Data in brief 27 (2019) 104745

Contents lists available at ScienceDirect

Data in brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Dataset of biogenic crusts from submarine caves of the Aegean Sea: An example of sponges vs microbialites competition in cryptic environments

Adriano Guido [a, *], Vasilis Gerovasileiou [b], Franco Russo [a], Antonietta Rosso [c, d], Rossana Sanfilippo [c, d], Eleni Voultsiadou [e], Adelaide Mastandrea [a]

[a] Department of Biology, Ecology and Earth Sciences, University of Calabria, Via Bucci, Cubo 15b, 87036, Rende, Cosenza, Italy
[b] Institute of Marine Biology, Biotechnology and Aquaculture, Hellenic Centre for Marine Research, 71500, Heraklion, Crete, Greece
[c] Department of Biological, Geological and Environmental Sciences, Catania University, Corso Italia, 57 95129, Catania, Italy
[d] National Inter-University Consortium for Marine Sciences (CoNISMa), URL Catania, 95129, Catania, Italy
[e] Department of Zoology, School of Biology, Aristotle University of Thessaloniki, 54124, Thessaloniki, Greece

ARTICLE INFO

Article history:
Received 21 August 2019
Received in revised form 21 October 2019
Accepted 28 October 2019
Available online 4 November 2019

Keywords:
Metazoa
Microbialites
Competition
Cryptic environments
Submarine caves

ABSTRACT

This dataset aims at illustrating the relationships between Metazoa and Bacteria in confined environments. For this purpose, the biotic crusts inside two submarine caves of the Aegean Sea were examined in order to characterize organisms involved in their formation. The present manuscript provides additional data and information to our research article "Composition and biostratinomy of sponge-rich biogenic crusts in submarine caves (Aegean Sea, Eastern Mediterranean)" [1] (Guido et al.). The data were collected with an integrated approach utilizing microfacies observations in optical microscopy and micromorphological and geochemical characterization in electron microscopy (SEM and EPMA). We present here microfacies showing the boundstone framework, which is rich in microcavities partly filled by sponge spicules and scant autochthonous micrite. SEM and EPMA data put

DOI of original article: https://doi.org/10.1016/j.palaeo.2019.109338.
* Corresponding author.
E-mail address: aguido@unical.it (A. Guido).

https://doi.org/10.1016/j.dib.2019.104745

in evidence the abundance of sponge spicules inside the crusts and allow discriminating between two types of micrite: detrital micrite and autochthonous micrite. The data presented in this article and those described in Guido et al. [1] allow the evaluation of the relationship between sponges and carbonatogenetic bacteria in the cryptic conditions of submarine caves, and provide new knowledge to interpret the fossil record.

Specifications Table

Subject	Palaeontology, Ecology.
Specific subject area	Geobiological characterization of biogenic structures formed by the interaction between skeletonised organisms and endolithic sponges in submarine caves.
Type of data	Photos, Images, Table, Chart, Figures
How data were acquired	Microfacies: Zeiss Axioplan Imaging II. Epifluorescence: Hg high-pressure vapor bulb, attached to Axioplan Imaging II microscope (Zeiss). SEM: FEI-Philips ESEM-FEG Quanta 200F. EPMA: Electron Probe Micro Analyzer - JEOL - JXA 8230.
Data format	Raw Analyzed Filtered
Parameters for data collection	The analyses were performed on thin sections and freshly broken surfaces of the examined biogenic crusts.
Description of data collection	Polished thin sections were analyzed by optical microscopy under plane and cross-polarized light, at magnifications of 2.5, 5, 10, 20 and 40×. The thin sections and small fragments of the crusts were observed also at incident light, using ultraviolet excitation, to reveal the organic matter content. SEM observations and EPMA analyses were performed on thin sections and small fragments, using secondary and backscattered electron images to characterize the micromorphologies. Furthermore, Energy Dispersive Spectroscopy (EDS) and Wavelength Dispersive Energy (WDS) were used to determine the sample composition.
Data source location	Department of Biology, Ecology and Earth Sciences, University of Calabria, Rende, Cosenza, Italy. Institute of Marine Biology, Biotechnology and Aquaculture, Hellenic Centre for Marine Research, Crete, Greece. Department of Biological, Geological and Environmental Sciences, University of Catania, Catania, Italy. Department of Zoology, School of Biology, Aristotle University of Thessaloniki, Thessaloniki, Greece. Latitude and longitude for collected samples: The two caves, Agios Vasilios (38.969°N, 26.541°E) and Fara (38.969°N, 26.477°E), are located on rock islets off Lesvos Island, in the North Aegean Sea.
Data accessibility	Data are included in this article.
Related research article	A. Guido, V. Gerovasileiou, F. Russo, A. Rosso, R. Sanfilippo, E. Voultsiadou, A. Mastandrea. Composition and biostratinomy of sponge-rich biogenic crusts in submarine caves (Aegean Sea, Eastern Mediterranean). Palaeogeography, Palaeoclimatology, Palaeoecology 534 (2019) 109338. doi.org/10.1016/j.palaeo.2019.109338

Value of the Data

- The data are useful to understand the general framework of the biogenic crusts formed by metazoans and bacteria colonizing submarine caves.
- Understanding the formation process of biogenic crusts in submarine caves provides useful information on the interspecific relationships among invertebrate taxa in cryptic environments and furnish new data to interpret the fossil record.
- The data on recent bioconstructions from cryptic environments provide key information to interpret enigmatic bioconstructions of the fossil record and to help the palaeoenvironmental reconstruction.
- The data provide insights on the potential competition between endolithic sponges and microbial communities in confined environments.

1. Data

In the last decades, numerous studies have focused on the structure of hard substrate benthic assemblages in cryptic environments such as confined submarine caves [2–9]. Particular attention was given to the bioconstructions formed by the complex interplay of skeletonised organisms (mainly

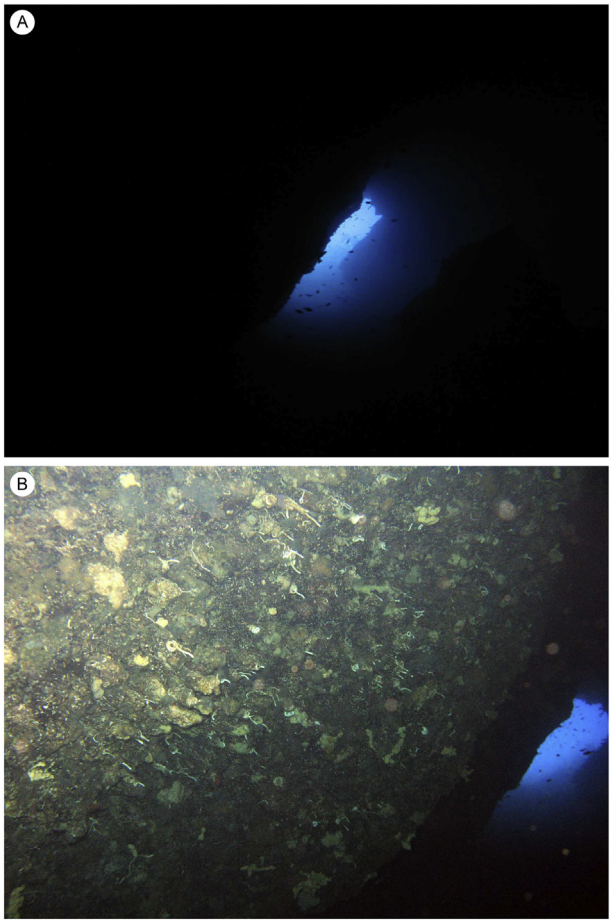


Fig. 1. Photos of the Fara Cave. A) Natural light intensity in the innermost sector of the cave. B) Wall illuminated with artificial light; note the widespread cover of biogenic crusts on the cave walls. Photos by M. Sini.

