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Contribution to the knowledge of protected *Axinella* (Porifera, Demospongiae) species along the Montenegrin coast

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ABSTRACT

Along the coast of Montenegro four Axinella *(Porifera, Demospongiae) species were reported on 44 locations.* A. polypoides *was the rarest and it was found on only four locations.* A. damicornis *was recorded on 15 locations and almost all of them are outside of the Boka Kotorska Bay. Similar to previous species* A. verrucosa *was mostly present in the open sea (20 locations), while the great majority of records for* A. cannabina *was located in the inner part of the Boka Kotorska Bay (12 out of 18). Further research and protection measures are needed.*

Keywords: *Axinella*, sponges, protected species, Adriatic Sea

INTRODUCTION

There are evidences that sponges have been collected and used since ancient times by Egyptians, Phoenicians, Greeks and many others (Voultsiadou 2005; Baldacconi & Trainito, 2013). Due to the existence of research centers mainly in the northern Adriatic, through the XVIII and XIX centuries many species were described based on specimens from the Adriatic Sea, and this is also the reason why the Adriatic became one of the best examined parts of the Mediterranean. Studies like "Zoologia Adriatica" by Olivi (1792) and "Spongiariorum classification" by Nardo (1833) were significantly improved with a descriptive list of 115 species by Schmidt (1862). Nowadays, more than 600 species are known in the Mediterranean and many of them are endemic (Baldacconi & Trainito, 2013). Unlike the Northern Adriatic, the areas in the south were not so well studied. Regarding the coast of Montenegro, few authors reported several species (Karaman & Gamulin-Brida, 1970; Gašić *et al.*, 1983; Fant *et al.*, 2011) and up to now only 36 species are reported (Golder Associates, 2013).

Apart their simple body structure, sponges play an important ecological role in Mediterranean ecosystems, particularly in rocky-bottom communities (Maldonado 2012). Sponges are filter-feeders and act as biofilters. It is estimated that 1 cm3 of the sponge's body in 1 h can filtrate up to 1 l of water, so that one medium sized sponge can filtrate up to 1000 liters of water per hour (Baldacconi & Trainito, 2013). Furthermore, they are slow-growing, long-living organisms, but highly competitive and they add complexity to the marine habitats (Maldonado 2012, Baldacconi & Trainito, 2013). For all these reasons, any serious natural or anthropogenic disruption of sponge communities could initiate a cascade of ecological changes in the sublittoral systems (Maldonado, 2012). It was already evident on the beginning

of the XX century, when enormous quantities of selected species were collected thanks to the development of SCUBA diving. But the collection of sponge species without any control is not the only negative anthropogenic impact. Unfortunately, these species are also impacted by water pollution, destruction of habitat (dumping of solid waste; illegal collection of date shell (Lithophaga lithophaga)), physical damage from fisheries (bottom gear, potting, some fixed nets, trawling, dredging, in some cases also angling), increased levels of suspended sediments (from nearby constructions or dredging), on some locations physical damage resulting from careless divers, etc. Furthermore, the competition with invasive species, the impact of climate change and also the increased collection of sponges for scientific purposes (such as analysis of metabolites as potential drugs) have a serious impact on their distribution and biodiversity (Northen & Irving, 2008; Baldacconi & Trainito, 2013; Yalcin, 2007; Kljajić *et al.*, 2006). On account of all these threats, some sponges are listed as protected or endangered species in several international conventions and national laws.

The genus *Axinella* (class Demospongiae, order Halichondrida, family Axinellidae) contains about 100 species distributed world-wide (WoRMS 2015, Van Soest *et al.*, 2015). Porifera database (Van Soest *et al.*, 2015) in the Mediterranean Sea lists 23 taxa and 20 of them are listed as valid species. Furthermore, for the Adriatic Sea are listed 7 species while Pansini & Longo (2008) for italian coast of the Adriatic Sea listed only 6 species, namely *A. cannabina* Esper 1794, *A. damicornis* Esper 1794, *A. verrucosa* Esper 1794, *A. polypoides* Schmidt 1862, A. macrostyla Babic 1922 and A. pumila Babic, 1922. Anyhow, by the national law in Montenegro 4 *Axinella* species are protected: *A. cannabina*, *A. damicornis*, *A. polypoides* and *A. verrucosa.* Furthermore, species *A. polypoides* is protected by the Bern Convention (1979), while *A. cannabina* and previous one are also protected by the Barcelona Convention (1976).

