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RESEARCH PAPER

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First Inventory of the Semi-Submerged Marine Caves in South Dinarides Karst (Adriatic Coast) and Preliminary List of Species

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Abstract

Marine caves are classified as a biodiversity hotspot and priority habitat by the EU Habitats Directive. Despite of this fact, no information was available on these habitats and their associated species for the South Dinarides karst along the Adriatic coast of Montenegro. During 2013–2016, we surveyed the entire coastline of Montenegro (288km) in order to register and map the semi-submersed marine caves of the country. A total of 70 caves were registered of which 2 caves were 17m long and 22 caves were 25 m long or longer. The majority of the investigated caves were anchihaline (with fresh water overlying the sea water) while only few caves were euhaline (completely under marine conditions). Some caves were found to host considerable biodiversity and the presence of 6 protected and endangered species was registered inside the caves. During the surveys caves with morphological features suitable as potential habitat for the endangered Mediterranean monk seal (*Monachus monachus*) were also highlighted. Given the abundance and diversity of organisms registered in these marine caves further surveys are needed in order to document in detail the biodiversity and the habitat characteristics, as well as to ensure the protection of these endangered habitats.

Introduction

Caves can be formed by various processes: tectonic caves, for instance, are formed by purely mechanical processes; sea caves are formed by wave action on sea cliffs; solution caves by chemical dissolution of the bedrock by circulating groundwater (White & Culver, 2012). Solution caves is the most frequently occurring type of caves and they are formed by the action of the moving groundwater that chemically dissolves the bedrock (Palmer, 2012). Most solution caves are formed in limestone. They appear in a great variety depending on the type of rock as also on the chemical conditions in the water dissolving the substrate (White & Culver, 2012). Furthermore, caves in coastal environments are controlled by different factors from those controlling caves in traditional inland settings.

In the Mediterranean Sea and also at the global level, marine caves are considered a biodiversity hotspot of great scientific interest deserving further study and full protection (Williams, 2008; Gerovasileiou & Voultsiadou, 2012; UNEP, 2013; Perez-Moreno, Iliffe & Bracken-Grissom, 2016). Thus, marine caves are generally considered an important and endangered habitat and they are listed in Annex I of the EU Habitats Directive (1992). In this document, the description of the habitat under the code 8330 "Submerged or partially submerged sea caves" is given as follows: "Caves situated under the sea or opened to it, at least at high tide, including partially submerged sea caves. Their bottom and sides harbor communities of marine invertebrates and algae". But the definition of a cave's

dimensions, the inclination of its main channel and other parameters are not described in the above document. In other documents, various classifications of speleological objects have been made using speleomorphological and speleohydrogeological criteria (Garašić, 1991; Onorato, Denitto & Belmonte, 1999; Official Gazette No. 62/13). Usually, speleological objects are defined as those cavities in the earth's crust in which a man can be physically present but, according to the definition of the Union Internationale de Speleologie (UIS), caves must be more than 10 m long (Garašić, 1991). In other countries, some other definitions of a marine cave exist but, in summary, a general definition for marine caves does not exist.

Habitats and communities in caves vary considerably depending on several factors. Main habitat types in the submerged karst, characteristic of the Eastern (mainly Croatian) part of the Adriatic Sea, are anchihaline caves, sea caves, cold sea caves, pits with bathyal elements, *vruljas* (submarine springs), karst estuaries, submerged river canyons, submerged tuffa barriers, marine lakes, and bare karst in the sea (Bakran-Petricioli & Petricioli, 2008). In the Croatian part of the Adriatic, the marine caves and their environment have been thoroughly studied in terms of biology and morphology as also as a valuable archive of the evidence of sea level changes (Garašić, 1991; -Pijevac, Benac, Kovačić & Kirinčić, 2001; Bakran-Petricioli *et al.,* 2007; Surić, Lončarić & Lončar, 2010; Radolović, Bakran-Petricioli, Petricioli, Surić & Perica, 2015). Unfortunately, only few such studies exist for the Montenegrin and Albanian coasts (Belmonte, Constantini, Moscatello, Denitto & Shkurtaj, 2006; Mačić, 2014; Mačić, Panou, Bundone & Varda, 2015; RAC SPA 2016).

The aims of this paper are: (1) to summarize our data on coastal caves along the coast of Montenegro (South Dinaric karst) and (2) to provide a baseline for future detailed research of these endangered and protected habitats.