serpulids and bryozoans) and heterotrophic microbial communities [10–19]. Here, we focus on additional micro- and nano-morphological features of the biogenic crusts from two Aegean submarine caves, and highlight the role of endolithic sponges in limiting the development of carbonatogenetic bacteria. Light level inside the caves decreases sharply from the well-lit entrances to the innermost dark sectors (Fig. 1). The crusts largely cover the walls and ceiling and show a variable thickness ranging from few millimetres to few centimetres (Figs. 1 and 2). The crusts and relative microfacies show different skeletal composition and framework from the entrance to the inner part (Table 1, Fig. 3). The crusts are characterized by a high porosity and the cavities are rich in sponge spicules of different types (Figs. 3–5). Spicules are embedded into fluorescent material (Fig. 5). Electron microscopy observations proved the diffuse presence of spicules inside the microporosity of the crusts (Fig. 6). A small amount of peloidal micrite occurs inside the cavities and is generally associated to sponge spicules (Fig. 7). Small corals, microtubules, sponge spicules bearing spherical corpuscles, nanoparticles and honeycomb texture are also observable (Figs. 7 and 8). The spicules show well defined microborings (Fig. 9). EDS and WDS microanalyses allowed to characterize the composition of the spicules and micrite components (Figs. 10–12).

2. Experimental design, materials, and methods

2.1. Materials

Three replicate quadrats of 400 cm^2 (20 × 20 cm) were scraped from 10 sampling stations (6 in the F cave and 4 in the AV cave), in summer 2010, by SCUBA diving. Sampling stations represented different assemblages of the sidewalls and ceiling, at different distances from the entrance of the caves [20,21]. Samples were sieved (0.5 mm) and preserved in 10% formalin. After the sorting process for macro-invertebrates, all concretions/crusts were naturally dried. Crusts were subdivided into two parts

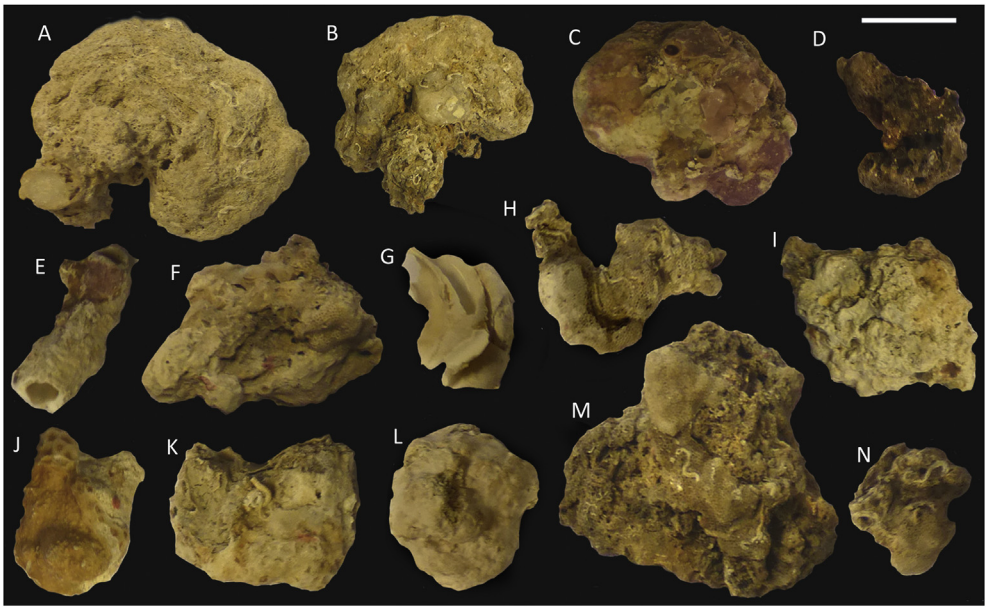


Fig. 2. Biogenic crusts from the Lesvos caves. Fara Cave: A-D. Concretions from the ceilings: A-B, station FC2; concretions from the walls: C-D, stations F1 and F4. Agios Vasilios Cave: E-N. Concretions from the ceiling: E-F, station VC1; G-H, station VC2; concretions from the walls: I-M, station V1; N: station V2. Scale bar: 2 cm.

Table 1
List of examined concretions with their provenance and main macroscopic constituents. Each line corresponds to an analyzed sample of the relevant replicate quadrat (see Refs. [20,21]).

Lesvos caves	Sampling station	Sample	Macroscopic composition
Fara Cave	F1		Nodular colony of the bryozoan *Rhynchozoon neapolitanum* covered by squamariacean coralline algae
	FC2	*Crust 1*	Concretion formed by the bryozoan *Hippaliosina depressa* with subordinate small serpulids, mostly *Josephella marenzelleri*
		Crust 2	Concretion formed by the bryozoan *H. depressa* with subordinate small serpulids, mostly *J. marenzelleri*
	F4		Concretion with Fe–Mn coatings including a small colony of the bryozoan *Onychocella marioni*
Agios Vasilios Cave	V1	*Crust 1*	Nodular colony of the bryozoan *R. neapolitanum* and the scleractinian *Madracis pharensis* covered by squamariacean coralline algae and a small colony of the bryozoan *Cribrilaria radiata*
		Crust 2	Concretion of the scleractinian *M. pharensis* and the bryozoans *Parasmittina rouvillei, Crassimarginatella maderensis* and *C. radiata*, plus squamariaceans
		Crust 3	Laminar concretion with non geniculate coralline algae, cyclostome bryozoans (mostly *Frondipora verrucosa*), agglutinant sabellariid polychaetes and foraminifers
		Crust 4	Large concretion with the bryozoans *Porella concinna concinna*, *O. marioni* and further subordinate species, plus sponges
		Crust 5	Laminar concretion with the surface covered by non-geniculate coralline algae, sponges and tubes of the serpulid *J. marenzelleri*
	VC1	*Crust 1*	Fragment of the serpulid *Spirobranchus polytrema* covered by the bryozoan *C. radiata*, plus squamariacean algae and sponges
		Crust 2	Concretion of the scleractinian *M. pharensis,* the bryozoans *O. marioni*, *C. radiata*, *Glabrilaria pedunculata*, the serpulids *Semivermilia crenata* and *Metavermilia multicristata*, non-geniculate and squamariacean coralline algae, colonised by terebellid polychaetes
	V2		Concretion with the serpulids *S. crenata* and *M. multicristata* and the bryozoan *O. marioni*
	VC2	*Crust 1*	Fragment of a coiled tube of the serpulid *Protula* sp.
		Crust 2	Concretion mainly formed by the bryozoans *H. depressa* and *O. marioni* with colonies of *Hippopodina ambita*, the serpulids *J. marenzelleri* and *M. multicristata*, sponges and foraminifers

and, considering the two corresponding cutting surfaces, one part was utilised to obtain small freshly broken fragments and the other one, for a thin section. In this way, it was possible to observe, for each fragment, the three-dimensional distribution of the main components inside the framework, and the relative microfacies on thin section. The texture, presence of fine bioclasts and epifluorescence allowed to discriminate detrital *vs* autochthonous micrite [1]. These fractions were then analyzed using EDS and EPMA microscopy.

