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NEW RECORDS OF RARE SPECIES *SPONGIA (SPONGIA) LAMELLA* (SCHULZE, 1879) (PORIFERA) IN MONTENEGRIN COAST

Nikola ĐORĐEVIĆ[1*], Vesna MAČIĆ[1], Slavica PETOVIĆ[1]

[1] Institute of Marine Biology, University of Montenegro, I bokeljske brigade 68, 85330 Kotor, Montenegro, *e-mail: nikoladj@ucg.ac.me

ABSTRACT

Presence of the rare Mediterranean species *Spongia (Spongia) lamella* is documented in Montenegro at six locations with a total of 13 specimens. All specimens are found on hard bottom between 10 m and 17 m depth in areas with lower sea water transparency due to the vicinity of Bojana river. Five of the six locations documented in Montenegro are situated in the future MPA Stari Ulcinj, and four of these five locations are situated along 3 km coastline of the Valdanos Bay. The sixth location, situated at the islet of Đeran in closest vicinity of Bojana River, showed the highest density of *S. lamella*. A map and a bibliographical list of the updated global distribution expand the knowledge about the species.

Keywords: *Spongia (Spongia) lamella*, endemic species, sponges, Porifera, Adriatic Sea

INTRODUCTION

Sponges have been known and harvested since ancient time and although they are a very diverse group of organisms and sometimes dominant in sessile benthic communities only recently their functional role has been highlighted (Bertolino *et al*., 2013; Enrichetti *et al*., 2020; Canessa *et al*., 2021; Trainito *et al*., 2020). Furthermore, many new studies are reporting increased threats and pressures caused by global warming and anthropogenic activties (Bell *et al*., 2015; Di Camillo & Cerrano, 2015; Gerovasileiou *et al*., 2018).

In the Mediterranean Sea there are more than 600 sponge species (Van Soest *et al*., 2012; Baldacconi & Trainito, 2013). Although many species are endemic for the Mediterranean, only a small number of sponge species are protected by national legislation and/or international Conventions. Nine species are protected by national legislation (Official Gazette of Montenegro, 76/2006) and 15 species are protected by Barcelona and Bern Conventions (Genovesi & Shine, 2004; UNEP/MAP-SPA/RAC, 2018).

Spongia (Spongia) lamella (Schulze, 1879) (Porifera, Demospongiae, Spongiidae)

is commonly known as elephant's ear. Easy recognizable, massive, cup-shaped, dark gray sponge with many oscula clustered inside the cup. In second half of the nineteenth century *S. lamella* was described from the coast of Hvar Island in Croatia (Schulze, 1879). For a long time, it was considered as a synonym for *S. agaricina*, a species described from the Indo-Pacific region. After comparison of morphology and tensile strength that showed differences in populations from these regions, these two sponges were separated in two neotypes: *S. lamella* is known as Mediterranean elephant's ear described by Schulze in 1879 and *S. agaricina* described by Pallas in 1766 (Cárdenas *et al*., 2012; Castritsi-Catharioset *et al*., 2007; Pronzato & Manconi 2008). This species is commercially exploited as bath sponge and its collection is regulated by Annex III of Barcelona Convention (UNEP/MAP-SPA/RAC, 2018). However, conservation status of this and many other protected sponge species is not very well known, so the main goal of this paper is to update the existing knowledge on *S. lamella* distribution by adding the first findings from Montenegrin coast (South Adriatic Sea) and to contribute to the better evaluation of the conservation status and the need for measures of protection.

MATERIAL AND METHODS

Research on sponges included 87 dive locations on the Montenegrin coast realized during different projects in the period from 2015 until 2020 (Mačić *et al*., 2015; Petović & Marković, 2017; Mačić *et al*., 2019; Trainito, 2019; Đorđević & Petović, 2020; Trainito *et al*., 2020; Petović *et al.*, 2021). In addition to these, 17 new locations have been observed during 2019-2020. During the field work, photo documentation was made *in situ*, using this as the least invasive method.