Materials and Methods

Study Area

Over two-thirds of Montenegro's territory including the coastline belongs to the karst of the South Dinarides (Radulovic & Radulovic, 1997, Radović, 1964). The Montenegrin coastline (288 km) consists of a great variety of rocks including carbonates, flysch and volcanics (Antonijević, Pavić & Karović, 1969, Pikelj & Juračić, 2013). Eusebio, Bordin, Jarre and Minciotti, (2005) carried out topographic and hydrogeological studies in 4 marine caves inside the Boka Kotorska Bay (caves Sopot, Spilja, Gurdić and Ljuta). On the other hand, Milanović (2007) classified these 4 caves as deep siphonal karstic springs, thus, karstic springs with a large discharge and significant discharge fluctuation. Based on this feature, and although they do have an underground connection to the sea, they are not considered typical marine caves. The rest of the karstic coastline of the country had never been surveyed and there was a complete lack of knowledge about these specific habitats.

Collection and Analysis of Data

The survey of the Montenegrin coast was carried out in the period 2013-2016 and we registered all semi-submersed caves with an entrance at sea level (Figure 1). Based on the definition of the caves in the former national Law on Nature Protection (Official Gazette No. 51/08) we surveyed all naturally formed holes longer than 5 meters with an entrance partially above sea level where a person can enter. Marine caves with an entrance under the sea surface were not considered within the framework of this work. Whenever a marine cave with an entrance visible above sea level was noted it was carefully entered by snorkeling or diving. For all registered caves, the following basic data were noted: number and name of the location, date of survey, geographic coordinates (Garmin 76), dimensions in meters (measured with a Leica Disto DXT LASER measure), exposition, morphological characteristics and photographic documentation of typical living organisms inside the cave. We used a non-destructive photographic method despite its limitations for the proper species identification because it is highly recommended for protected and sensitive habitats such as marine caves (Bianchi *et al.,* 2004; Dimarchopoulou, Gerovasileiou & Voultsiadou, 2018). With respect to the biodiversity particular attention was given to rare, endangered or endemic organisms (such as some algae, corals, bats, etc.), but also to potentially suitable resting and pupping caves (i.e. with a beach inside) for the endangered Mediterranean monk seal (*Monachus monachus*).

During the post-processing of the data, all locations were mapped by Quantum GIS software (2013). We divided the caves into two groups not only because of their geographical positions along the coast, but also because of their different geological characteristics. The "Northern group" is located in limestone sediments, while in the "Southern group" only one cave (Valdanos) is in limestone while the other caves are in flysch deposits. Cave dimensions are under constant changes because of the erosion and other processes. Despite of this fact, and in order to provide a baseline for further monitoring (and hopefully achievement of good ecological status) a part of our work was focused on the measurements of physical characteristics.

Results

In the surveyed area, we registered a total of 70 semi-submerged caves, of which 2 were 17m long and

