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FIRST DATA ON THE SPONGE FAUNA OF A SEMI-SUBMERGED CAVE OF THE ADRIATIC APULIAN COAST (SOUTHERN ITALY, MEDITERRANEAN SEA)

PRIMI DATI SULLA SPONGOFAUNA DI UNA GROTTA SEMISOMMERSA LUNGO LA COSTA ADRIATICA PUGLIESE (ITALIA MERIDIONALE, MAR MEDITERRANEO)

Abstract - Marine caves are vulnerable habitats considered an important hotspot for biodiversity in the Mediterranean Sea. They contain unique taxa assemblages and play the precious role of refuge for endemic and/or "relict" species. Although the Apulian Adriatic coast hosts numerous marine caves, only two caves have been studied for poriferans. In this paper, we present the first data on the sponge fauna of the Colombi Cave, a semi-submerged cave 70 meters long, located along the cliff of Polignano a Mare (Apulian coast). A non-destructive photographic method was employed, followed by advanced image analysis and targeted sampling of some species. A total of 55 sponge taxa were identified in the cave. Porifera dominated the benthic community and reached the maximum covering percentage in semi-dark conditions. The present study improves the state of knowledge of Apulian caves and can be used both for comparative studies and as a solid baseline for future monitoring.

Key-words: marine caves, Porifera, Apulian coast.

Introduction – Marine caves are important coastal habitats for fauna conservation, biodiversity protection and landscape preservation. Indeed, submerged and semi-submerged marine caves host unique assemblages characterised by a rich community of filter-feeding invertebrates. The most abundant benthic *phylum* is Porifera which represents the main component of sessile benthic communities in marine caves in terms of abundance, diversity, covering and biomass. More than 3000 marine caves have been recorded along the Mediterranean rocky coastline (Gerovasileiou *et al.*, 2021) and, although many of them are located along the Apulian coast, they have not been uniformly surveyed. Particularly, along the Adriatic coastal region near Bari, studies of the sponge fauna have focused on only two caves, and their sponge fauna has been poorly investigated (Longo *et al.*, 2023 and references therein). Currently, marine cave habitats are considered endangered in the Mediterranean Sea because of their particular sensitivity to pollution, marine litter, thermal anomalies, alien species occurrence and unregulated underwater and touristic activities. Submerged and semi-submerged marine caves are thus one of the European Habitats of Community Interest listed in Annex I of the Habitat Directive (92/43/CEE) - code 8330, whose ecological status must be monitored and preserved in order to mitigate any human impacts and reduce potential deterioration phenomena.

Materials and methods – This study was carried out in the "Colombi Cave", a semi-submerged marine cave located in the Adriatic Sea along the Polignano a Mare cliff (Apulian coast, southern Italy). It is a coastal cave belonging to an ancient underground karst system that came to light for the cliff retreat (Favale, 1994). The cave entrance is 6 meters high and 22 meters wide. It is 70 meters long and reaches a maximum depth of 4 meters at the entrance. About 60 meters from the entrance there are two

wide openings in the vault of the cave, allowing the penetration of sunlight (Fig. 1). This preliminary study of the sponge fauna of the Colombi cave was carried out in three stations along its whole length: at the entrance (A), in the middle (B) and in the innermost (C) part of the cave. A video-transect was conducted along the southern wall, established from the cave entrance to the end of the cave. Ten frames per station were extracted from the video and then analyzed using photoQuad (v_1.4) software (Trygonis & Sini, 2012). A standard area of 400 cm² was established for each image and analyzed for the percentage coverage of each taxon. The sponges observed have been identified at the lowest possible taxonomic level. However, targeted sampling was carried out for those species that required microscopic identification. Due to their indistinguishable external morphology, some species were grouped into operational taxonomic units (OTUs), such as "horny sponges" (HS) and encrusting orange sponges (EOS). The use of OTUs as morphospecies is considered an effective method for determining distribution patterns in benthic invertebrates particularly in marine sponges (Gimenez *et al.*, 2022). Finally, according to their morphology, sponges were distinguished into "massive taxa" and "encrusting taxa" as reported in Table 1. It is important to note that for the perforating species belonging to the genus *Cliona*, we have considered only the papilla present on the substratum.

