

## First record of the endemic anthozoan *Spinimuricea klavereni* (Carpine & Grasshoff 1975) (Cnidaria, Anthozoa, Plexauridae) in the Adriatic Sea

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*We present the first record of the endemic Mediterranean anthozoan *Spinimuricea klavereni* (Carpine & Grasshoff 1975) (Cnidaria, Anthozoa, Plexauridae) for the Adriatic Sea (Boka Kotorska bay, Montenegro). A density of 0.72 colonies m<sup>-2</sup> could be measured in the area, which was compared with the scant available data in the literature. Having in mind that this species is very rare and endemic for the Mediterranean, it is important to increase our knowledge on its distribution and biology in order to better assess its ecological role, the pending threats and the need for specific conservation measures*

**Key words:** Boka Kotorska Bay; Montenegro; *Spinimuricea klavereni*; Mediterranean

### INTRODUCTION

The Mediterranean Sea is one of the 36-biodiversity hot spots of the World, with more than 17000 described marine taxa, with experts estimating that there are still many undescribed species (COLL *et al.*, 2010). Unfortunately, as a centre of ancient civilizations, the Mediterranean is under constantly increasing human pressure. In recent decades, the anthropogenic impact has grown dramatically, diversifying and increasing its distribution in the basin, causing an alteration of ecosystems and a decrease in biodiversity (COLL *et al.*, 2010, BIANCHI *et al.*, 2012). The semi-enclosed nature of the Mediterranean Sea aggravates the multiple effects of the said impacts, whose causes have been outlined by numerous authors: professional and recreational

fishing, overfishing, maritime traffic, water pollution, coastal development, introduction of nonindigenous species, and offshore oil and gas prospection and exploitation (MedPAN & SPA/RAC, 2019). Effects of these multiple drivers are intensified by global climate change, with the consequences of the acidification process still not foreseeable.

Having in mind the cumulative character of the ongoing process, it is not strange that many national and international initiatives are taken in order to halt biodiversity loss and plan sustainable development goals (Barcelona Convention, Bern Convention, EU Habitat directive, MSFD). One of those is the IUCN Red list of Threatened Species and Overview of the conservation status of the Mediterranean Anthozoa (OTERO *et al.*, 2017).

Table 1. Records of *Spinimuricea klavereni* based on literature and on present paper

AUTHOR	YEAR	SITE	NATION	DEPTH	X	Y	NOTE
KOCH	1887	Naples Gulf	Italy		14.266160	40.785525	
CARPINE & GRASSHOFF	1975	Algeria	Algeria		3.046894	36.922207	
CARPINE & GRASSHOFF	1975	Monaco	Monaco	50m	7.436084	43.734130	Harbor dike, mud
CARPINE & GRASSHOFF	1975	Samotracia	Greece	55m	25.503408	40.413192	Calypso SME station 1613, 2 colonies, muddy sand
CARPINE & GRASSHOFF	1975	Bosphorus	Turkey		29.128676	41.216964	
VIEIRA	2008	Algarve	Portugal		-8.322760	36.953590	Grassoff, 1992
AGUILAR et al.	2008	Placer de la Barra y Hoya, Columbretes Islands	Spain	80-90	0.533333	39.833333	Oceana
AGUILAR et al.	2008	Bajos del Oeste, Columbretes Islands	Spain	80-90	0.700000	39.950000	Oceana
BO et al.	2012	S.Eufemia Gulf S1, Calabria	Italy	70-110m	16.087000	38.738667	
AGUILAR	2014	Formentera Island	Spain		1.349780	38.689045	
TOPÇU & ÖZTÜRK	2015	Marmara Sea, Balıkcı Island (north)	Turkey	25-38m	29.090062	40.861458	max density 3,1 m <sup>2</sup> in 14 sites
TOPÇU & ÖZTÜRK	2015	Marmara Sea, Marmara Island (south)	Turkey	30m	27.637892	40.522632	max density 0,1 m <sup>2</sup> in 1 site
ISPRA	2016	Capo Milazzo 13, Sicily	Italy	75-101m	15,218917	38,251167	2 colonies
ISPRA	2016	Capo Milazzo 11, Sicily	Italy	35m	15,233433	38,261267	
ECOSAFIMED	2016	Golfo di Patti, Sicily	Italy	36-70m	15.074648	38.200576	average 1±1,8 colonies m <sup>-2</sup> ; max 13 m <sup>-2</sup>
SANTIN & GORI	2018	Cap de Creus, Catalonia	Spain	10m	3.27766	42.34070	3 colonies
MACIC et al.	2021	Verige Turski Rt, Boka Kotorska Bay	Montenegro	28-32m	18.686263	42.477892	36 colonies; 0,72 colonies m <sup>-2</sup>