2.2. Optical microscopy

The thin sections were processed for microfacies characterization with an optical microscope (Zeiss Axioplan Imaging II), under plane and cross-polarized light, at magnifications of 2.5, 5, 10, 20 and 40×. Incident light, emitted by Hg high-pressure vapor bulb, attached to Axioplan Imaging II microscope (Zeiss), with high-performance wide bandpass filters, was used to reveal the distribution of organic matter remains through epifluorescence observations (BP 436/10 nm/LP 470 nm, no 488 006, for the green light; and BP 450–490 nm/LP 515 nm, no. 488009, for the yellow light).

2.3. Electron microscopy

Samples, used for Scanning Electron Microscope (SEM) observations and Electron Probe Micro Analyzer (EMPA) microanalyses, were previously polished with 0.25 μm diamond-impregnated surfaces, then gently etched (0.05% HCl, 1 min). The samples were carbon- or gold-coated (ca. 250 Å

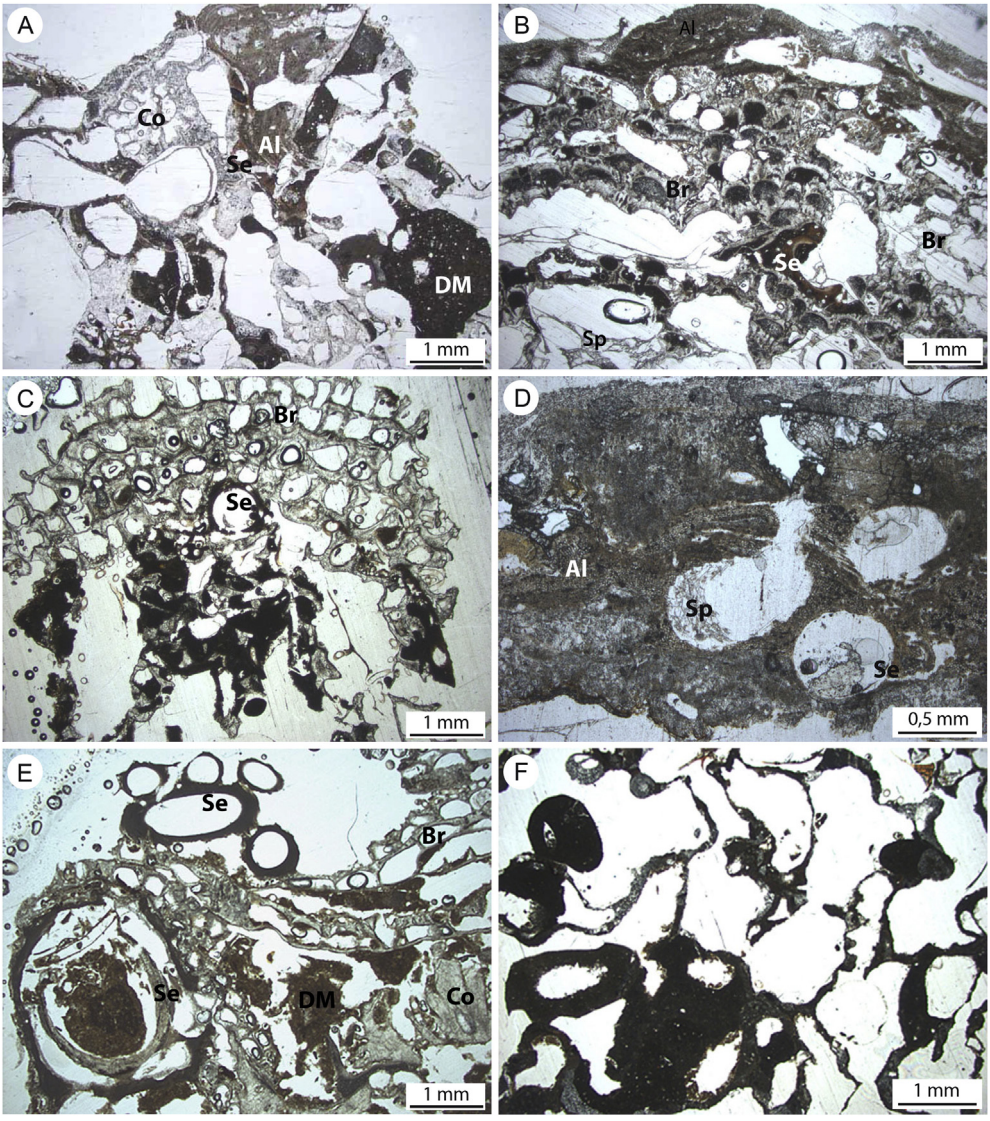


Fig. 3. Microfacies of the biogenic crusts. The skeletal framework is characterized by high porosity and microcavities hosting sponge spicules. Co: corals; Al: coralline algae; Se: serpulids; Br: bryozoans; Sp: sponge spicules; AM: autochthonous micrite; DM: detrital micrite.

coating thickness), depending whether they were prepared for microanalysis (EMPA) or morphological study (SEM). SEM micro- and nano-morphological analyses were carried out on polished thin-sections and freshly broken surfaces, using a FEI-Philips ESEM-FEG Quanta 200F, operating at 15kV and with a working distance between 10 and 15 μm. Mineralogical and chemical compositions were detected using an Electron Probe Micro Analyzer - JEOL - JXA 8230. EMPA working conditions were as follows: voltage 15 kV, probe current 10 nA, working distance 11 mm, take-off angle 40°, live time 50 sec.