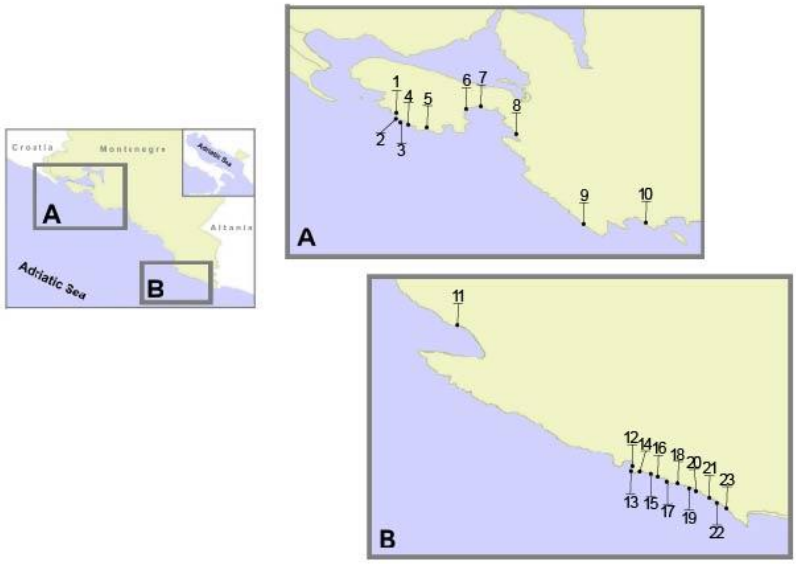

Figure. 1. Area of survey (caves of 17 m or longer are marked with numbers) 1. Franštica, 2. Plava špilja, 3. Niska, 4. Mala gora, 5. Tijesna luka, 6. Oblatno, 7. Trašte, 8. Bigova, 9. Krekavica, 10. Vrančeva sika, 11. Valdanos, 12. Kraljeve skalice 1, 13. Kraljeve skalice 2, 14. Kraljeve skalice 3, 15. Pinješ 3, 16. Pinješ 4, 17. Ženska (Sumporna) (Pinješ 5), 18. El Kaminova (Pinješ 6), 19. Pinješ 7, 20. Pinješ 8, 21. Pinješ 9, 22. Pinješ 12, 23. Pinješ 16.

21 caves were 25 m or longer. In the northern part of the Montenegrin coast, a total of 9 caves longer than 25 m were recorded (Northern group of caves) while 11 caves longer than 25m were registered in the southern part of the country (Southern Group of caves) (Figure 1).

Most of these caves have a simple structure (i.e. only one chamber) and in only 6 caves we found two or more entrances (Table 1). A small pebble or sandy beach was registered in the back of ten caves. It is noteworthy to mention that, in the majority of the surveyed caves, there is an inflow of fresh water at the surface, while marine water remains at the bottom. Thus, these caves can be classified as anchihaline caves (Sket, 2012) while only few caves were euhaline (completely under marine conditions). In several caves, cave rock formations (mostly flowstone) were registered and photographed (Figure 2A, B). Furthermore, fossils of *Pecten* sp. that lived in the middle Miocene were found in cave Pinješ16 (Ulcinj) (Figure 2C).

The species observed in the 23 caves of 17 m or longer are presented in Table 1. In total, 73 species were recorded: 1 Mammalia, 10 Pisces, 2 Tunicata, 4 Bryozoa, 8 Echinodermata, 6 Crustacea, 7 Mollusca, 5 Annelida, 6 Cnidaria, 12 Porifera, 9 Rodophyta and 3 Chlorophyta.

In the "Northern group of caves", the Plava špilja (Blue Cave) is the best-known marine cave in the South Dinarides. This cave is 60 m long and 46 m wide and has two entrances (Table 2). Inside the cave, there is a single chamber, with a height of 25 m above sea level. On the vertical walls close to the entrances many sessile organisms were registered (Table 1), especially in the western part of the cave. The most abundant were various species of sponges (*Petrosia ficiformis, Spirastrella cunctatrix, Clathrina clathrus, Ircinia variabile* and *Phorbas tenacior)*, the cnidaria *Leptopsammia pruvoti* and bryozoa *Myriapora truncata.*

In the same inlet, close to the Plava špilja cave, we found two more interesting caves, but only in the Niska cave, a large population of the protected bat species *Miniopterus schreibersii* was found (as well as in Bigova cave located further to the south). Furthermore, because of the beach in the back of both the Niska cave and the Oblatno cave we marked these caves as a potential coastal habitat for monk seals, as well as the Valdanos cave and the El Kamino cave in the southern group of caves.

The largest cave in the northern part of Montenegro's coast is the Krekavica cave (Table 2), located in the future Marine Protected Area of Platamuni (RAC SPA, 2016). The entrance of the cave is at the bottom of a very high cliff with south exposure. The vertical walls are overgrown by an immense quantity and diversity of organisms (Table 1). Some of them are*: Madracis pharensis, Leptopsammia pruvoti, Adeonella calveri, Myriapora truncata, Reteporella grimaldii, Petrosia ficiformis, Sarcotragus foetidus, Haliclona mucosa, Stenopus spinosus,* etc (RAC-SPA, 2016). In terms of biodiversity, this is by far the richest cave along the Montenegrin coast (Figure 3) and deserves special attention both in terms of research and protection.