RESULTS AND DISCUSSION

Out of more than 100 locations surveyed in the Montenegrin coast in the period between 2015 and 2020, only on six locations presence of *S. lamella* was noted (Fig. 1). This species was found at depths from 10 down to 17 meters and in total only 13 specimens were observed (Table 1).

Five specimens of *S. lamella* have been registered at the islet Đeran and this is the highest population density in Montenegro. This small area is situated close to the mouth of river Bojana and it is characterized by small rocky outcrop surrounded by sandy-muddy bottom. In this area rocky substrate is in upper parts, so-called barren, with scarce photophilous algae, but mostly overgrown by meadows of *Posidonia oceanica* and precoralligenous. At this location *S. lamella* was sighted at depths between 10 and 13 m (Fig. 2a, b).

Location inlet Vučja jama is situated in the Valdanos Bay and it is characterized by abundance of sponges of the genus Axinella, mainly the protected species *Axinella cannabina.* At this location 2 individuals of *S. lamella* were clustered together. Furthermore, in the Valdanos Bay, at 12 m depth the largest specimen of *S. lamella* was observed with upper diameter of almost 80 cm (Fig. 3).

Only one specimen was observed fragmented and in a bad condition at the location of Cape Ademov Kamen (Fig. 4). It was located just above the sandy bottom, and one of the possible reasons for bad condition of the sponge could be the abrasion from the sand mobilized by strong underwater currents. Five sites (all except Islet Đeran) are located in the future marine protected area (MPA) Stari Ulcinj. Out of these, 4 are posted very closely, along 3 km of northern coastline of the Valdanos Bay. This part of the inlet is proposed for the higher level of protection in the future