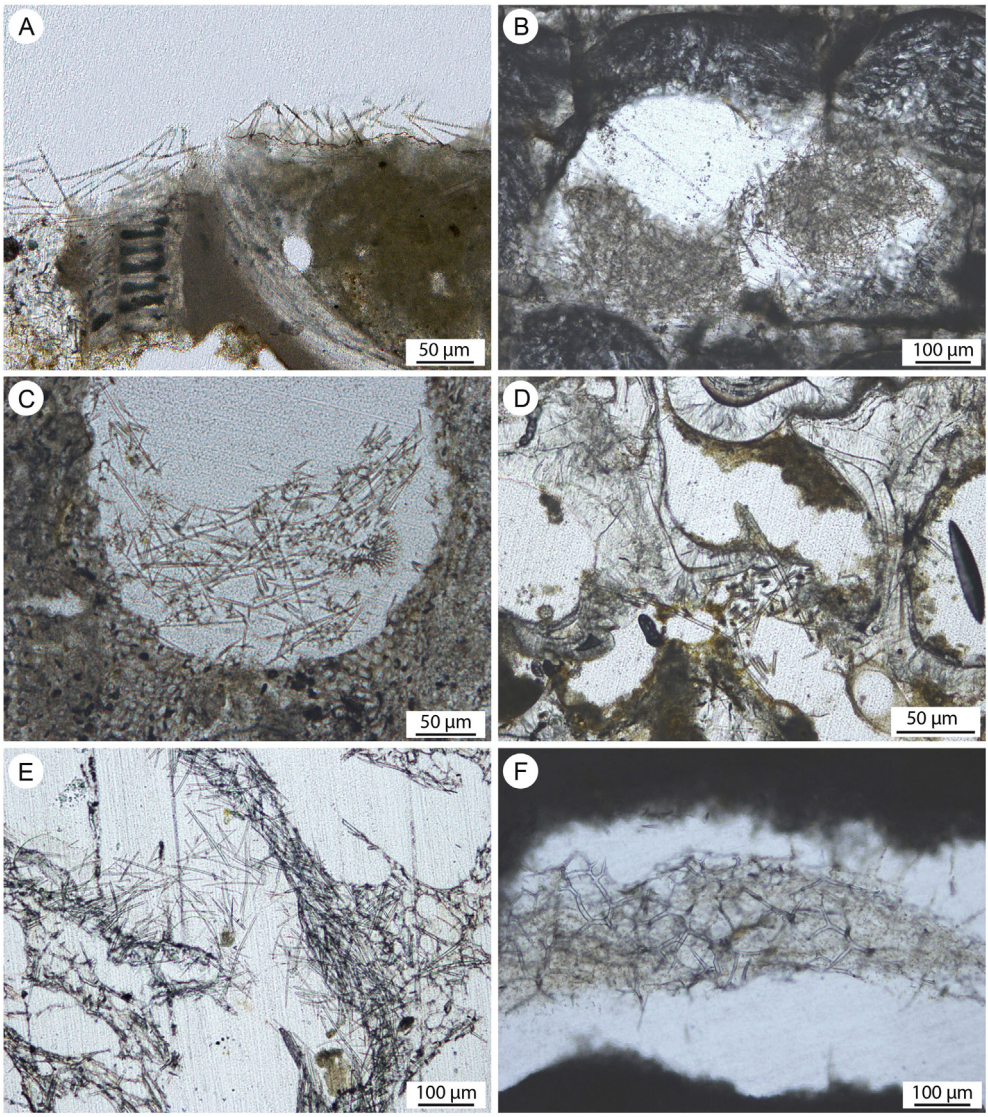


Fig. 4. Microcavities inside the biogenic crusts with sponge spicules, mostly oxeas and (sub-)tylostyles (A–E), triaenes and spongin remains (F).

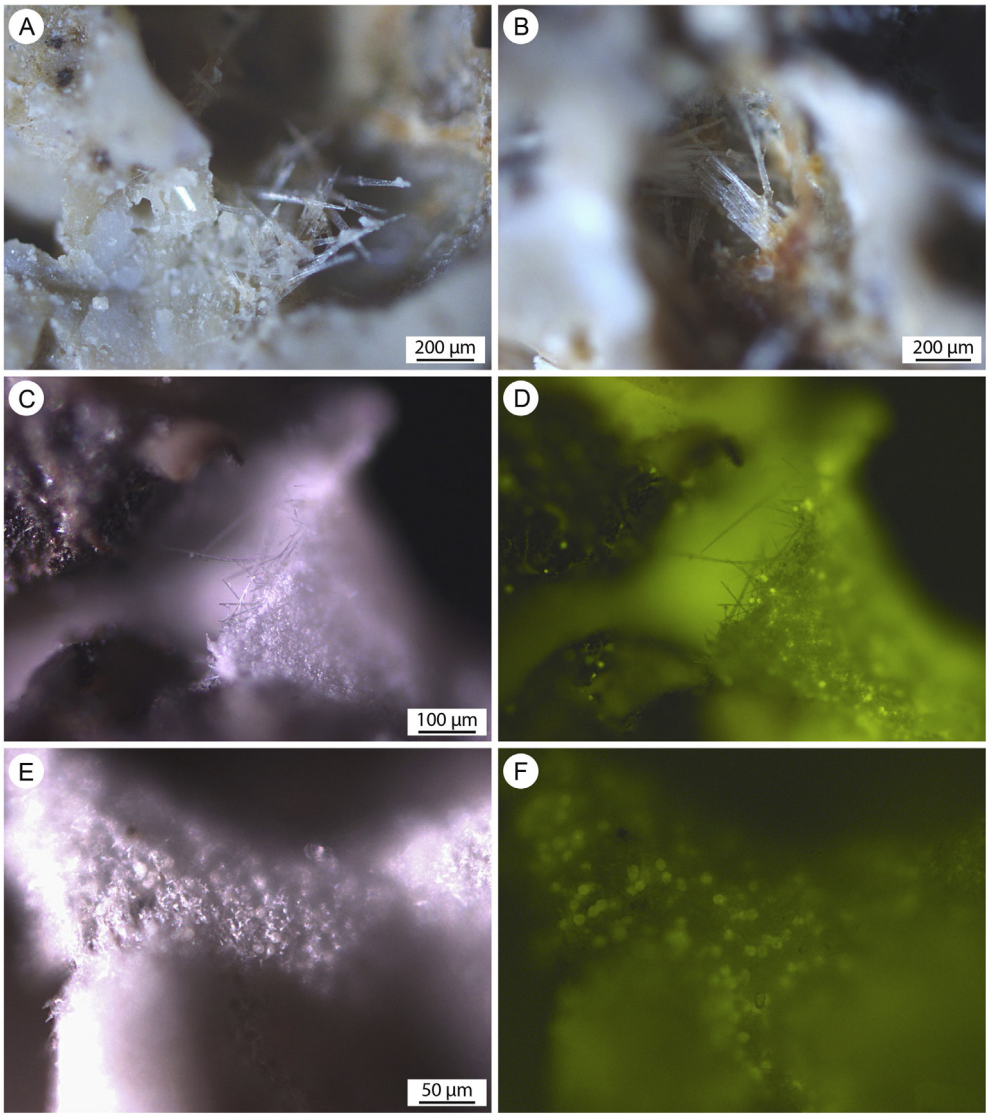


Fig. 5. Sponge spicules observed on freshly broken fragments with incident light (A–B). Spicules and spongin remains observed with incident light (C, E) and UV-epifluorescence (D, F).