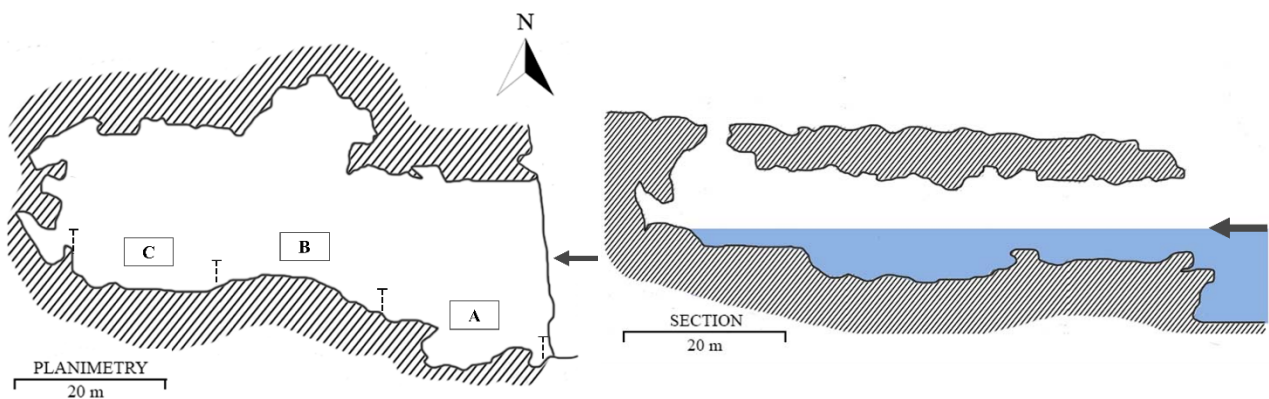


Fig. 1 - Planimetry (left) and section (right) of the Colombi Cave; arrow indicates the entrance; "A": entrance, "B": middle zone, "C": innermost zone of the cave.
 Planimetria (a sinistra) e sezione (a destra) della Grotta dei Colombi; la freccia indica l'ingresso; "A": entrata, "B": zona centrale, "C": zona interna della grotta.

Tab. 1 - List of the taxa included into the "massive" and "encrusting" categories. HS= Horny Sponges; EOS= Encrusting Orange Sponges.

Lista dei taxa inclusi nelle categorie ad habitus "massivo" e "incrostante". HS= Spugne Cornee; EOS= Spugne Incrostanti Arancioni

Massive	<i>Petrosia</i> spp.	<i>Chondrosia reniformis</i> (Nardo, 1847)	<i>Agelas oroides</i> (Schmidt, 1864)	<i>Axinella verrucosa</i> (Esper, 1794)	<i>Haliclona</i> spp.	<i>Penares helleri</i> (Schmidt, 1864)	<i>Geodia cydonium</i> (Linnaeus, 1767)	<i>Tethya aurantium</i> (Pallas, 1766)	HS	
Encrusting	<i>Cliona</i> spp.	<i>Phorbas tenacior</i> (Topsent, 1925)	<i>Dendroxea lenis</i> (Topsent, 1892)	<i>Bubaris vermiculata</i> (Bowerbank, 1866)	Suberitidae	<i>Phorbas fictitius</i> (Bowerbank, 1866)	<i>Jaspis johnstonii</i> (Schmidt, 1862)	<i>Hymedesmia</i> spp.	EOS	<i>Terpios gelatinosus</i> (Bowerbank, 1866)

Results - The preliminary results allowed the censusing of a total of 55 sponges taxa divided as follows: 2 Calcarea subdivided into one order, two families and two genera; one Homoscleromorpha; 52 Demospongiae comprising 13 orders, 28 families and 41 genera. Within demosponges, the most represented order is Poecilosclerida, with 9

species belonging to 5 genera and 4 families, and Tetractinellida with 9 species belonging to 7 genera and 3 families. The order of Haplosclerida is also well represented, with 8 species. Finally, the less represented orders were the Keratosa order of Dictyoceratida, the orders of Axinellida, Suberitida and Clionaida with 4 species each (Fig. 2). From the cave entrance to the innermost part of the cave, a slight decrease in the covering values of massive sponges was recorded, reaching the maximum value at station A (21,06 %). The encrusting sponges, instead, increased from the entrance to the innermost semi-dark station, where it reached the maximum value (60,14 %) (Fig. 3), mainly due to *B. vermiculata* (Bowerbank, 1866), *D. lenis* (Topsent, 1892) and *J. johnstonii* (Schmidt, 1862) (Fig. 4). Taxa like *Petrosia* spp., *C. reniformis* Nardo, 1847, *J. johnstonii*, *G. cydonium* (Linnaeus, 1767) were found in all the investigated stations. The highest value for the number of taxa was found in the first station investigated (A), while the percentage covering was the lowest in this station.

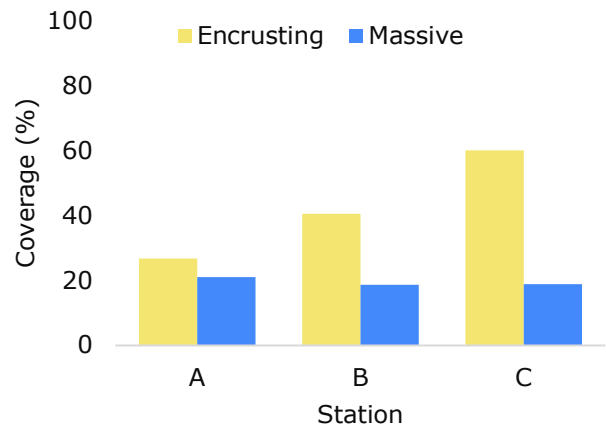
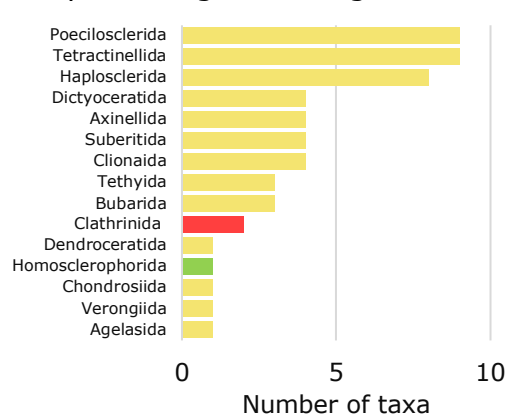