Unfortunately, species distribution maps are missing for many protected (and unprotected) species, therefore the aim of this work is to present the distribution in Montenegro of four protected *Axinella* species, to contribute to their better knowledge and hopefully better protection.

MATERIALS AND METHODS

As a part of several different scientific projects from 2010 to 2014 we surveyed 51 coastal locations by free and SCUBA diving, down to 40m depth (Figure 1). Sponges have been identified visually and a photo documentation was made, but in some cases samples have been collected and studied in laboratory.

RESULTS AND DISCUSSION

Altogether 4 *Axinella* species (Figure 2) were reported on 44 locations. Only 10 of these were previously reported by other authors, while 34 are new records.

A. polypoides was the rarest of the 4 *Axinella* species. It was found on three locations on Kočište cape or very close to it and on one location on Katič isle (Figure 3, Table 1). On all four locations, from two to five individuals were recorded. All of them were bright yellow, growing on the rocky bottom from 21m to 37m depth. Two specimens on Seka Kočište and one on Kočište cape were higher than 50 cm and intensively branched.

Fishing by bottom nets and angling are the threats for this arborescent species. Furthermore, close to Kočište cape there is the terminal of a drain pipe and in summer of 2013 the pipes were broken (probably due to illegal anchoring) and for a few months waste

waters were discharged approximately 800m of Kočište cape. It would be very interesting to check in the future the locations where *A. polypoides* was recorded and to evaluate the actual impact of waste water discharge.

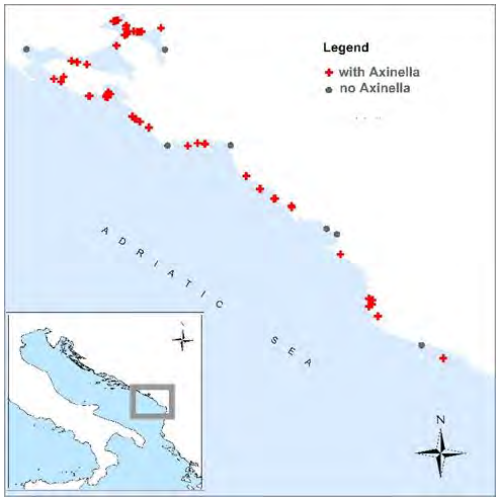

Figure 1. Locations with (+) and without (•) *Axinella* species along the Montenegrin coast

A. damicornis was recorded on 15 locations and almost all of them were outside of the Boka Kotorska Bay (Figure 4, Table 2). On the open sea this species was recorded at depths from 6 m to 20 m and mostly close to the mosaic Posidonia oceanica meadows, on the coralligenous and detrital bottom. In the Boka Kotorska Bay was recorded close to the entrance of the bay (Žanjice) on the bigger rock, surrounded by sandy bottom (25 m depth) and on two locations inside the bay (Kumbor and Perast) on the coralligenous habitats. In many cases *Parazoanthus axinelle* was settled on the sponge.

Due to the small dimensions of this species, it looks like it is not threatened by fishing as *A. polypoides.*

Similarly to previous species *A. verrucosa* was mostly present in the open sea (15 locations), while in the Boka Kotorska Bay only few (5 locations) were registered (Figure 5, Table 3). On all locations *A. verrucosa* was present on the coralligenous, detrital and dark habitat from 6 m to 28 m depth. In almost all cases it was abundantly covered by *Parazoanthus axinelle.*

On different locations *A. verrucosa* was more than 20 cm high and arborescent. That was reported as a possible cause of some damage from the fishing nets (Baldacconi & Trainito, 2013), but we consider this as a sporadic threat.