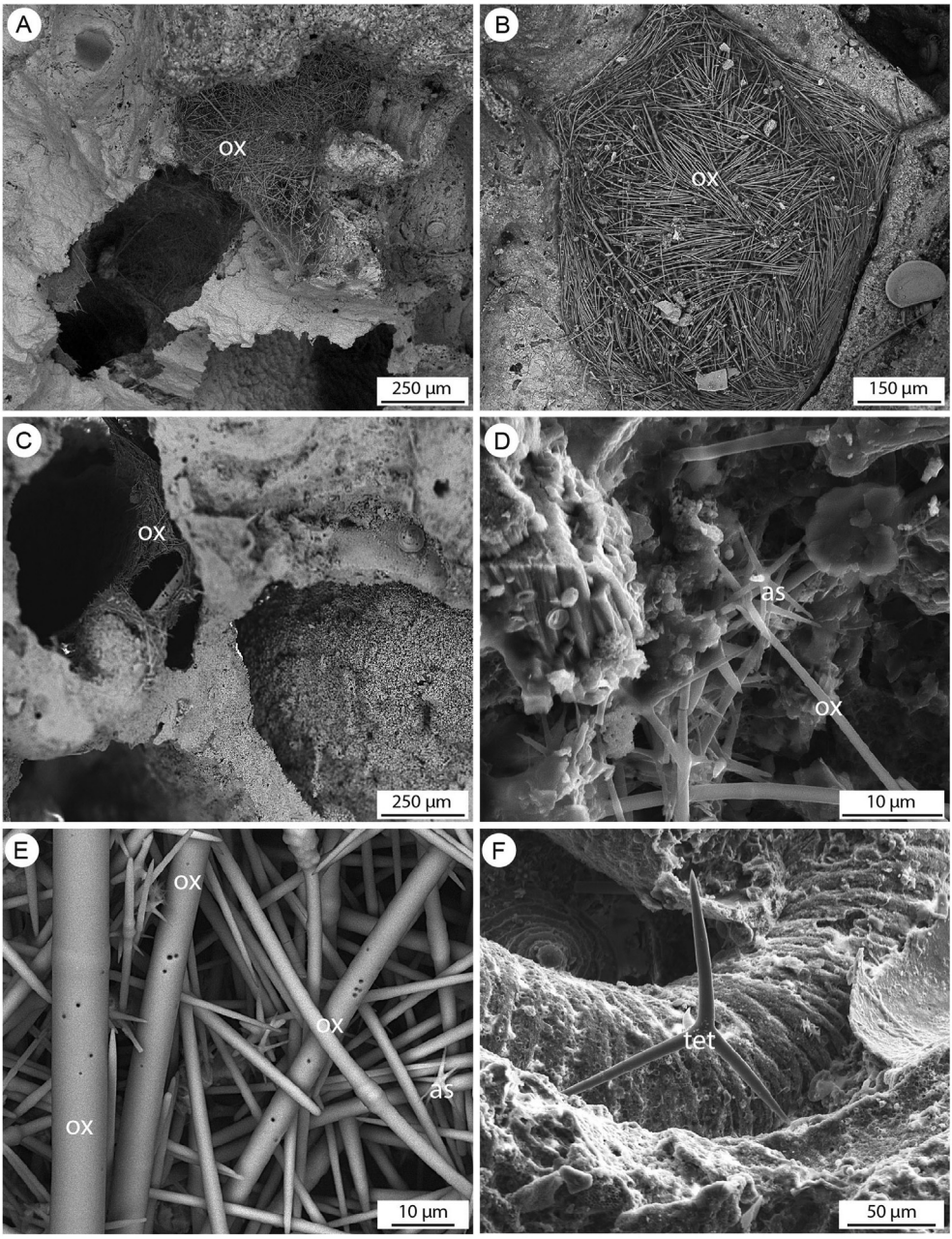


Fig. 6. SEM photos of sponge spicules, including oxeas (A–E), asters (D–E) and tetractines (F), inside the microcavities of the skeletal framework. ox: oxeas; as: asters; tet: tetractines.

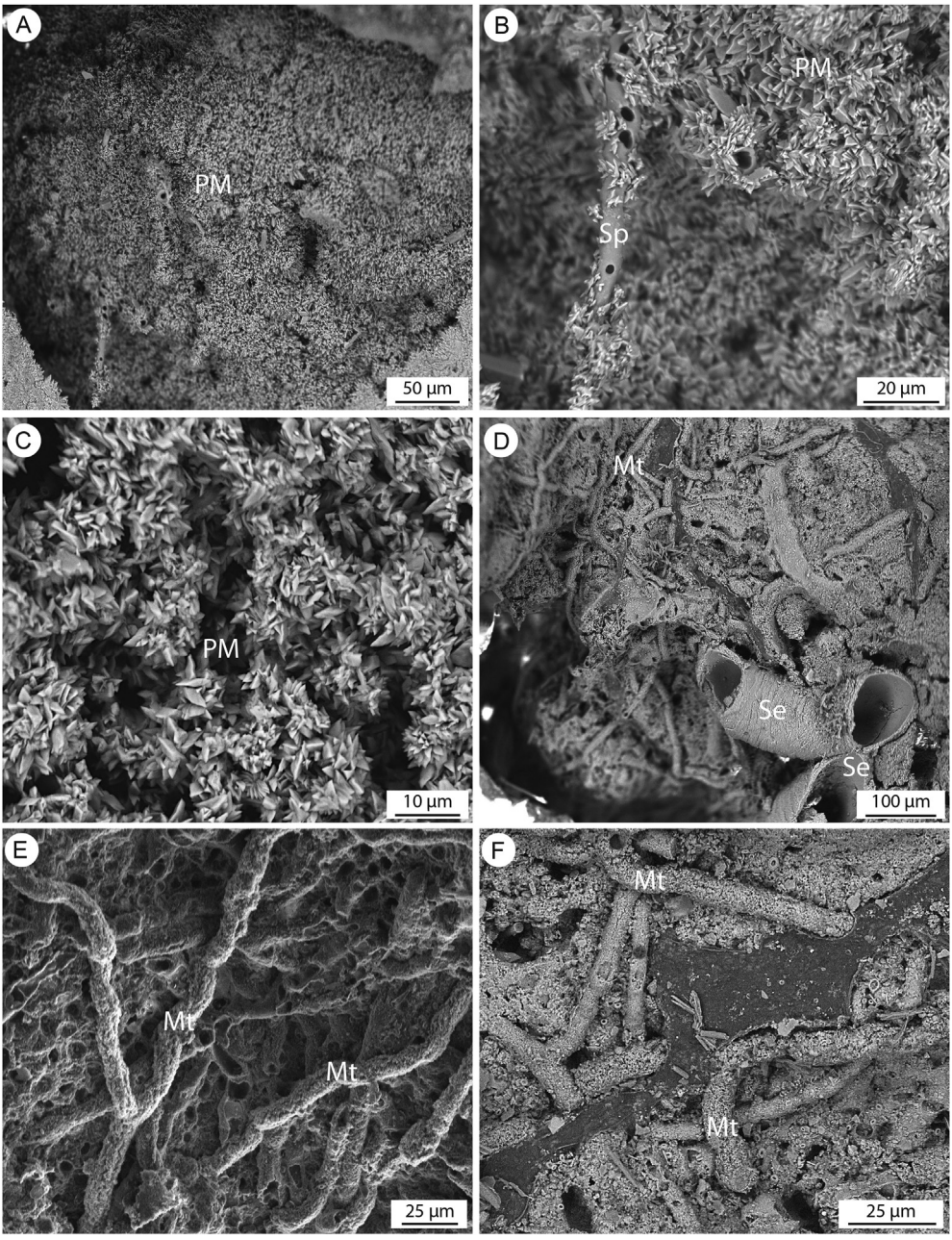


Fig. 7. A-C) Peloidal micrite in the microcavities of the biogenic crusts. When present, this micrite type engulfs sponge spicules (B). D-F) Undetermined microtubules encrusting both the external surfaces and the microcavities of the biogenic crusts. Pm: peloidal micrite; Sp: sponge spicules; Se: serpulids; Mt: microtubules.