In the southern group of caves, we registered 13 coastal caves longer than 25 m (Figure 1). Twelve caves were situated close to the town of Ulcinj, which is a very crowded area during the summer months. Nine of these caves are characterized by a single chamber (Figure 1, numbers 12-15, 19-23). They were between 25 and 65 m long and, in most cases, very narrow (1.5-2.9 m wide;

Table 1. Species recorded in the interior of 23 caves throughout the study area. Locations are: 1. Plava špilja, 2. Niska, 3. Mala gora, 4. Franštica 5. Tijesna luka, 6. Oblatno, 7. Trašte cave, 8. Bigova, 9. Krekavica, 10. Vrančeva sika, 11. Valdanos, 12. Kraljeve skalice 1, 13. Kraljeve skalice 2, 14. Kraljeve skalice 3, 15. Pinješ 3, 16. Pinješ 4, 17. Ženska (Sumporna) (Pinješ 5), 18. El Kaminova (Pinješ 6), 19. Pinješ 7 (nudist, 20. Pinješ 8, 21. Pinješ 9, 22. Pinješ 12, 23. Pinješ 16

Species	Cave's numbers (for cave's names see Figure 1)																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Chlorophyta																							
Anadyomene stellata									1														
Flabellia petiolata									1	1			1										
Palmophyllum crassum	1	1		1	1			1	1														
Rhodophyta																							
Corallina elongata	1	1	1	1	1		1		1	1	1		1	1			1	1			1		1
Hildenbrandia rubra	1	1	1	1	1				1	1													
Lithophyllum sp.	1	1	1	1		1	1	1	1	1			1				1						
Mesophyllum alternans				1	1		1																
Osmundaria volubilis									1														
Peyssonnelia rosamarina									1														
Peyssonnelia rubra	1	1	1	1	1	1	1	1	1	1	1		1	1			1	1					
Peyssonnnelia squamaria		1						1	1														
Sphaerococcus coronopifolius		1	1	1	1	1	1	1															
Porifera																							
Agelas oroides	1	1	1	1	1				1														
Chondrosia reniformis						1	1																
Clathrina clathrus					1		1		1														
Cliona celata													1	1									
Cliona sp.	1			1	1	1			1	1		1	1	1			1	1	1				1
Haliclona mucosa	1	1							1														
Ircinia oros	1	1			1	1			1	1													
Ircinia variabilis	1											1											
Petrosia ficiformis	1	1	1	1	1	1	1	1	1	1													
Phorbas tenacior	1	1	1		1		1		1	1													
Sarcotragus foetidus	1				1				1														
Spirastrella cunctatrix	1	1	1	1	1	1	1		1	1	1												
Cnidaria																							
Actinia cari													1	1				1					
Actinia equina						1	1		1	1	1		1	1		1	1	1	1	1	1	1	1
Madracis pharensis	1	1			1				1														
Leptopsammia pruvoti	1			1	1				1														
Parazoanthus axinellae									1														
Polycyathus muellerae									1														
Annelida																							
Bonellia viridis					1																		
Filograna sp.			1	1					1														
Hermodice carunculata					1				1	1													
Protula sp.	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1				
Serpula vermicularis	1	1		1	1	1			1	1			1	1			1						
Bryozoa																							
Myriapora truncata		1	1	1	1				1														
Reteporella sp.									1														
Schizobrachiella sanguinea									1	1													
Smittina cervicornis	1				1				1														
Mollusca																							
Clavagella sp.					1																		
Gastrochaena dubia		1				1	1		1	1													
Lithophaga lithophaga	1	1	1	1	1	1			1	1	1												
Mytilus galloprovincialis	1	1	1	1	1				1				1	1									
Patella rustica	1							1					1	1	1	1	1	1	1	1	1	1	1
Peltodoris atromaculata					1				1														
Felimare orsinii		1																					
Crustacea																							
Eriphia verrucosa													1				1						
Stenopus spinosus	1	1							1														
Cirripedia sp.	1	1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1
Palaemon serratus							1					1	1	1			1	1	1				
Dromia personata					1																		
Pachygrapsus marmoratus												1	1	1		1	1	1			1		
Echinodermata																							
Arbacia lixula	1	1	1		1	1		1	1	1	1	1					1						
Hacelia attenuata	1		1		1				1														
Holothuria tubulosa	1	1				1				1	1												