The number of species of Anthozoans present in the Mediterranean Sea is quite disputed: VAFIDIS (in COLL *et al.*, 2010) listed 167 species, including 3 introduced and 37 endemic taxa; TRAINITO & BALDACCONI in 2016 listed 182 confirmed species, including 32 endemic and 6 introduced taxa, and 20 taxa whose taxonomic status is doubtful. In the Mediterranean Anthozoan Red List OTERO *et al.* in 2017 listed 212 species, including 62 whose taxonomic status is unconfirmed and 26 endemic taxa. The high level of uncertainty regarding the class of Anthozoa is confirmed by the 69 species whose

status assessment is Data Deficient (OTERO *et al.* 2017) and this also regards endemic species. *Spinimuricea klavereni* (CARPINE & GRASSHOFF 1975) is one of them.

This gorgonian species was known from the XIX century but at that time it was confused with *Paramuricea placomus* (described as *Gorgonia placomus* [Linnaeus, 1758]) and it was redescribed in 1975 (CARPINE & GRASSHOFF, 1975) as *Echinomuricea klavereni*, based on specimens from Monaco and Samotracia (Aegean Sea, Greece). Its current taxonomy was established in 1992 by GRASSOFF with the

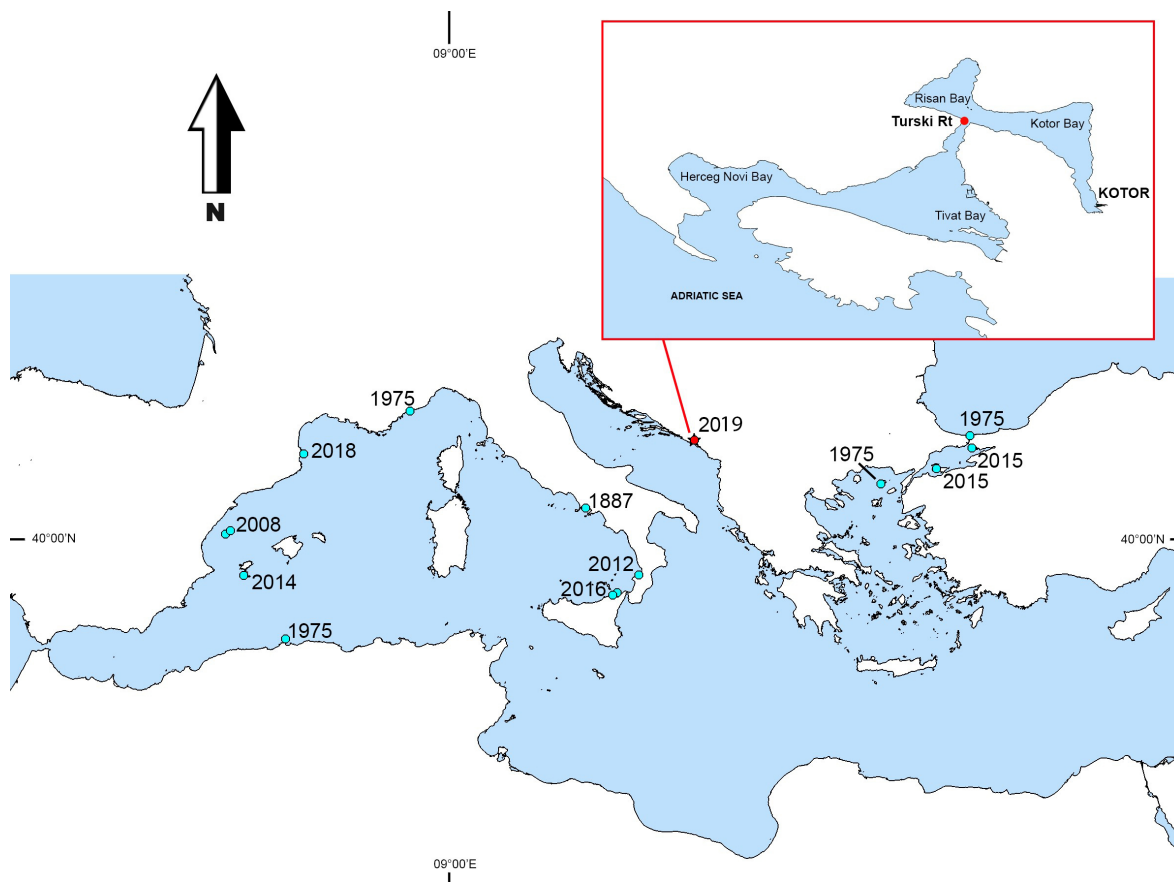


Fig. 1. Distribution of *Spinimuricea klavereni* records from bibliography (blue dots) and new record in the Adriatic Sea (red dot)

institution of the genus *Spinimuricea*, which includes also the Atlantic *Spinimuricea atlantica* (Johnson, 1882). The colonies of *S. klavereni* stand vertical with few or no branches. The basal zone is not covered by coenenchyme, while polyps are placed close to each other and more or less in two opposite rows. The colonies exceptionally may reach up to 110 cm height (TOPÇU & OZTÜRK 