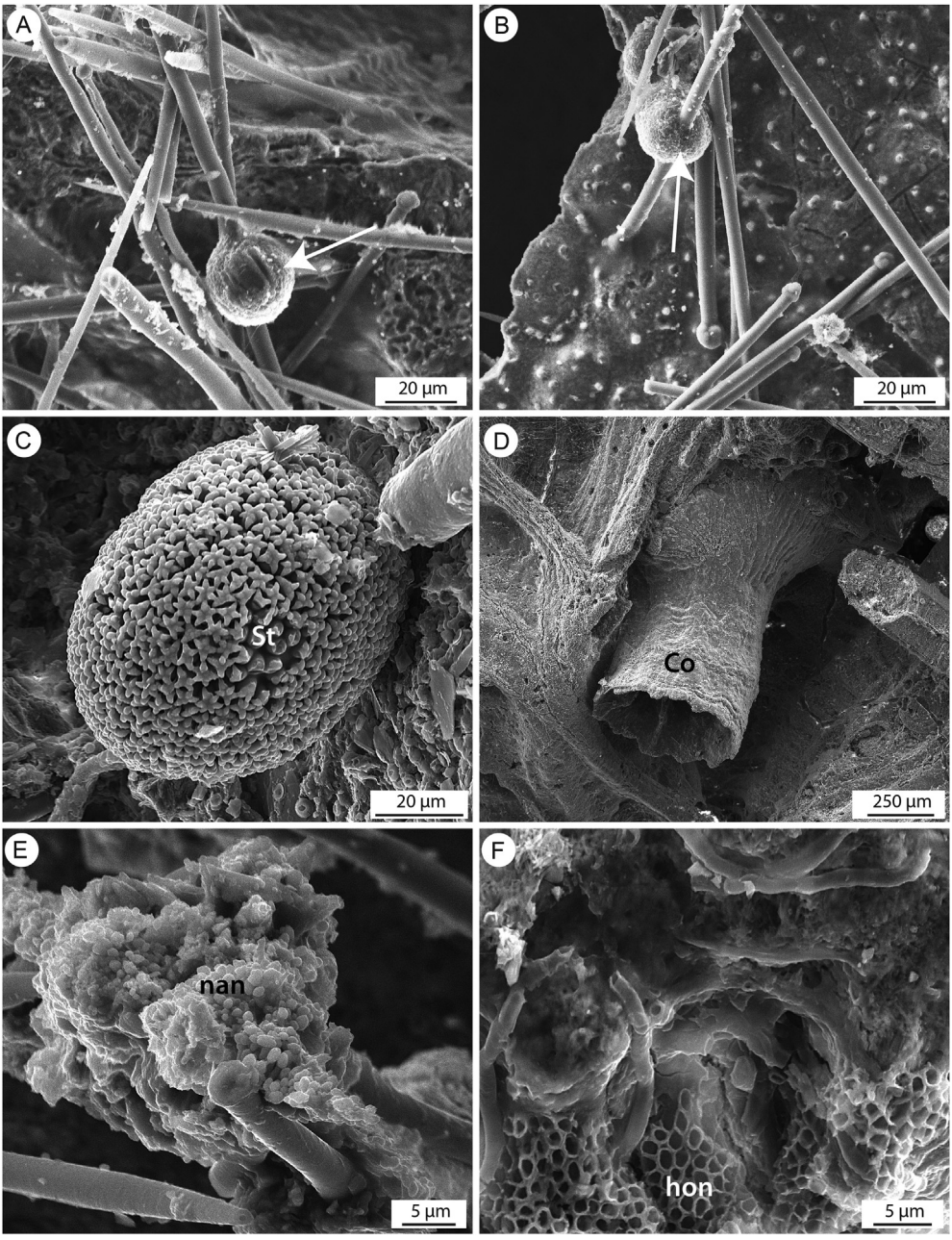


Fig. 8. A-B) Spherical corpuscles on sponge spicules (white arrows). C) Sterraster (St) of a geodiid sponge. D) Small coral (Co) on the surface of the sample from station V2. E) Nanoparticles (nan) encrusting sponge spicules. F) Honeycomb (hon) texture encrusting external surfaces and microcavities of the biogenic crusts.

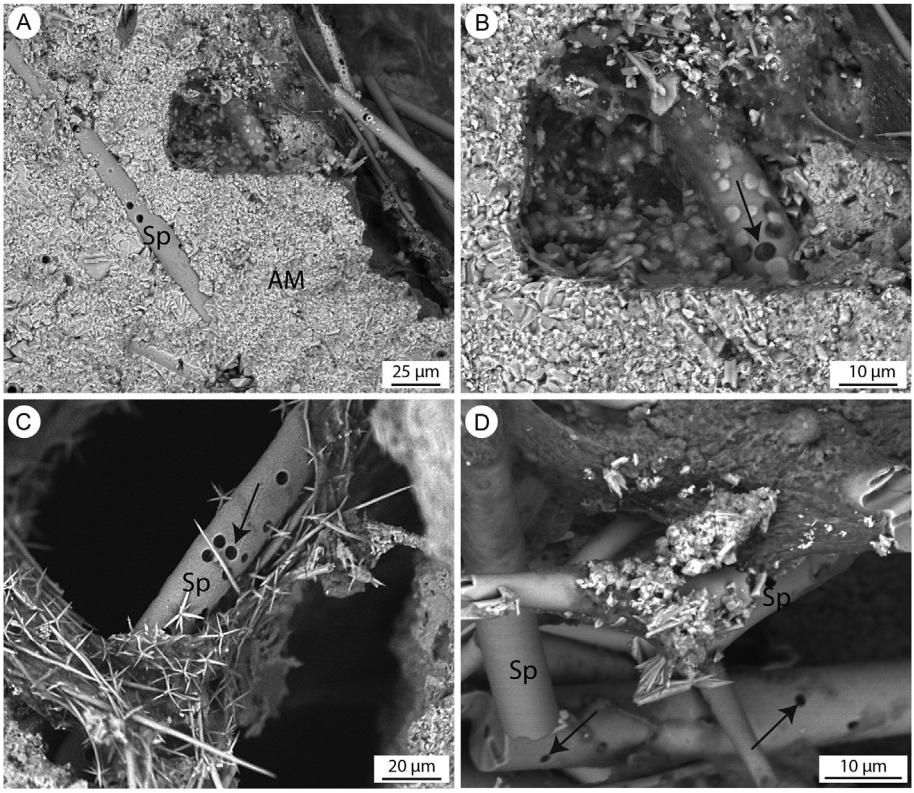
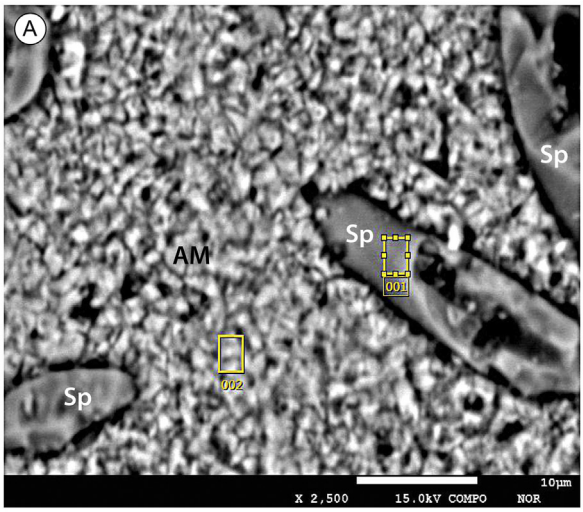
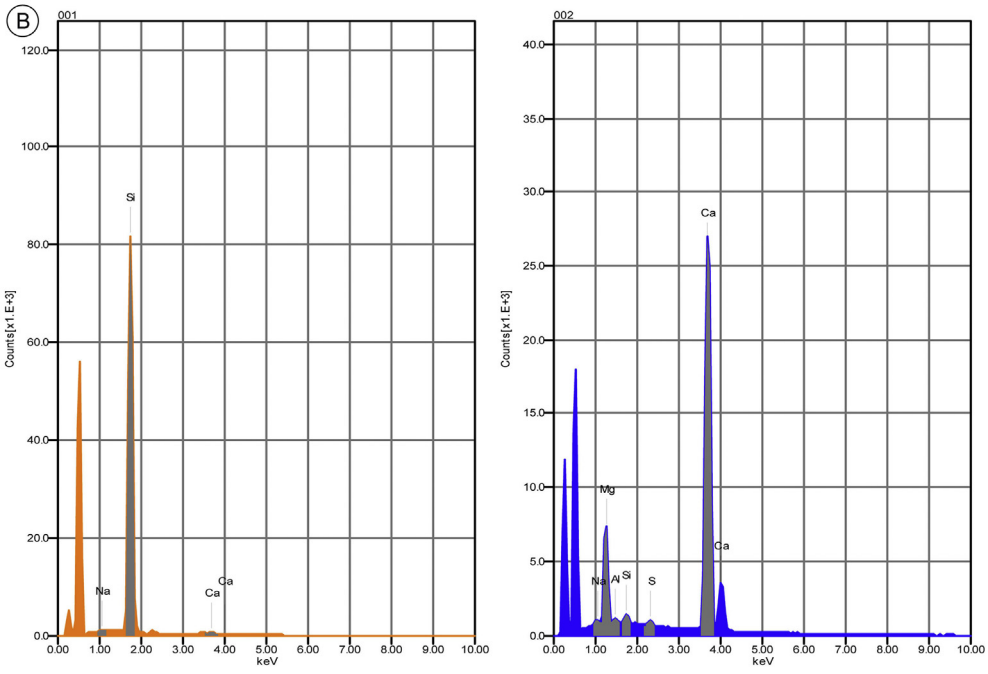


Fig. 9. A) Sponge spicules (Sp) engulfed within autochthonous micrite (AM). B) Detail of A showing well-defined circular boreholes in the spicules (black arrow). C-D) Other sponge spicules with circular erosion marks (black arrows).