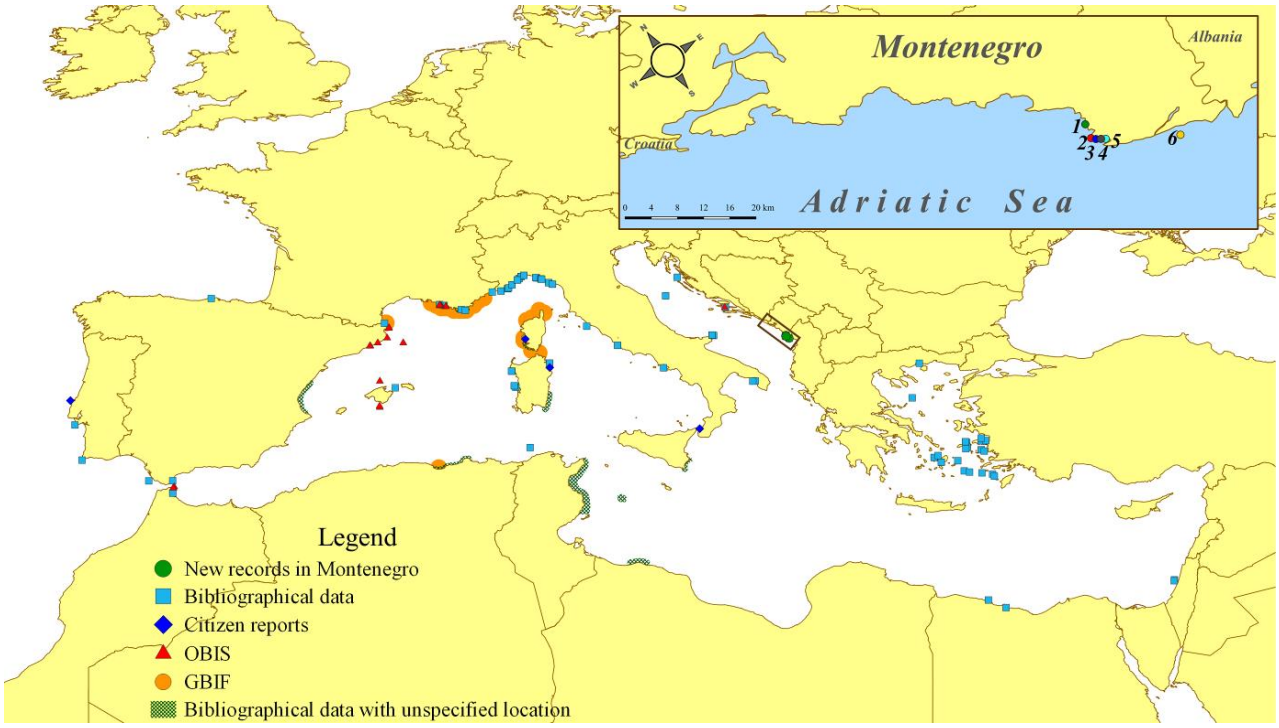

Figure 1. Compilation of new records in Montenegro (1. Cape Ademov Kamen, 2. Cape Rep, 3. Inlet Udovica, 4. Inlet Vučja jama, 5. Valdanos Bay, and 6. Islet Đeran) and all other available data

MPA, due to very dense population of *Axinella cannabina* but also for the presence of *S. lamella* and some other protected species like *Spongia (Spongia) officinalis, Axinella verrucosa, Axinella damicornis, Axinella polypoides, Palinurus elephas, Tonna galea, Epinephelus marginatus* (Official Gazette of Montenegro, 76/2006; UNEP/MAP-SPA/RAC, 2018). Prohibition of anchoring and fishing with bottom impacting nets, pots and fishing lines in this area could prevent possible physical destruction of erected and vulnerable species such as *S. lamella* and hopefully contribute to its better conservation.

All known records of *S. lamella* are located in the southern part of Montenegrin coast, highly influenced by strong north flowing currents and influx of nutrient rich water originating from Bojana River. During the fieldwork on these sites was noticed lower visibility due to increased amount of suspended sediment and sandy-muddy bottoms influenced by strong currents. Presence of *S. lamella* on these locations is in accordance with statement that, due to its "elephant's ear" form, the species is tolerant to the higher levels of sedimentation, but further research is needed to evaluate which are other environmental parameters crucial for its distribution and successful development (Voultsiadou *et al*., 2008).

In the Adriatic Sea first sighting of *S. lamella* was reported by Schulze in 1879 at the Hvar Island near Lesina. For the Adriatic Sea Bakran-Petricioli *et al*., (2012) reported *S. lamella* in the middle and in the north Adriatic Sea (in Bakran-Petricioli by Grubelić 2001), but with no specific locations. Recently, Angeletti and Taviani (2020) reported *S. lamella* for two locations in the West Adriatic Sea. Data obtained from Ocean Biodiversity Information System (OBIS) (2021) provided geographical coordinates for 22 locations in the Mediterranean Sea (Fig. 1). Seven locations