2016a), but mostly less than 50 cm. It is reported both on hard and muddy substrates, usually attached to stones in a depth range of 50 - 80 m. On the contrary *S. atlantica* may be distinguished by the more ramified aspect of colonies and presence of ramified sclerites in the coenenchyme (CARPINE & GRASSHOFF, 1975; TRAINITO & BALDACCONI, 2016; TOPÇU & OZTÜRK, 2016a).

When described, *S. klavereni* was known only for Algeria, Monaco, Bay of Naples, North Aegean Sea and Bosphorus (CARPINE & GRASSHOFF, 1975). Up to nowadays, only several new

records are added from the North Aegean Sea (VAFIDIS *et al.*, 1994), the Sea of Marmara (TOPÇU & OZTÜRK, 2016a), the Thyrrenian Sea (BO *et al.*, 2012; ISPRA, 2016; ECOSAFIMED, 2016), the Balearic Archipelago and the northern Mediterranean coasts of Spain (AGUILAR *et al.*, 2015; SANTIN & GORI, 2018). The reported presence of *S. klavereni* in the waters of Algarve (South Portugal, Atlantic Ocean) (CURDIA, 2012) needs confirmation. Recent studies in the Marmara Sea by TOPÇU and OZTÜRK (2016a, 2016b) reported the highest density of *S. klavereni* (3.1 ind. m<sup>-2</sup>) and highlighted depth range, morphometry, growth rates and reproduction (TOPÇU & OZTÜRK, 2016a, 2016b). Being these the only in-depth studies on the species, it is not strange that OTERO *et al.*, (2017) in the Overview of the conservation status of the Mediterranean Anthozoa classified *S. klavereni* as Data Deficient. Table 1 summarizes all the record of the species. Figure 1 shows the geographical distribution of the records.

The aim of this work was to first report *S. klavereni* for the Adriatic Sea and contribute to the knowledge of this endemic, rare and probably threatened species.