Table 1 Continued

Holothuria (Platyperona) sanctori	1			1					1															
Ophioderma longicauda	1								1															
Marthasterias glacialis		1			1				1															
Coscinasterias tenuispina	1																							
Sphaerechinus granularis				1																				
Tunicata																								
Halocynthia papillosa		1								1							1							
Microcosmus sp.	1			1	1				1															
Pisces																								
Apogon imberbis	1	1	1	1	1				1	1			1				1	1						
Coris julis	1	1	1																					
Microlipophrys nigriceps					1												1							
Mugil cephalus											1	1	1											
Mullus barbatus	1	1							1			1	1											
Muraena helena										1														
Scorpaena notata		1	1		1			1		1														
Serranus cabrilla	1	1							1									1						
Serranus scriba	1						1		1	1														
Thorogobius ephippiatus									1															
Mammalia																	1							
Miniopterus schreibersii	1	1						1									1	1						
TOTAL	37	33	20	23	35	15	15	11	48	24	7	7	19	15	3	5	18	13	6	3	5	3	5	

Table 2. Physical characteristics of the 23 semi-submersed marine caves in the study area

Cave Name	Exposition	Entrance Above the Sea [wide x high(m)]	Length	Depth at the Entrance	Notes
Franštica	W	15 x 12	30	3	
Plava špilja	SW W	11 x 3.5 6 x 2	60	6	Two entrances
Niska cave	SW	4 x 1	50	3	After the entrance the cave is curved on the right side. In the back there is a beach 10m long and 8m wide with a slope of 40°. After this slope the beach has a horizontal part about 2-3m wide.
Mala gora	NW	7 x 6	17	2	
Tijesna luka	SE	5 x 8	30	4	Cave is with 2 semi-submersed channels and one underwater channel 19m long which started at 4m depth and ended with a small air chamber.
Oblatno	SE	10 x 3		4	Small sandy beach. 1,5 m long and 4 m wide.
Trašte	S	10 x 5	25	6	Cave had 2 channels but because of new infrastructure it is destroyed.
Bigova cave	W	2 x 2	25	2	Small pebble beach 1,5m x 1m.
Krekavica cave	S	20 x 33		30	Underwater, on the right side there is a part of the vertical rock creating division so that you can enter the cave also from this smaller hole.
Vrančeva sika	S W W	6 x 7 4 x 1 3 x 5	30	4 0.5 3	There are 3 entrances and small beach inside the cave but close to beach with sharp rocks, seems like crashed recently.
Valdanos cave	W	4 x 7	17	3	The first room is ending with a pebble beach 4m long. Close to the ending of this first room there is a passage to the second, rounded room. In this, second room there is also a small pebble beach, 5m long and there is an underwater passage to the open sea.
Kraljeve skalice 1	S	2.9 x 2.6	57	3	
Kraljive skalice 2	S	1.7 x 6	65	1	
Kraljeve skalice 3	S	5 x 7	44	2	
Pinješ 3	S	1.8 x 2	30	1	
Pinješ 4	SW S	3.4 x 3.3 1 x 2.5	37	0.5 1	
Sumporna (Ženska) cave	S	1,5 x 1,3	42	3	Strong smell of sulphur. Some of the channels leading to the interior are connected towards the cave's interior so that the cave has nine entrances.
El Kaminova cave	S	8 x 2	85	2	Strong smell of sulphur. Two semi-submersed entrances and hole on the ceiling
Pinješ 7	S	1.5 x 2.2.	25	2	
Pinješ 8	S	1.8 x 0.8	29	1	
Pinješ 9	S	1.8 x 5.4	36	1	
Pinješ 12	S	3.5 x 2.2	29	1	
Pinješ 16	S	1.2 x. 1.2	36	1	

Figure 2. Flowstone in Trašte Cave (A) flowstone in Mala gora Cave (B) and fossil of *Pecten* sp. from the middle Miocene in Pinješ 16 Cave (Ulcinj) (C).

only one cave is 5 m wide), with a depth at the entrance of 0.5 to 3 m. In the majority of caves, a sandy or pebble beach of various dimensions and an inflow of fresh water were registered. Although it seemed that there is no disturbance caused by tourists inside the caves, pollution was evident, especially on the caves' beaches where a huge quantity of marine litter was present, mostly plastic.

The Ženska Cave (Ladies' Cave) or the Sumporna Cave (Sulfurous Cave) is a very interesting and well-known cave (Fig. 4). We found a total of nine entrances. Some of the channels led directly to the interior and others were connected to each other. In this cave and also in the El Kaminova Cave nearby there were bat populations (*Miniopterus schreibersii*) with numerous individuals (Figure 3), while marine life was quite scarce (Table 1). These caves are characterized by a strong smell of sulfur, particularly the Ženska cave.