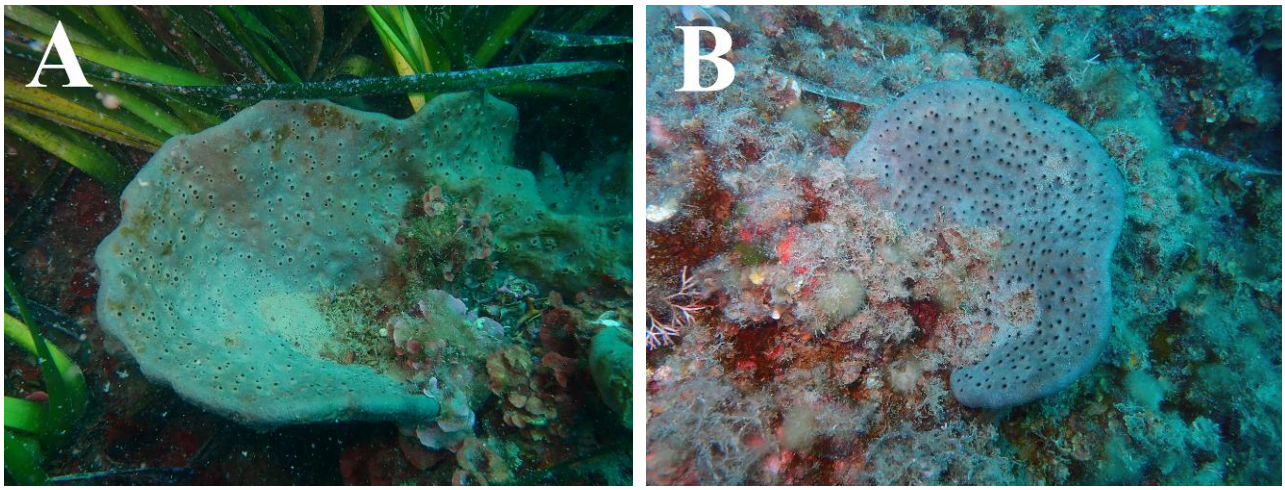

Figure 2. *S. lamella* on the location islet Đeran A) within *Posidonia oceanica* B) in precoralligenous

Table 1. List of locations where *S. lamella* was sighted in Montenegro

Location name	Longitude	Latitude	Depth	No. of specimens	Habitat type
Cape Ademov Kamen	19.14484	42.00254	16 m	1	Sandy and rocky bottom with sciaphilic algae
Cape Rep	19.13802	41.97601	17 m	1	Rocky bottom with sciaphilic algae and sponges
Inlet Udovica	19.1425	41.97192	10-15 m	2	Rocky bottom with sciaphilic algae and sponges
Inlet Vučja jama	19.15203	41.96338	15-17 m	3	Sandy and rocky bottom with sciaphilic algae
Valdanos Bay	19.16008	41.95811	12 m	1	Mosaic of rocky bottom, sand and Posidonia meadow
Islet Đeran	19.27462	41.88389	10-13m	5	Mosaic of rocky and sandy bottom, Posidonia meadow, and sciaphilic algae

are situated on the Mediterranean coast of France in the vicinity of Marseille and 14 locations are in Spanish waters of the Mediterranean Sea. The list of the records available from the literature and online database are reported in Table 2, providing information for 113 locations in the Mediterranean Sea and Atlantic Ocean. (Van Soest *et al.*, 2021; WORMS, 2021). Here we should underline that most of the older records reporting sightings of the *S. lamella* are mentioned as *S. agaricina*. Although from the Fig. 1. this species seems quite well distributed in the whole Mediterranean Sea (especially in the northern part). Rarity of the species could be illustrated with data reported by Gerovasileiou *et al.* (2018) where out of 1529 records of sponges from the Aegean Sea only 19 records are referring to *S. lamella*. Furthermore, the quantitative data on population trends of *S. lamella* together with 3 other harvested bath sponges (*Hippospongia communis, Spongia officinalis* and *S. zimocca*) in the Aegean Sea indicate that these species should be evaluated as Endangered, according to IUCN categories (Gerovasileiou *et al.* 2018). In our opinion, at least before more

detailed study on population trend of *S. lamella* for the whole Mediterranean Sea is not performed, the species should be listed in the list of protected species (Annex II) of the Barcelona Convention instead of Annex III, list of species whose exploitation is regulated.