## MATERIAL AND METHODS

Surveys were performed in Verige strait, Turski Rt, Boka Kotorska Bay, Montenegro (N 42.477888° E 18.686523°) by SCUBA diving in September 2019 (Fig. 1). After preliminary surveys, a rectilinear video and photo-transect of 100m x 0.5 m were performed in correspondence with the presence of the colonies of *S. klavereni*. The video was performed with a Go Pro camera and photographs with a SONY  $\alpha$ 6000, APSC, 24-megapixel, 16-55 mm lens in Sea & Sea housing with wetlens Nauticam WW1, macro shots were taken with 30mm lens. All colonies along the transect were counted and three samples were collected. One sample was treated with 30% hydrogen peroxide to extract the sclerites for taxonomic determination. Sclerites were examined and photographed with Zeiss Axio Imager.A1. Samples are stored at the Institute of Marine Biology, Kotor, University of Montenegro.

## RESULTS

*Spinimuricea klavereni* colonies were observed on an almost horizontal muddy bottom from 28 to 32 m depth. Colonies were white, almost all unbranched and approximately 5 to 28 cm high (Fig 2). The sclerites extracted from the collected sample indicate thornscales from the calix (Fig 3A) and spindles or needles from the coenenchyme (Fig 3B). The comparison with the images presents in the literature corroborates the identification of *S. klavereni* both based on of the external morphology and of the structure of sclerites (CARPINE & GRASSHOFF, 1975; SANTIN & GORI, 2018). Therefore, this is the first report of the species for the Adriatic Sea.

All the colonies in the area of the transect were counted giving a density of 0.72 colonies  $m^{-2}$ , which is consistent with the range of densities known from the poor data available in the

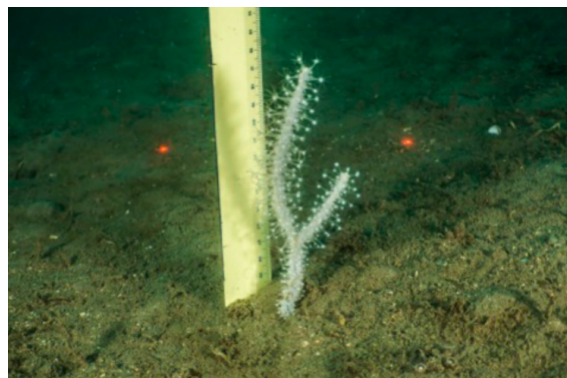


Fig. 2. *Spinimuricea klavereni*, Verige strait, Adriatic Sea

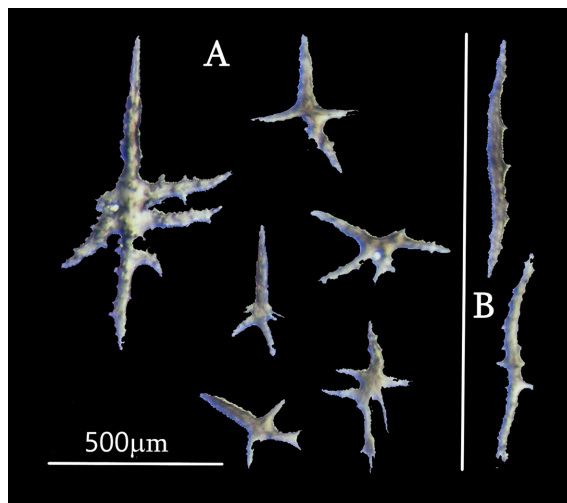


Fig. 3 The sclerites extracted from the collected sample of *Spinimuricea klavereni*: A) thornscales from the calix, B) spindles or needles from the coenenchyme

literature. As depicted in Table 1, the density was measured in the Marmara Sea in a range of 0.1-3.1 colonies  $m^{-2}$  (TOPÇU & OZTÜRK, 2015) and 1-1.8 colonies in the Patti Gulf (ECOSAFIMED, 2016). All other records refer to few or single individuals.

