

MARINE CAVES

OF THE EASTERN MEDITERRANEAN SEA

BIODIVERSITY, THREATS AND CONSERVATION

Edited by
Bayram ÖZTÜRK



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Habitat mapping of underwater Bilge Taş Cave (Wisdom Stone Cave) in the Northeastern Mediterranean Sea: Structure and biodiversity

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Introduction

Marine caves constitute an ordinary highlight of the Mediterranean rough coastline. Up to date, 738 marine underwater caves were reported within the eastern Mediterranean, representing one fourth of the known Mediterranean marine underwater caves (Giakoumi *et al.* 2013). Despite that, data with respect to their biodiversity and community structure is restricted in comparison to their north-western and central Mediterranean regions (Gerovasileiou *et al.* 2016).

Mediterranean marine caves play important roles as reservoirs for the restocking of important species and have a critical environmental value in connection to function (Cicogna *et al.* 2003; Chevaldonne and Lejeusne 2003). Besides, the marine caves are considered to be a connection between closed habitats. (Rastorgueff *et al.* 2015; Bussotti *et al.* 2015). The caves also play an economically important role for a local diving center due to the high frequency of requests from divers to explore them. Management action will need to be evaluated in order to reduce and prevent the impact of recreational divers on the benthic community (Di Franco *et al.* 2009; Di Franco *et al.* 2010).

The primary logical information about the biodiversity of the eastern Mediterranean marine caves were obtained during the Calypso undertaking within the 1950s to Kastelorizo, in the Levantine Basin (Laborel 1961). Afterward, Riedl (1966) gave extra biodiversity information for Aegean caves, centering mainly on the description of uncommon and recent species (Bailey 1969; Hayward 1974; Pulitzer-Finali 1983; Voultsiadou and Vafidis 2004).

There are restricted studies about marine cave biodiversity in the Levantine Basin (Tsumamal 1969; Tsumamal 1975; Ben-Eliahu and Ten Hove 1992),

which gives information from the coasts of Lebanon, where a number of new species were reported (Pérez *et al.* 2004; Vacelet *et al.* 2007; Harmelin *et al.* 2009).

The objective of the current study was to describe, for the first time, the geomorphology and biodiversity of a marine cave named Bilge Taş (Wisdom Stone) in the Antakya Bay, Northeastern Mediterranean Sea, including the assessment of ecology, biodiversity and structure for the environmental management of critical habitats in the Mediterranean coast of Turkey.

Material and method

The study was carried out in 2018 in the underwater Bilge Taş Cave in the Antakya Bay, northeastern Mediterranean Sea, Turkey (Figure 1). The coordinates of the cave are (35°57'17.2"N 35°55'19.8"E).

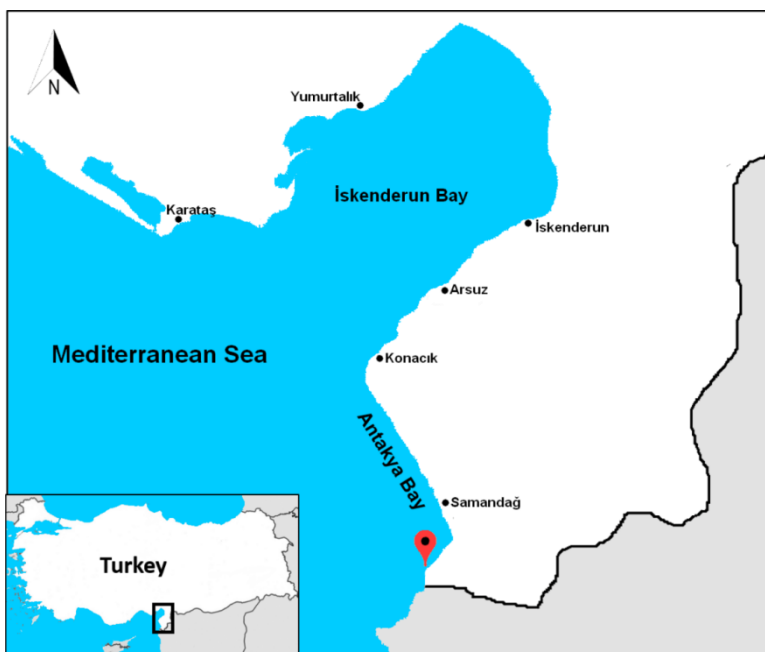


Figure 1. Location of the Bilge Taş Cave.