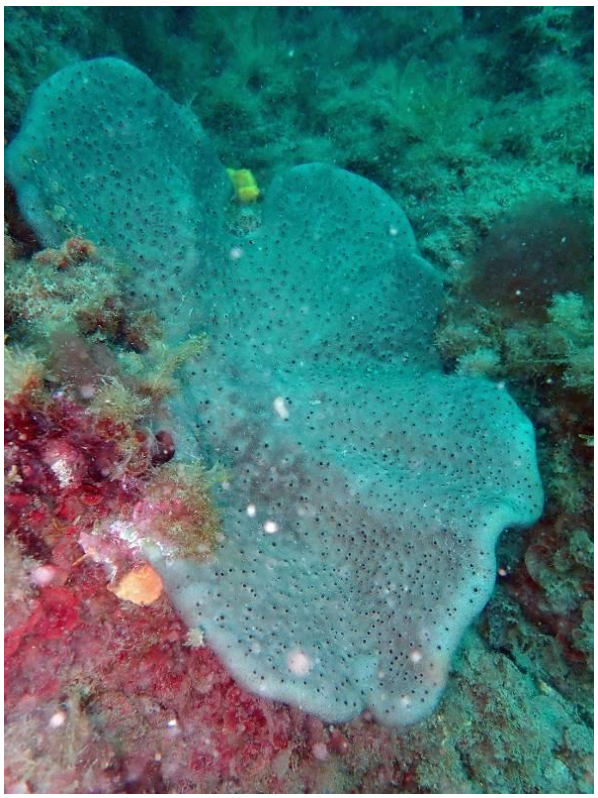

Figure 3. Valdanos Bay - the largest specimen of *S. lamella* on the Montenegrin coast

Figure 4. Cape Ademov Kamen - *S. lamella* in bad condition

Another interesting characteristic is that species has been reported not only in a large depth range (from 0 to 123 m), but also in a variety of habitats like rocky beds, soft substrate, *Posidonia* meadows, coralligenous, rhodolite beds, caves and overhangs (Gerovasileiou *et al*. 2018, Idan *et al*., 2018). However, due to its specific shape and higher number of enthusiast divers and availability of digital underwater photography it was expected to have more records in recent years. As it was reported for another rare sponge species, *Calyx nicaensis* (Risso, 1826), seems that the rarity and ecological role sometimes we do not understand and further in-depth studies are needed in order to better plan conservation measures (Trainito *et al.*, 2020).

Having in mind the rarity of *S. lamella*, our records from the coast of the Montenegro are an important contribution to the knowledge on the distribution of this endangered species. So far, in the Boka Kotorska Bay out of the 51 registered sponge species, 46 are Demospongiae (Petović & Marković, 2017; Trainito, 2019; Đorđević 2020; Đorđević & Petović, 2020). Outside of the Bay, along the Montenegrin coast literature data are reporting 61 species from 52 different locations (Mačić *et al*., 2015; Mačić *et al*., 2019; Petović *et al*., 2021). In total, together with our new records there are 79 sponge taxons registered on the Montenegrin coast. Although this is a small part of the Adriatic Sea, knowledge of the sponge fauna is still insufficient and far away from the number of 283 species of sponges registered in the Adriatic Sea by Bakran-Petricioli *et al*. (2012). Further studies will provide more information on sponge fauna in the south Adriatic Sea and contribute to the better national and regional assessment of conservation status for vulnerable and protected species *S. lamella* and many others.

Table 2. Bibliographical records for *S. lamella*

Location	Country	Latitude	Longitude	Depth	Author	Year
Algiers	Algeria				Pronzato & Manconi	2008
Gulf of Breja	Algeria				GBIF	2020
Lesina	Croatia	43.116670° N	16.733333° E		OBIS	2005-2008
Lesina	Croatia	43.116667° N	16.733333° E		Schulze	1879
Midle Adriatic	Croatia				Bakran-Petricioli *et al.*	2012
North Adriatic	Croatia				Bakran-Petricioli *et al.*	2012
Gulf of Kanais	Egypt	31.102780° N	27.924440° E	25-40 m	Ramadan *et al.*	1989
Marsa-Matrouh	Egypt	31.406110° N	27.225280° E	30-42 m	Ramadan *et al.*	1989
Calanques Coast, in cave	France	43.200560° N	5.512500° E		Pouliquen	1972
Marseille - Nice coast	France				GBIF	2020
Marseille region	France	43.160120° N	5.587090° E		OBIS	2005-2008
Marseille region	France	43.185560° N	5.393390° E		OBIS	2005-2008
Marseille region	France	43.150000° N	5.583333° E		OBIS	2005-2008
Marseille region	France	43.208170° N	5.332150° E		OBIS	2005-2008
Marseille region	France	43.183333° N	5.383333° E		OBIS	2005-2008
Marseille region	France	43.200000° N	5.345510° E		OBIS	2005-2008
Marseille region	France	43.200000° N	5.333333° E		OBIS	2005-2008
Marseille region	France	43.233333° N	5.333333° E		Vacelet	1959
North coast of Corsica	France				GBIF	2020
North of Island Hyères	France	43.033333° N	6.200000° E	42 m	Topsent	1928
Of the coast of Perpignan	France				GBIF	2020
Otionu	France	41.852217° N	8.751501° E	4-100 m	Citizen report No: 1	2019
Port-Cros National Park	France				Pronzato & Manconi	2008
Port-Cros National Park	France	43.000000° N	6.358333° E	15 m	Vacelet	1976
South coast of Corsica	France				Pronzato & Manconi	2008
South coast of Corsica	France				GBIF	2020
South Gulf of Lion	France	42.483333° N	3.133333° E	25-75 m	Boury-Esnault	1971

