem.

The sponge fauna of the studied Levantine marine caves is characterized by the largest number of endemic and warm-water species in the entire Mediterranean Sea (Gerovasileiou & Voultsiadou, 2012). They host 3 sponge species with a narrow range of distribution, *Cinachyrella levantinensis*, *Euryspongia raouchensis*, and *Gastrophanella phoeniciensis*, which possibly constitute remnants of the thermophilous biota that lived in the Mediterranean Sea during warmer periods and have survived in the warmest part of the Levantine Basin only (Pérez *et al.*, 2004; Vacelet *et al.*, 2007). A large number of hydrozoans and bivalves have been found in marine caves of the area, possibly reflecting the specific research interests of the experts involved (e.g. Morri *et al.*, 2009; Crocetta *et al.*, 2013a). The large number of alien species reported from marine caves in this area highlights the need for scientific monitoring.

#### Conclusive remarks

This overview of eastern Mediterranean marine caves revealed a rich biodiversity, including several protected, endemic, and alien species. However, many taxonomic groups (e.g. macro-algae, hydrozoans, and bryozoans) were inadequately or unevenly studied across different areas. Furthermore, cave biodiversity data are completely lacking for certain eastern and southern areas (e.g. coasts of Turkey, Syria, Egypt, and Libya). The fact that the existing knowledge concerning the marine cave biota of the eastern Mediterranean is far from being complete, and that a moderate research effort yielded several new and alien species, indicates that future surveys are expected to increase the number of cave-dwelling species in this area significantly, including important endemic and alien components.

The high levels of biodiversity and endemism characterizing eastern Mediterranean marine caves highlight

the need for protecting these ecosystems. Marine caves constitute fragmented habitats (Harmelin *et al.*, 1985), especially in the eastern Mediterranean, an area presenting heterogeneity in abiotic conditions, seascape, and coastline geomorphology. These features may function as phylogeographic breaks, influencing isolation and triggering speciation processes, as shown by Rastorgueff *et al.* (2014). The vast majority of marine caves recorded in the Aegean ecoregion are located in insular areas (Giakoumi *et al.*, 2013), possibly indicating a higher level of isolation (Bibili *et al.*, 1989). However, isolation mechanisms for marine cave assemblages are not always clear and the availability of a large number of caves in this area could facilitate connectivity among cave populations, in so far as caves could be used as ‘stepping-stone habitats’ (Rastorgueff *et al.*, 2014). As connectivity is an important consideration in marine conservation planning, the availability and isolation of these habitats should be considered in future spatial prioritization schemes.

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