Discussion

Our survey is the first inventory of semi-submerged marine caves in the South Dinarides karst, along the Montenegrin coast. Therefore, our effort was concentrated on providing an accurate inventory and the topography of these caves. In summary, we registered a total of 70 caves of which 2 caves are 17m long and 21 caves are 25m or longer (Fig. 1).

The Ženska cave (Figure 4), nearby the namesake beach, is very well known because of the spring of sulfurous water. It has been visited by women from the town of Ulcinj and elsewhere since old times because of the medical properties of its sulfurous water. The first instance of popularizing this site was the book of Dr. Jovan Kujačić about Ulcinj as a SPA resort, published in 1932. The first scientific research on this sulfurous water was conducted by Italian scientists back in 1925 and

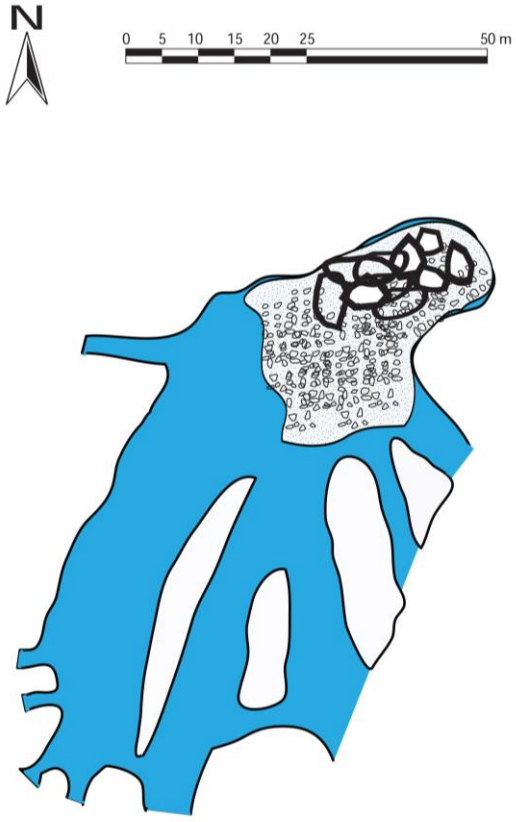

Figure 3. Different communities in caves: (A) *Madracis pharensis* and various *Porifera* in Krekavica cave, (B) *Palaemon serratus* in El Kaminova cave, (C) *Actinia equine* in Pinješ 8, (D) *Miniopterus schreibersii* in Ženska cave.

later by the Russian scientist Ščererbakov who compared the sulfurous mineral water springs of Ulcinj with the famous springs in Aachen, Germany (Karamanaga, 2015). Unfortunately, this natural potential has not been adequately studied or utilized so far and a more detailed study of marine life in it is not available.

Furthermore, in the Southern group of caves we registered a fossil of *Pecten sp.* For the area of Ulcinj (south of Montenegro), Vinassa de Regny (1902) was the first to publish data on sediments of the Eocene flysch, and the middle Miocene lithothamnium limestones and sands. He also recorded many fossils of molluscs (*Pecten* sp. and *Ostrea* sp.), the crustacean *Balanus spongicola* and one fossil shark tooth of *Odontaspis* sp. (Vinassa de Regny, 1902; Ćulafić, 2012).