Table 2. Bibliographical records for *S. lamella* (continued)

Location	Country	Latitude	Longitude	Depth	Author	Year
Tremis cave	France	43.200000° N	5.516667° E		Manconi *et al.*	2013
West coast of Corsica	France				GBIF	2020
AG. Paraskevi, Samos	Greece	27.065833° N	37.717667° E	65-110 m	Kefalas & Castritsi-Catharios	2007
Agathinisi, (Gaidouronissi)	Greece	26.935833° N	37.419000° E	60-80 m	Kefalas & Castritsi-Catharios	2007
Amogos	Greece	36.984019° N	26.002475° E	80-90 m	Kefalas *et al.*	2003
Anirgis	Greece	25.343333° N	36.921667° E	90-100 m	Kefalas & Castritsi-Catharios	2007
Antiparos	Greece	25.056667° N	37.112500° E	89-90 m	Kefalas & Castritsi-Catharios	2007
Antitilos	Greece	36.364959° N	27.460701° E	30-50 m	Voultsiadou *et al.*	2008
Astypalea	Greece	36.528213° N	26.471627° E	20-35 m	Voultsiadou *et al.*	2008
Astypalea	Greece	36.574811° N	26.256726° E	20-50 m	Voultsiadou *et al.*	2008
Farmakonisi	Greece	37.370269° N	27.056191° E	60-80 m	Kefalas *et al.*	2003
Gulf of Kavala	Greece	40.883333° N	24.466667° E		Voultsiadou-Koukoura & Koukouras	1993
Ikaria	Greece	37.463443° N	26.319267° E	65-100 m	Kefalas *et al.*	2003
Ikaria	Greece	37.744660° N	26.307409° E	60-80 m	Kefalas *et al.*	2003
Kandelioussa	Greece	36.496910° N	26.970473° E	25-40 m	Voultsiadou *et al.*	2008
Nisos Samos	Greece	37.788706° N	27.120566° E	90-110 m	Kefalas *et al.*	2003
Nisos Samos	Greece	37.885269° N	26.935912° E	50-110 m	Kefalas *et al.*	2003
Paleophanaro Cape, Ikaria	Greece	26.355000° N	37.711667° E	90-110 m	Kefalas & Castritsi-Catharios	2007
Paros	Greece	37.189003° N	25.213035° E	90-100 m	Kefalas *et al.*	2003
Phourni Islands	Greece	26.383333° N	37.515333° E	50-110 m	Kefalas & Castritsi-Catharios	2007
Sporades islands	Greece	39.500000° N	24.183333° E		Voultsiadou-Koukoura & Koukouras	1993
Tilos	Greece	36.445337° N	27.389779° E	25-50 m	Voultsiadou *et al.*	2008
Vathi, Samos	Greece	26.936667° N	37.780833° E	60-80 m	Kefalas & Castritsi-Catharios	2007
Herzliya Deep	Israel	32.177100° N	34.633060° E	95-120 m	Idan *et al.*	2018
Shefayim	Israel	32.214220° N	34.643230° E	95-123 m	Idan *et al.*	2021
Arenzano	Italy	44.402373° N	8.689905° E	30-48 m	Almudena *et al.*	2014
Bergeggi cave	Italy	44.216667° N	8.433333° E		Manconi *et al.*	2013
Bisbe ceve	Italy	40.566667° N	8.200000° E		Manconi *et al.*	2013