None of the colonies in the surveyed site was affected by epibiosis or necrosis.

## DISCUSSION

This rare gorgonian species typically inhabits depths below recreational diving (Table 1) and this could be one of the reasons for the lack of knowledge on its distribution and biology in general (TOPÇU & OZTÜRK, 2013, 2016a). Exceptionally shallow and dense populations of *Spinimuricea klavereni* in Marmara Sea gave the

opportunity for the first studies on the growth rate and reproduction of this species (TOPÇU & ÖZTÜRK, 2016a, 2016b). Furthermore, it seems that this dense population could be a result of the specific oceanographic conditions of the Marmara Sea. This semi-enclosed sea connects the Black Sea and the Aegean Sea and it is characterized by vertical stratification and brackish water at the surface (TOPÇU & ÖZTÜRK, 2016b). Interestingly, the Verige strait where *S. klavereni* was reported for the first time in the Adriatic Sea could be compared to the Marmara Sea. This is the narrowest part of the Boka Kotorska Bay (Fig. 1) and connects the inner part of the bay, characterized by a strong inflow of freshwater springs (mostly during winter) and several “vrulja” (underwater springs of freshwater), with western part connected to the open sea (BELLAFIORE *et al.*, 2011).

Currents in the Verige strait are usually strong and at the upper layers brackish water flows toward the open sea, while in the deeper layers currents are toward the inner part of the bay. Furthermore, Boka Kotorska Bay is under strong anthropogenic impact first of all because of eutrophication and habitat destruction (DRAKULOVIĆ *et al.*, 2016; MAČIĆ & ZORDAN, 2018). On the coast along the site of the here described finding of *S. klavereni* just a few years ago a new infrastructure was built and, unfortunately, habitat destruction on the bottom of the sea is very evident: the dumping of building materials, and of a huge amount of marine litter of any dimension (plastic waste, cars, a rubbish container, a bus) was favored by the proximity of the road to the sea coast.

Despite these anthropogenic conditions, the population of *S. klavereni* showed no signs of

degradation: this is consistent with the opportunistic behavior of the species as described by TOPÇU & ÖZTÜRK (2016a) reporting the low necrosis and high growth rates in the Marmara populations.

## CONCLUSIONS

Further analyses are needed in Boka Kotorska Bay to point out the characteristics of this population and its evolution in time and space; it will be also of primary importance to investigate the possible presence of other similar populations in the bay. Having in mind that *S. klavereni* is very rare and endemic for the Mediterranean, it is important to increase our knowledge on its distribution and biology in order to better assess its ecological role, the pending threats and the need for specific conservation measures.

## ACKNOWLEDGEMENTS

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**Prvi nalaz endemskog žarnjaka *Spinimuricea klavereni*  
(Carpine & Grasshoff 1975) (Cnidaria, Anthozoa, Plexauridae)  
u Jadranskom moru**

Vesna MAČIĆ\*, Egidio TRAINITO i Slavica PETOVIĆ

**SAŽETAK**

Prikazan je prvi nalaz endemičnog sredozemnog žarnjaka *Spinimuricea klavereni* (Carpine & Grasshoff 1975) (Cnidaria, Anthozoa, Plekauridae) za Jadransko more (Bokokotorski zaliv, Crna Gora).

Dobijeni rezultati i izmjerena gustina od 0,72 kolonije m<sup>-2</sup> su uspoređeni s oskudnim podacima dostupnim u literaturi. Imajući u vidu da je ova vrsta vrlo rijetka i endemska za Sredozemno more, važno je poboljšati znanje o njejoj distribuciji i biologiji kako bismo bolje procijenili njenu ekološku ulogu, prijetnje i potrebu za određenim mjerama zaštite.

**Ključne reči:** Bokokotorski zaliv; Crna Gora; *Spinimuricea klavereni*; Sredozemno more