Fig. 2 - Distribution of the number of sponge taxa belong to the different orders. Yellow: Demospongiae; green: Homoscleromorpha; red: Calcarea. *Distribuzione del numero di taxa di poriferi afferenti ai diversi ordini. Giallo: Demospongiae; verde: Homoscleromorpha; rosso: Calcarea.*

Fig. 3 - Cover values (%) of sponges with massive and encrusting habitus at the three investigated stations. *Valori di ricoprimento (%) delle spugne ad habitus massivo e incrostante nelle tre stazioni indagate.*

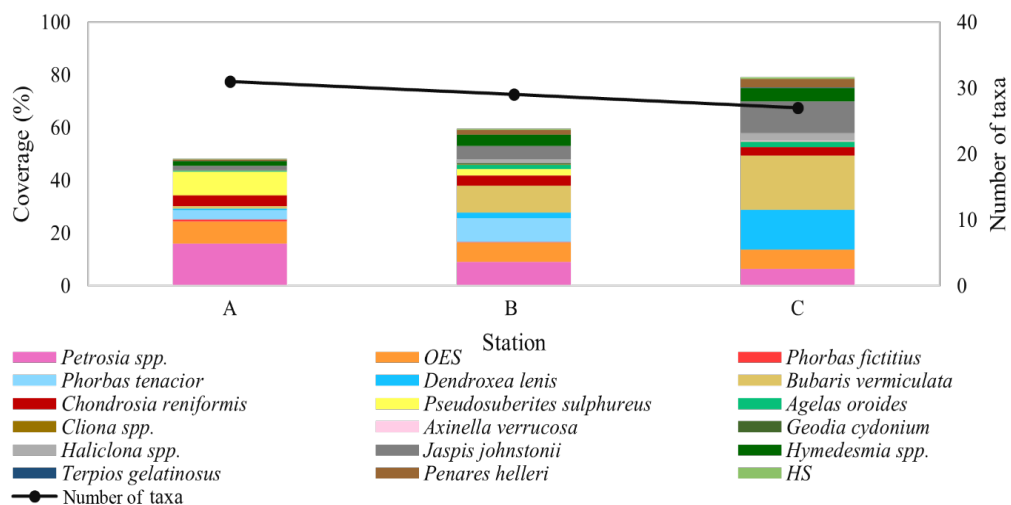


Fig. 4 - Cover values (%) and total number of sponges taxa at the entrance (A), middle (B) and inner (C) stations of the Colombi Cave. OES= Orange Encrusting Sponges; HS= Horny Sponges. *Valori di ricoprimento (%) e numero totale di taxa di poriferi all'ingresso (A), nella stazione intermedia (B) e nella stazione terminale (C) della Grotta dei Colombi. OES= Spugne Incrostanti Arancioni; HS= Spugne Cornee.*

Conclusions – The rocky coastline of the Apulian Adriatic coast near Bari is characterized by a strong karst activity and so it hosts several marine caves. However, a recent research (Longo *et al.*, 2023) has revealed that only two marine caves have been studied: Regina Cave and Cala Incina Cave. This work shows, for the first time, the preliminary results on the sponge fauna of the semi-submerged Colombi Cave, in which the dominant role of poriferans was confirmed for both taxonomic richness and percentage of cover. The highest values of sponge cover were found in the innermost station (79,1%), probably due to the morphology and the presence of two openings in the vault of the cave. Moreover, in accordance with the literature, some Porifera species were preferentially distributed in some parts of this cave (Bibiloni *et al.*, 1989; Corriero *et al.*, 2000; Costa *et al.*, 2018). For example, *C. rhodensis* Rützler & Bromley, 1981, *P. fictitius* (Bowerbank, 1866) and *P. tenacior* (Topsent, 1925) were mostly found near the entrance; *D. lenis*, *Penares helleri* (Schmidt, 1864) and *P. (Strongylophora) pulitzeri* Pansini, 1996 were found in the semi-dark zone of the cave; while *P. (Petrosia) ficiformis* (Poiret, 1789), *C. reniformis*, *Spirastrella cunctatrix* Schmidt, 1868, *B. vermiculata*, *J. johnstonii*, *C. schmidtii* (Ridley, 1881) and *A. oroides* (Schmidt, 1864) were found to be ubiquitous. The extreme geomorphological and topographical variability leads to different conditions in each cave, favouring the presence of characteristic populations, whose uniqueness underlines the importance of their conservation and the need to increase the knowledge of unexplored marine caves. Further research will be carried out to obtain a more detailed analysis for the conservation of this rich and peculiar habitat.

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