Table 2. Bibliographical records for *S. lamella* (continued)

Location	Country	Latitude	Longitude	Depth	Author	Year
Bonaccia	Italy	43.591667° N	14.335167° E	77-83 m	Angeletti & Taviani	2020
Budoni	Italy	40.710422° N	9.726363° E	38-56 m	Citizen report No: 3	
Capo Berta	Italy	43.897776° N	8.085331° E	30-60 m	Almudena *et al.*	2014
Cinque Terre	Italy	44.109695° N	9.684911° E	19-58 m	Enrichetti *et al.*	2019; 2020
East coast of Sardinia	Italy				Pronzato & Manconi	2008
Falco cave	Italy	40.566667° N	8.216667° E		Manconi *et al.*	2013
Galatea cave	Italy	40.566667° N	8.216667° E		Manconi *et al.*	2013
Gulf of Napoli	Italy	40.700000° N	14.266667° E		Topsent	1925
Imperia	Italy	43.870830° N	8.048009° E	33-157 m	Enrichetti *et al.*	2019; 2020
Isola di Bergeggi	Italy	44.216940° N	8.433044° E	25-113 m	Almudena *et al.*	2014
Isola Gallimara	Italy	44.027611° N	8.223160° E	25-45 m	Almudena *et al.*	2014
Isola Mal di ventre	Italy	39.980327° N	8.310286° E	20-35 m	Citizen report No: 4	
Lampedusa	Italy				Pronzato & Manconi	2008
Monte Argentario, in cave	Italy	42.366667° N	11.200000° E	12 m	Pulitzer-Finali & Pronzato	1981
North coast of Sardinia	Italy				GBIF	2020
Peninsula of Sinis	Italy	39.925534° N	8.375601° E		Trainito	2008
Porto Venere	Italy	44.047808° N	9.833434° E	10-30 m	Almudena *et al.*	2014
Portofino	Italy	44.300000° N	9.200000° E	30-50 m	Pulitzer-Finali & Pronzato	1981
Portofino	Italy	44.316667° N	9.166667° E	45 m	Sarà	1958
Punta Manara	Italy	44.251097° N	9.404356° E	21-35 m	Almudena *et al.*	2014
Sanremo	Italy	43.775114° N	7.783732° E	44-87 m	Enrichetti *et al.*	2019; 2020
Santa Caterina, deep site	Italy	40.165900° N	17.824100° E		Longo *et al.*	2018
Savone	Italy	44.268938° N	8.501174° E	50-143 m	Enrichetti *et al.*	2019; 2020
Secche di Tor Paterna	Italy	41.599283° N	12.433553° E		Trainito	2014
Sestri Levante	Italy	44.258774° N	9.372777° E	30-85 m	Enrichetti *et al.*	2019; 2020
Sicilla	Italy	38.263485° N	15.707834° E	70 m	Citizen report No: 2	2019
South-east coast of Sicily	Italy				Pronzato & Manconi	2008
Tavolara - Molara Islands	Italy	40.887982° N	9.721757° E	40-56+ m	Canessa	2021

Table 2. Bibliographical records for *S. lamella* (continued)