Nearly 30 dives have been performed since 2018, and average dive time was 45 minutes. Species sampling along the cave was carried out by visual identification, photographing and videos using three underwater cameras. During visual identification and taking videos, three 5000 lumens video lights and 2000 lumens spot lights were used for diving. The species were cross-

checked and listed with taken notes, photographs and videos by each diver after each dive. A yellow colored cord was lined along the cave at the beginning of the study in case of any loss or accident. The biggest challenge during the dives was temperature differences between the Galleries in the cave. In Gallery 3, there is a freshwater spring which is 21-22°C along the year that negatively affects diving comfort. During summer, the water temperature is 28°C in the entrance of the cave. In winter, it is reversed, the water temperature in the entrance of the cave is about 16°C, and 21°C in the Gallery 3. Therefore, divers should be ready for temperature shock during dives in the cave.

Geomorphological depictions of the Bilge Taş Cave were carried out with classic topographical and hydrobiological techniques comprising dimensional mapping (Ereskovsky *et al.* 2013; Ereskovsky *et al.* 2016). The coordinates of the Bilge Taş Cave passages were described with a dive watch. The cave depths were instantly measured with a diving gauge. Two divers used underwater meters in cooperation to measure the dimensions of tunnels, domes and other parts. Underwater topographic mapping was carried out with length measured between the entrance and the end of the cave, then navigation survey was followed with an underwater compass. Distribution of species mapping along the cave was carried out using R studio.

Result

Bilge Taş Cave is structured as entrance and 3 galleries. The entrance of the cave is surrounded with sandy ground but the interior of the cave ground was rocky. Width and depth of the cave were measured as 38 m and 27 m for entrance, 33 m - 25 m for gallery_1, 33 m and 27 m for gallery_2 and 32 m and 12 m for gallery_3, respectively (Figure 2, 3).

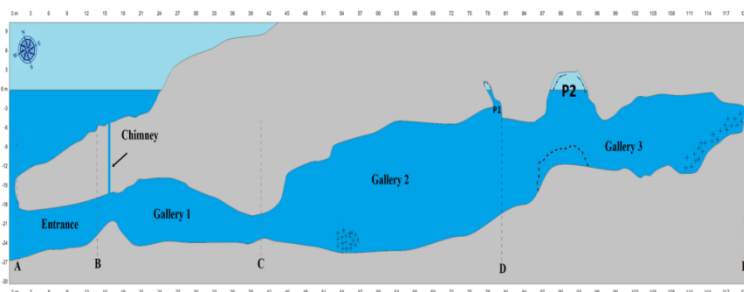


Figure 2. Side profile of the Bilge Taş Cave in the Antakya Bay, Northeastern Mediterranean Sea. P1 and P2, Air pocket; +, small rocks.

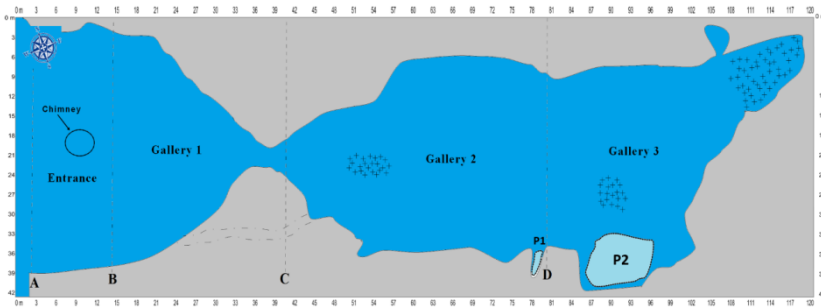


Figure 3. Top view of the Bilge Taş Cave in the Antakya Bay, Northeastern Mediterranean Sea. P1 and P2, Air pocket; +, small rocks.

The length of the cave was measured as 120 m. Moreover, there is 1 chimney in the entrance of the cave which is very narrow and has sun lights. There are also 2 air pockets (P1 and P2, Figure 2,3) in gallery_2 and gallery_3. A total of 27 species were identified in the studied cave, specifically 13 fish, 2 sponges, 4 crustaceans, 4 cnidarians and 4 echinoderms (Table 1).

Side profile and top view of the Bilge Taş Cave in the Antakya Bay, Northeastern Mediterranean Sea are presented in Figure 2 and Figure 3 respectively. The cave can be divided in four sections: entrance, gallery_1, gallery_2 and gallery_3. Moreover, the cave includes two internal air pockets as well as one chimney in the entrance (Figure 3). In the entrance of the cave, 23 species were observed, while the number of species decreased towards to interior of the cave.

For the taxonomic diversity, Pisces were the highest observed with 48%, Porifera species were lowest with 7% (Table 2).

For the origin of the species observed in the cave, Atlantic and Mediterranean originated species were highest (58%), however, non-indigenous species of Indo-Pacific origin was recorded 31% of the species in comparison to the indigenous species. Some observed species belonging to different Phylums in the Bilge Taş Cave are given at Figure 4. Two Porifera species (*Haliclona* sp. and *Axinella* sp.) were unspecified at the species level.