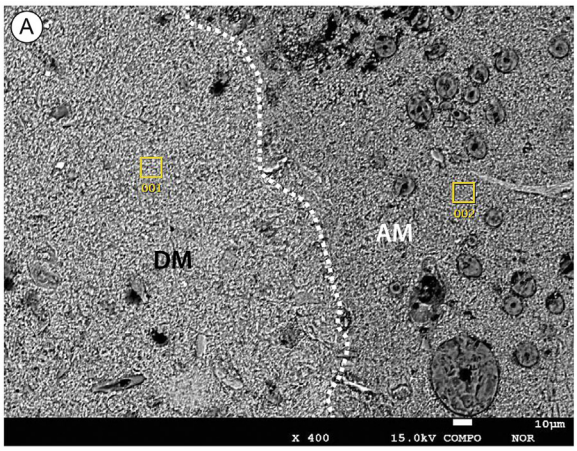

```
Volt            : 15.00 kV
Mag.            : x 2,500
Date            : 2018/02/07
Pixel           : 1280 x 960
```

```
Acquisition Condition
Instrument      : 8230
Volt            : 15.00 kV
Current         : ---
Process Time    : T4
Live time       : 30.00 sec.
Real Time       : 44.21 sec.
DeadTime        : 32.00 %
Count Rate      : 49390.00 CPS
```



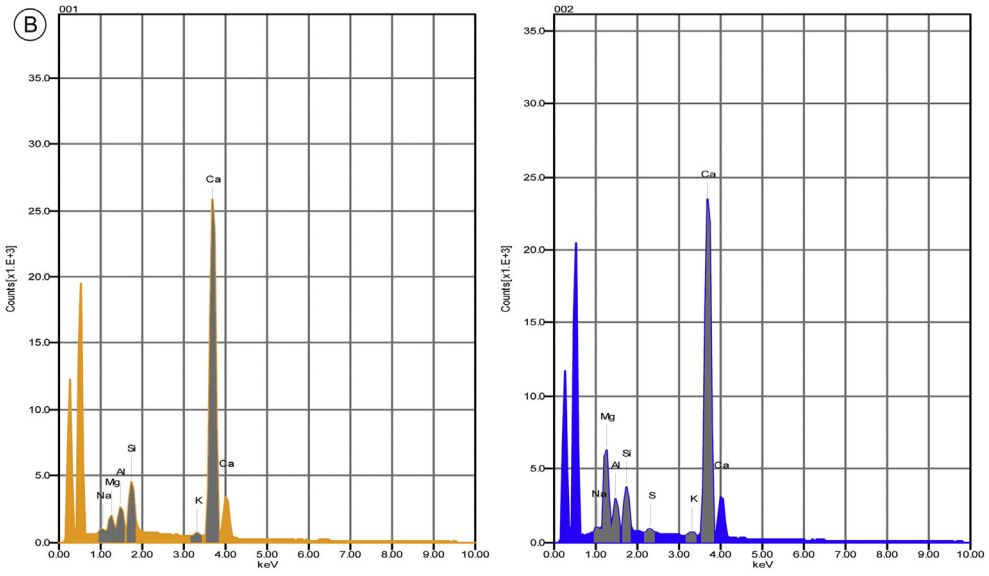
	Na	Mg	Al	Si	S	Ca
001	0.33			98.24		1.43
002	0.37	9.90	0.34	0.92	0.24	88.23

Fig. 10. Raw EPMA report. A) Backscattered-Electron (BSE) photo showing sponge spicules (Sp) engulfed in autochthonous micrite (AM); yellow rectangles represent the analyzed areas. B) Spectra of the Energy Dispersive X-Ray microanalysis (EDS) performed on a spicule (SP, analysis 001 in A) and on autochthonous micrite (AM, analysis 002 in A). Instrumental acquisition conditions and wt% of elements are reported on the right and below, respectively.



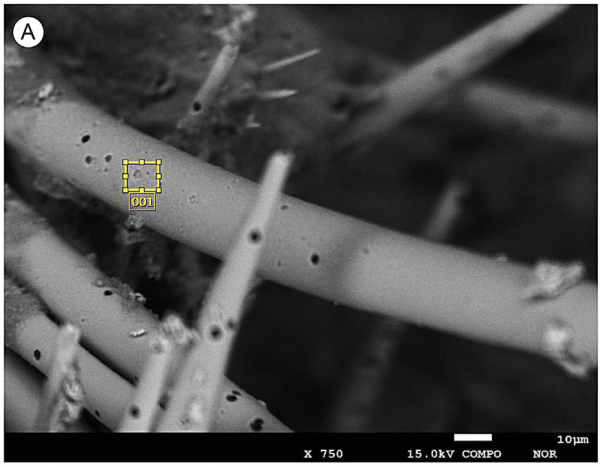

```
Volt            : 15.00 kV
Mag.            : x 400
Date            : 2018/02/07
Pixel           : 1280 x 960
```

```
Acquisition Condition
Instrument      : 8230
Volt            : 15.00 kV
Current         : ---
Process Time    : T4
Live time       : 30.03 sec.
Real Time       : 38.71 sec.
DeadTime        : 22.00 %
Count Rate      : 31415.00 CPS
```

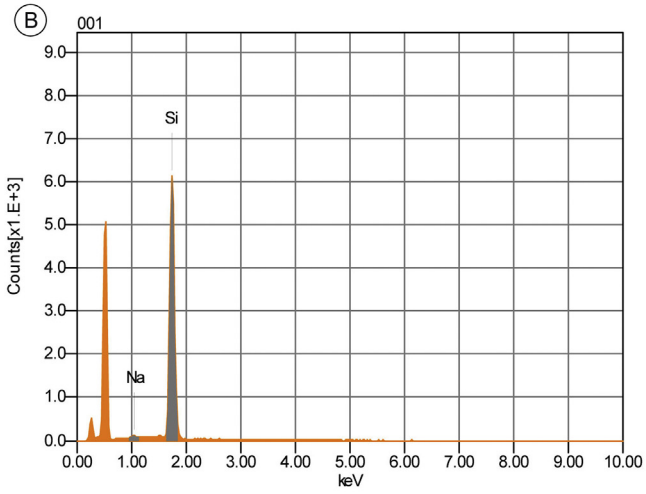


	K	Na	Mg	Al	Si	S	Ca
001	0.63	0.43	1.72	2.70	5.38		89.13
002	0.78	0.38	8.70	3.02	4.69	0.20	82.23

Fig. 11. Rough EPMA report. A) BSE photo showing detrital micrite (DM) and autochthonous micrite (AM) engulfing sponge spicules (Sp); dotted line represents the boundary between the two components. Yellow rectangles represent the analyzed areas. B) EDS spectra of microanalysis (EDS) performed on detrital micrite (DM, analysis 001) and on autochthonous micrite (AM, analysis 002). Instrumental acquisition conditions and wt% of elements are reported on the right and below, respectively.



Volt : 15.00 kV
Mag. : x 750
Date : 2018/02/21
Pixel : 1280 x 960



Acquisition Condition
Instrument : 8230
Volt : 15.00 kV
Current : ---
Process Time : T4
Live time : 30.00 sec.
Real Time : 30.96 sec.
DeadTime : 3.00 %
Count Rate : 3555.00 CPS

	Na	Si
001	0.73	99.27

Fig. 12. Unprocessed EPMA data. A) BSE photo showing sponge spicules and instrumental acquisition conditions reported on the right. Yellow rectangle represents the analyzed area. B) EDS spectra of microanalysis (EDS) performed on a spicule (analysis 001). Instrumental acquisition conditions and wt% of elements are reported on the right and below, respectively.