Location	Country	Latitude	Longitude	Depth	Author	Year
Torre Inserraglio, shallow site	Italy	40.177600° N	17.925000° E		Longo *et al.*	2018
Varazze	Italy	44.353324° N	8.580876° E	29-45 m	Almudena *et al.*	2014
Vieste (5 transects)	Italy	42.032333° N	16.170667° E	48-75 m	Angeletti & Taviani	2020
Tripoli area	Libya				Pronzato & Manconi	2008
Monaco	Monaco	43.733333° N	7.433333° E		Topsent & Olivier	1943
M'diq	Morocco	35.688639° N	5.290111 ° W		Krikech *et al.*	2019
Cape Espichel, in cave	Portugal	38.412220° N	9.212780° E		Lopes & Boury-Esnaul	1981
Peniche, in cave	Portugal	39.387665° N	9.391595° W		Citizen report No: 5	2008
Sagres, in cave	Portugal	37.005000° N	8.928333° W		Boury-Esnault *et al.*	2005
Balearic Islands	Spain	40.166670° N	2.950000° E		OBIS	2005-2008
Balearic Islands	Spain	39.116670° N	2.950000° E		OBIS	2005-2008
Balearic Islands	Spain	39.168030° N	2.939240° E		OBIS	2005-2008
Barcelona region	Spain	41.893850° N	3.245120° E		OBIS	2005-2008
Barcelona region	Spain	42.303060° N	3.317230° E		OBIS	2005-2008
Barcelona region	Spain	41.569100° N	2.553050° E		OBIS	2005-2008
Barcelona region	Spain	41.700000° N	3.883333° E		OBIS	2005-2008
Barcelona region	Spain	42.283333° N	3.333333° E		OBIS	2005-2008
Barcelona region	Spain	41.698720° N	2.867970° E		OBIS	2005-2008
Barcelona region	Spain	41.577080° N	2.569170° E		OBIS	2005-2008
Barcelona region	Spain	41.566670° N	2.550000° E		OBIS	2005-2008
Ceuta	Spain	35.937700° N	5.252450° W		OBIS	2005-2008
Ceuta	Spain	35.883333° N	5.283333° W		OBIS	2005-2008
Ceuta	Spain	35.883333° N	5.333333° W		OBIS	2005-2008
Ceuta	Spain				GIBF	2020
Gulf of Valencia	Spain				Pronzato & Manconi	2008
La Atunara	Spain	36.181670° N	5.314170° W	40 m	Carballo & Garcia-Gómez	1994
Menorca Channel	Spain	39.901940° N	3.562778° E	53-58 m	Santín	2018
Placer de Meca	Spain	36.175000° N	6.266667° W	30 m	Carballo & Garcia-Gómez	1994

Table 2. Bibliographical records for *S. lamella* (continued)

Location	Country	Latitude	Longitude	Depth	Author	Year
Santander	Spain	43.475000° N	3.774440° W		Ferrer Hernández	1914
Galite Islands	Tunisia	37.509170° N	8.944444° E	40-200 m	Ben Mustapha *et al.*	2003
Tunis - Sfax area	Tunisia				Pronzato & Manconi	2008

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NOVI NALAZI RIJETKE VRSTE SPONGIA (SPONGIA) LAMELLA (SCHULZE, 1879) (PORIFERA) NA CRNOGORSKOJ OBALI

Nikola ĐORĐEVIĆ, Vesna MAČIĆ, Slavica PETOVIĆ

SAŽETAK

Prisustvo rijetke mediteranske vrste *Spongia (Spongia) lamella* dokumentovano je u Crnoj Gori na šest lokacija sa ukupno 13 primjeraka i predstavljeno zajedno sa dostupnim bibliografskim podacima. Svi primjerci su nađeni na čvrstoj podlozi na dubini između 10 i 17 m, u područjima sa smanjenom prozirnošću morske vode zbog blizine rijeke Bojane. Pet od šest lokacija dokumentovanih u Crnoj Gori nalazi se u budućem Zaštićenom morskom području "Stari Ulcinj", a četiri od ovih pet lokacija nalaze se duž 3 km duge obale u zalivu Valdanos. Šesta lokacija nalazi se kod ostrva Đeran u neposrednoj blizini ušća rijeke Bojane i na ovoj lokaciji je zabilježena najveća gustina naseljenosti *S. lamelle*. Potrebna su dalja istraživanja.

Ključne riječi: *Spongia (Spongia) lamella*, endem, sunđeri, Porifera, Jadransko more