Table 1. List of taxa recorded in the Bilge Taş Cave. Cave zones are given at Figure. 1. U: origin Unidentified; A, Atlantic Ocean; IP, Indo-Pacific; C, Cosmopolitan; *, Threatened (IUCN)

Species	Entrance	Gallery_1	Gallery_2	Gallery_3	Origin
Kingdom Animalia					
Subphylum Vertebrata					
Superclass Pisces					
<i>Sargocentron rubrum</i> (Forsskal, 1775)	x	x			IP
<i>Pagrus caeruleostictus</i> (Valenciennes, 1830)		x	x	x	A
<i>Diplodus vulgaris</i> (Geoffroy Saint-Hilaire, 1817)	x	x	x		A
* <i>Sciaena umbra</i> Linnaeus, 1758	x	x	x	x	A
<i>Mycteroperca rubra</i> (Bloch, 1793)	x	x			A
<i>Pempheris rhomboidea</i> (Kossmann & Räuber, 1877)	x	x	x		IP
<i>Apogon imberbis</i> (Linnaeus, 1758)	x	x	x		A
* <i>Dasyatis pastinaca</i> (Linnaeus, 1758)		x			A
<i>Epinephelus costae</i> (Steindachner, 1878)	x	x			A
<i>Parupeneus forsskali</i> (Fourmanoir & Guézé, 1976)	x	x			IP
<i>Cheilodipterus novemstriatus</i> (Rüppell, 1838)	x				IP
<i>Torquigener flavimaculosus</i> Hardy & Randall, 1983	x	x			IP
* <i>Umbrina cirrosa</i> (Linnaeus, 1758)		x			A
Phylum Porifera					
<i>Axinella</i> sp.	x	x			U
<i>Haliclona</i> sp.	x	x	x		U

Table 1. Continued

Phylum Arthropoda					
Subphylum Crustacea					
<i>Scyllarides latus</i> (Latreille, 1802)	x	x	x	x	A
<i>Plesionika narval</i> (Fabricius, 1787)		x	x	x	C
<i>Diogenes pugilator</i> (Roux, 1829)	x	x			A
<i>Saron marmoratus</i> (Olivier, 1811)	x				IP
Phylum Cnidaria					
<i>Cerianthus membranaceus</i> (Gmelin, 1791)	x				A
<i>Aglaophenia octodonta</i> Heller, 1868	x				A
<i>Actinia equina</i> (Linnaeus, 1758)	x	x			C
<i>Anemonia sulcata</i> (Pennant, 1777)	x				A
Phylum Echinodermata					
<i>Arbacia lixula</i> (Linnaeus, 1758)	x				A
<i>Sphaerechinus granularis</i> (Lamarck, 1816)	x				A
<i>Echinaster sepositus</i> Retzius, 1783	x				A
<i>Diadema setosum</i> Leske, 1778	x				IP

Table 2. Taxonomic diversity and origin of species observed in the Bilge Taş Cave.

Taxonomic Group	Total	Origin			
		Atlantic Species	Indo-Pacific Species	Cosmopolitan Species	Unidentified at Species level
Pisces	13	8	5	-	-
Porifera	2	-	-	-	2
Crustacea	3	2	1	-	-
Echinodermata	4	3	1	-	-
Cnidaria	4	3	-	1	-
Total	27	16	8	1	2

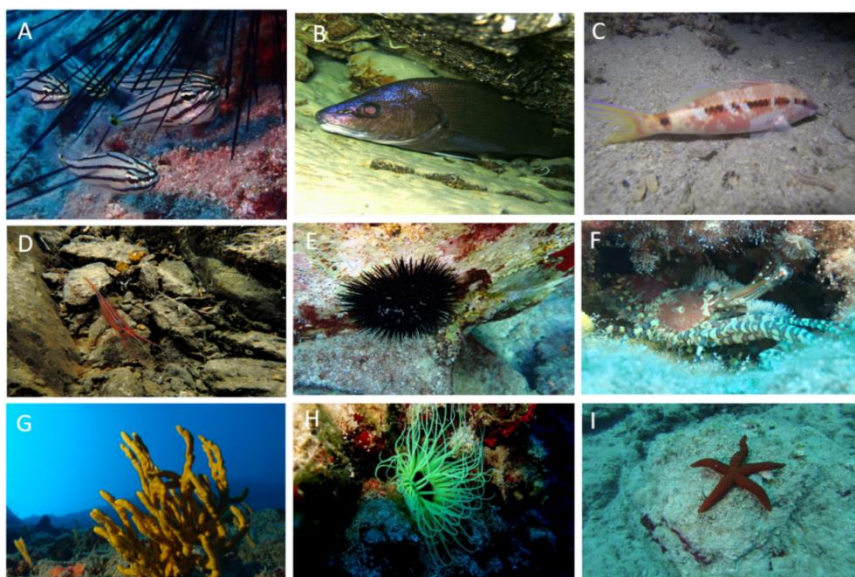


Figure 4. Some observed species from the Bilge Taş Cave. **A:** *Cheilodipterus novemstriatus*, **B:** *Sciaena umbra*, **C:** *Parupeneus forsskali*, **D:** *Plesionika narval*, **E:** *Arbacia lixula*, **F:** *Saron marmoratus*, **G:** *Axinella* sp., **H:** *Cerianthus membranaceus* and **I:** *Echinaster sepositus*.