Acknowledgments

The authors would like to thank Dr. Maria Sini, University of the Aegean, for her help during fieldwork. We thank Dr. Mariano Davoli, University of Calabria, for technical support during SEM and EPMA data acquisition. This research was financially supported by the Research Funding Programme "Heracleitus II: Investing in knowledge society" (EU Social Fund and Greek national funds), grants MIUR (ex 60% 2018 A. Mastandrea, University of Calabria), and funds for the Catania University Research Plan 2016/2018 to AR. VG also benefited from "Alexander S. Onassis Public Benefit Foundation" fellowship for postgraduate studies. This is the Catania Paleoecological Research Group contribution n°.453.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] A. Guido, V. Gerovasileiou, F. Russo, A. Rosso, R. Sanfilippo, E. Voultsiadou, A. Mastandrea, Composition and biostratinomy of sponge-rich biogenic crusts in submarine caves (Aegean Sea, Eastern Mediterranean), Palaeogeogr. Palaeoclimatol. Palaeoecol. 534 (2019), https://doi.org/10.1016/j.palaeo.2019.109338, 109338.

[2] J.G. Harmelin, Organisation spatiale des communautés sessiles des grottes sous-marines de Méditerranée, Rapports et Procés-Verbaux de la Commission International pour l'exploitation de la Mer Méditerranée 5 (1985) 149–153.

[3] J.G. Harmelin, Diversity of bryozoans in a Mediterranean sublittoral cave with bathyal-like conditions: role of dispersal processes and local factors, Mar. Ecol. Prog. Ser. 153 (1997) 139–152, https://doi.org/10.3354/meps153139.

[4] J.G. Harmelin, J. Vacelet, P. Vasseur, Les grottes sous-marines obscures: un milieu extrême et un remarquable biotope refuge, Tethys 11 (1985) 214–229.

[5] C.N. Bianchi, C. Morri, Studio bionomico comparativo di alcune grotte marine sommerse: definizione di una scala di confinamento, Istituto Italiano di Speleologia, Memoria 6 (1994) 107–123.

[6] R. Martí, M.J. Uriz, E. Ballesteros, X. Turon, Benthic assemblages in two Mediterranean caves: species diversity and coverage as a function of abiotic parameters and geographic distance, J. Mar. Biol. Assoc. U. K. 84 (2004) 557–572, https://doi.org/10.1017/S0025315404009567h.

[7] S. Bussotti, A. Terlizzi, S. Fraschetti, G. Belmonte, F. Boero, Spatial and temporal variability of sessile benthos in shallow Mediterranean marine caves, Mar. Ecol. Prog. Ser. 325 (2006) 109–119, https://doi.org/10.3354/meps325109.

[8] V. Gerovasileiou, E. Voultsiadou, Sponge diversity gradients in marine caves of the eastern Mediterranean, J. Mar. Biol. Assoc. U. K. 96 (2016) 407–416, https://doi.org/10.1017/S0025315415000697.

[9] V. Gerovasileiou, C. Dimitriadis, C. Arvanitidis, E. Voultsiadou, Taxonomic and functional surrogates of sessile benthic diversity in Mediterranean marine caves, PLoS One 12 (2017), e0183707, https://doi.org/10.1371/journal.pone.0183707.

[10] R. Onorato, P. Forti, G. Belmonte, A. Costantini, M. Poto, La grotta sottomarina lu Lampiùne: novità esplorative e prime indagini ecologiche, Thalass. Salentina 26 (suppl) (2003) 55–64.

[11] G. Belmonte, G. Ingrosso, M. Poto, G. Quarta, M. D'Elia, O. Onorato, L. Calcagnile, Biogenic stalactites in submarine caves at the Cape of Otranto (SE Italy): dating and hypothesis on their formation, Mar. Ecol. 30 (2009) 376–382, https://doi.org/10.1111/j.1439-0485.2008.00279.x.

[12] A. Guido, A. Mastandrea, A. Rosso, R. Sanfilippo, F. Russo, Micrite precipitation induced by sulphate reducing bacteria in serpulid bioconstructions from submarine caves (Syracuse, Sicily), Rendiconti Online della Società Geologica Italiana 21 (2012) 933–934.

[13] A. Guido, K. Heindel, D. Birgel, A. Rosso, A. Mastandrea, R. Sanfilippo, F. Russo, J. Peckmann, Pendant bioconstructions cemented by microbial carbonate in submerged marine caves (Holocene, SE Sicily), Palaeogeogr. Palaeoclimatol. Palaeoecol. 388 (2013) 166–180, https://doi.org/10.1016/j.palaeo.2013.08.007.

[14] A. Guido, C. Jimenez, K. Achilleos, A. Rosso, R. Sanfilippo, L. Hadjioannou, A. Petrou, F. Russo, A. Mastandrea, Cryptic serpulid-microbialite bioconstructions in the Kakoskali submarine cave (Cyprus, Eastern Mediterranean), Facies 63 (2017) 21, https://doi.org/10.1007/s10347-017-0502-3.

[15] A. Guido, A. Rosso, R. Sanfilippo, F. Russo, A. Mastandrea, Microbial biomineralization in biotic crusts from a Pleistocene marine cave (NW Sicily, Italy), Geomicrobiol. J. 34 (2017) 864–872, https://doi.org/10.1080/01490451.2017.1284283.

[16] R. Sanfilippo, A. Rosso, A. Guido, A. Mastandrea, F. Russo, R. Riding, E. Taddei Ruggiero, Metazoan/microbial biostalactites from present-day submarine caves in the Mediterranean Sea, Mar. Ecol. 36 (2015) 1277–1293, https://doi.org/10.1111/maec.12229.

[17] I.G. Macintyre, P.E. Videtich, Pseudostalactites from a Submarine Cave Near Columbus Cay, Belize Barrier-Reef Complex: Evidence of Extensive Submarine Lithification. Tulsa, Oklahoma. Program AAPG-SEPM Annual Convention, American Association Petroleum Geologists, Houston, 1979.

[18] E. Gischler, K. Heindel, D. Birgel, B. Brunner, J. Reitner, J. Peckmann, Cryptic biostalactites in a submerged karst cave of the Belize Barrier Reef revisited: pendant bioconstructions cemented by microbial micrite, Palaeogeogr. Palaeoclimatol. Palaeoecol. 278 (2017) 34–51, https://doi.org/10.1016/j.palaeo.2016.11.042.

[19] E. Gischler, D. Birgel, B. Brunner, A. Eisenhauer, G. Meyer, S. Buhre, J. Peckmann, A giant underwater stalactite from the Blue Hole, Belize, revisited: a complex history of massive carbonate accretion under changing meteoric and marine conditions, J. Sediment. Res. 87 (2017) 1260–1284, https://doi.org/10.2110/jsr.2017.72.

[20] R. Sanfilippo, A. Rosso, A. Guido, V. Gerovasileiou, Serpulid communities from two marine caves in the Aegean Sea, Eastern Mediterranean, J. Mar. Biol. Assoc. U. K. 97 (2017) 1059–1068, https://doi.org/10.1017/S0025315417000297.

[21] A. Rosso, V. Gerovasileiou, R. Sanfilippo, A. Guido, Bryozoan assemblages from two submarine caves in the Aegean Sea (eastern mediterranean), Mar. Biodivers. 49 (2019) 707–726, https://doi.org/10.1007/s12526-018-0846-0.