Among the various types of marine caves, Peres and Picard (1964) recognized the biocenosis of semi-dark caves and the biocenosis of caves and ducts in total darkness. Nevertheless, various studies have shown that there are transitions between these biocenoses as a result of the varying morphology of the caves and of multiple and interactive ecological processes (Benedetti-Cecchi, Airoldi, Abbiati & Cinelli, 1996, Bussoti, Terlizzi, Fraschetti, Belmonte & Boero, 2006; Bakran-Petricioli *et al.,* 2007; Radolović *et al.,* 2015; Gerovasileiou *et al.,* 2015). With respect to the zonation inside the surveyed caves and the availability of light, most of them can be classified as semi-dark caves. According to Bakran-Petricioli (2016), they belong to the biocenosis of mediolittoral caves. We registered a great variety of biocenoses, associations and facies of which some of the most common are mediolittoral caves with *Hildenbrandia rubra*, mediolittoral caves with *Peyssonnelia sp*. and *Palmophyllum crassum*, infralittoral caves with *Parazoanthus axinellae,* infralittoral caves with *Reteporella spp.* and *Madracis spp.,* infralittoral caves with various species of *Porifera* (Figure 3), and typically on the very back of the caves dominant facies was with various species of serpulides or in few cases it looks like typical “empty quarter” (Morri & Nike Bianchi 2003). Species richness, biological cover and biomass in the surveyed caves tend to decrease towards the inner parts of the caves, and this fact is in line with records from other parts of the Mediterranean (Harmelin, Vacelet & Vasseur, 1985; Knittweis, Chevaldonne, Ereskovsky, Schembri & Borg, 2015; Bakran-Petricioli *et al.,* 2007; Dimarchopoulou *et al.,* 2018). Caves in the northern group are deeper than those in southern group and characterized by more diverse semi-dark biocenoses and higher biological coverage, especially at the entrances to the caves. Most of the caves, and especially those in southern group are exposed to the south and because of that under the direct impact of strong south wind and waves. As indicated by Morri and Nike Bianchi (2003) very intensive hydrodynamism is causing impoverishment of cave biocenosis and most probably this is the main

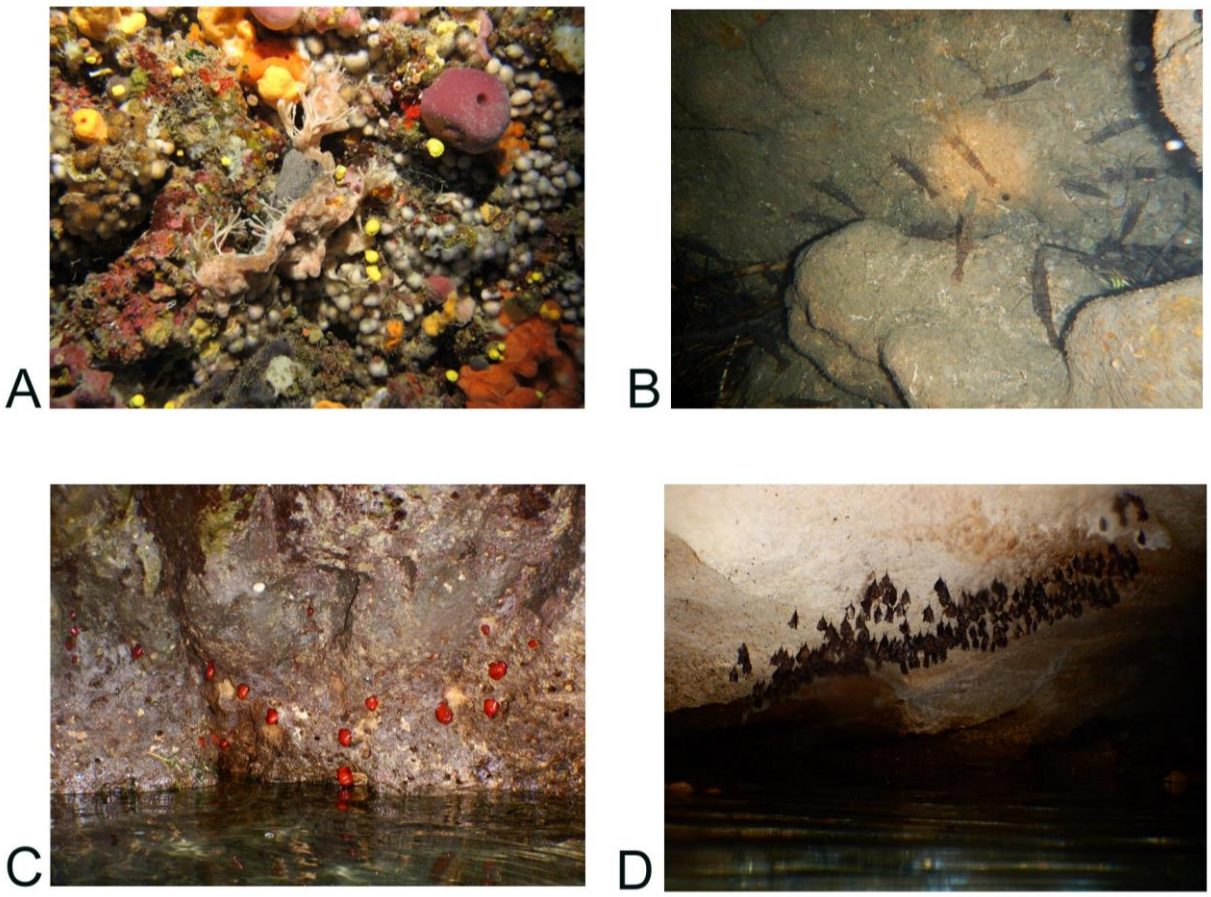

Figure 4. Morphology of the Ženska (Sumporna) Cave

factor causing diversity between the surveyed northern and southern groups of caves.