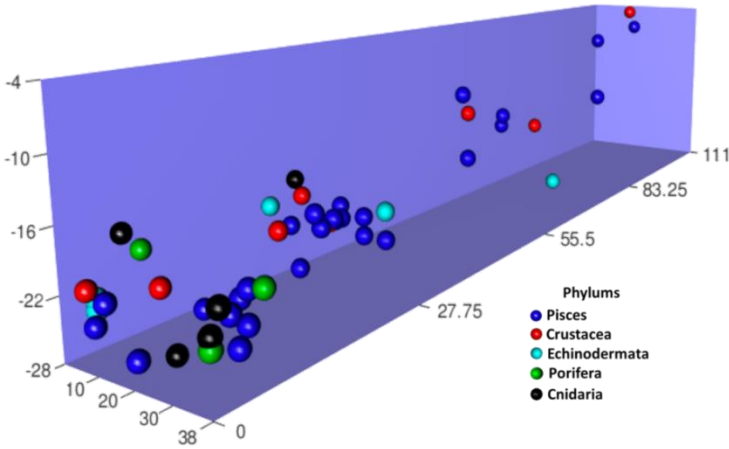


Figure 5. Distribution and location of the Phylums along the underwater Bilge Taş Cave. The dimension of the figure box is given as actual size of the cave as meter.

Distribution of the Phylums along the cave was given in Figure 5. In the entrance of the cave, relatively many species were observed, while the number of species decreased towards to interior of the cave. Porifera species were only observed at the entrance of the cave but were not observed in other parts of the cave. The species were generally observed at the bottom layer of the cave. Fish and crustacean species were monitored commonly in the most interior part of the cave.

Discussion

Caves are morphologically complex ecosystems with strong environmental gradients (Gerovasileiou and Voultziadou 2012). The caves are generally administered with restricted studies in the eastern Mediterranean in comparison to the western Mediterranean, just about one study per year for the eastern basin, versus five studies per year for the Mediterranean (Gerovasileiou and Voultziadou 2012; Gerovasileiou *et al.* 2015).

This study on the Bilge Taş Cave is just a preliminary study that surveys biodiversity and habitat mapping in the Mediterranean coast of Turkey. In total, 27 species were reported from the cave, of which 8 Indo-Pacific non-indigenous species (31%) inhabit the cave. In another cave study, Bussotti (2003) and Bussotti and Guidetti (2009) described a list of 34 fish species from three caves placed within the northwestern Ionian Sea (Bussotti *et al.* 2017). This percentage is higher compared to the Atlantic-Mediterranean species (55%). There is an increasing trend in the number of non-indigenous species in this region (Turan *et al.* 2016; Gerovasileiou *et al.* 2016; Doğdu *et al.* 2016;

Erguden *et al.* 2018 and Turan *et al.* 2018) which indicate that the effects of the climate change and nonindigenous species on the cave habitats in this region should be further investigated.

In similar studies, alien species were observed quite a lot at the entrance and semi dark zones in the Mediterranean caves (Gerovasileiou *et al.* 2016), indicating that dark caves are acceptable as highly selective habitats (Harmelin 1985; Bianchi and Morri 1994; Bussotti and Guidetti 2009; Gerovasileiou *et al.* 2016).

The present study contributes to fill the gap on underwater cave information as a sensitive habitat in the north-eastern Mediterranean. Moreover, one more important finding in the present study concerns the pattern of species diversity and the related possible conservation measures about some fish species such as *Sciana umbra*, *Umbrina cirrosa* and *Dasyatis pastinaca* that were represented on IUCN the Red List (IUCN 2018) and observed in Bilge Taş Cave. Therefore, the cave habitats can be helpful to protect these species and may be considered as marine protected areas (MPAs). Moreover, on account of ecological importance, Bilge Taş Cave in which endangered species live should be recognised as priority habitat for conservation purposes. A monitoring program in this cave should also be conducted in future conservation plans, in order to contribute to the underwater cave biodiversity in the north-eastern Mediterranean.

In conclusion, this study provides first information on marine species diversity and structure in underwater caves in the Mediterranean coast of Turkey, especially, endangered species according to IUCN inhabit caves that indicate conservation of cave biodiversity. Therefore, these important underwater marine caves should be prioritized for considering future MPAs and inclusion in the marine special management plans for the Mediterranean coasts of Turkey.

Acknowledments

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