Although the precise characterization of the biodiversity and of communities inside the caves is foreseen as a future step in research, we present here a preliminary list of the species registered during our surveys (Table 1). As expected, most of the species are sessile and the dominant group was Porifera, followed by Rhodophyta macroalgae. An exception is *Palaemon serratus* (common prawn) (Figure 3) that was found in small groups mostly in the caves of the Southern group of caves. Another non-sessile species common in caves – although mostly in the Northern group of caves – is the cardinal fish *Apogon imberbis*. This is in agreement with the findings of Bussoti and Guidetti (2009) who reported *Apogon imberbis* to be by far the most common fish species recorded both at the entrances and inside the caves. The species of mobile fauna with the highest numbers of individuals was the bat *Miniopterus schreibersii* (Figure 3) that was present in large groups in three caves of the Northern group (Plava špilja, Niska and Bigova) and in small groups in two caves of the Southern group (Ženska and El Kaminova). We should stress here the fact that the bat population in the Plava špilja (Blue cave) in 2014 was much more abundant before the tourist season in May 2014 than during high season in August 2014. A large number of people frequently visit Plava špilja during the summer months, when numerous tourist boats bring visitor groups into the cave for swimming and enjoying the intense blue color of the seawater. The noise caused by boats and humans may have a negative impact not only on marine organisms but also on the population of the protected bat species *Miniopterus schreibersi* living inside the cave. This bat species is protected by the national Law on Protected Species (Official Gazette No. 76/06) and also by the Bonn and Bern Conventions (1979) and by the Eurobats Agreement (1991). Furthermore, it is also included in Annexes II and IV of the EU Habitats Directive (1992). Hutson et al. (2008) reported disturbance caused by tourism in caves along with the loss of underground habitats and pesticide use as the most relevant threats for this species. Therefore, appropriate monitoring and conservation measures should be implemented here as soon as possible.

Apart from the bat species mentioned above we registered 5 more marine protected species: *Madracis pharensis* (CITES Convention 1990; Aronson, Bruckner, Moore, Precht & Weil, 2008), *Lithophaga lithophaga, Centrostephanus longispinus* (EU Habitats Directive 92/43; Barcelona Convention 1976; Official Gazette No. 76, 2006), *Holothuria tubulosa* and *Holothuria sanctori* (Official Gazette No. 76, 2006). Here we should underline again that the list of organisms given in Table 1 is only a start for a full inventory of marine cave biodiversity in Montenegro. The most common species listed in Table 1 are at the same time the more conspicuous species usually easily determined on the pictures. Further, more detailed research on cave biodiversity will obviously provide more precise information, especially on many more species of smaller dimensions, and will provide a basis for future monitoring (Dimarchopoulou *et al.,* 2018).

Taking into account the rapid urbanization and various increasing anthropogenic activities along the coast, our inventory of the coastal cave habitats will hopefully contribute to the implementation of appropriate conservation measures for this specific, rare and endangered habitat along with its protected species. In particular, we should mention here the Trašte cave (Tables 1, 2) in the central part of the bay of Trašte. Strong vibration from construction works above the cave forced us to stop the detailed survey for safety reasons, since above this cave the construction of a vast tourist complex with a new marina was ongoing in 2014. Unfortunately, the following year, the entrance to this cave was blocked because of the newly constructed beach and we can state that this cave does not exist any more. It is the obvious example why protection of these endangered habitats should be ensured as soon as possible. This applies in particular to caves under acute threat from increasing human activities such as the Plava špilja, the Ženska cave and the caves with particularly high biodiversity such as the Krekavica cave. More detailed data need to be collected in order to pay more scientific attention to this issue, hopefully to be followed by the monitoring and protection of these endangered and protected habitats.

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