Axinella species that also had a high number of reports in our research was *A. cannabina* (Figure 6, Table 4). Great majority of records for this species were in the inner part of the Boka Kotorska Bay, 12 out of 18. Except those in the inner part of the bay, another location (Spiljice) was in the Kumbor strait inside the Boka Kotorska Bay, while others were in the open sea and mostly close to Valdanos. On all locations a very high sedimentation rate is evident and probably it is one of the most important factors for the distribution of this

species (Brummer *et al.*, 2004). The population on Valdanos location was at 16 m to 20 m of depth (RAC SPA, 2013), while in the Boka Kotorska Bay they were found at depths from 7 to 31 m. On all locations we found specimens mostly of red or dark orange colour, few tens of centimetres high and branching. But the dimensions in the Boka Kotorska Bay were larger and sometimes more than 1 m. Because of its huge size and arborescent shape, *A. cannabina* is threatened by different types of fishing (bottom nets, traps, angling). The finding of some abandoned nets and traps in the inner part of the Boka Kotorska Bay proves this statement.

Table 1. Deatils of findings of *A. polypoides*

No.	Location	North	East	Date of survey	No. of individuals
1	Kamenova cape	42.370775°	18.656834°	15. 03. 2011	2
2	Katič isle	42.195725°	18.937156°	19. 08. 2012	2
3	Kočište cape	42.366133°	18.654077°	13. 03. 2011	2
4	Kočište seka	42.366005°	18.659590°	12. 03. 2011	5

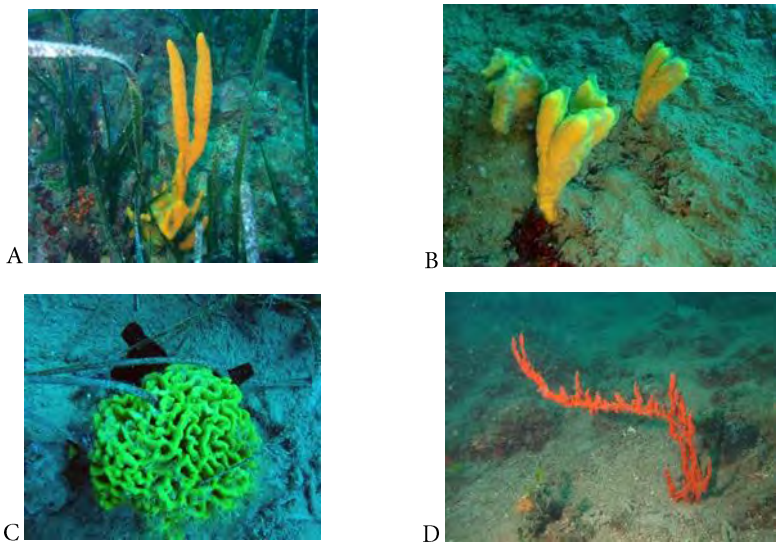

Figure 2. *Axinella polypoides* (A), *A. verrucosa* (B), *A. damicornis* (C) and *A. cannabina* (D)

Figure 3. Distribution of the *A. polypoides* along the Montengrin coast (locations are: 1. Kamenova cape, 2. Katič isle, 3. Kočište cape and 4. Seka Kočište

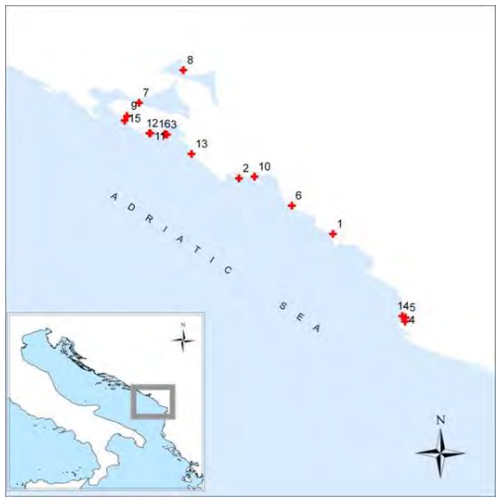

Figure 4. Distribution of the *A. damicornis* along the Montengrin coast (locations are: 1. Čanj, 2. Jaz cape, 3. Kočište cape, 4. Marjan cape, 5. Kruče, 6. Skočidjevojka cape, 7. Spiljice, 8. Perast, 9. Žanjice, 10. Mogren, 11. Kočište cape, 12. Ponta Veslo, 13. Žukovac cape, 14. Stari Ulcinj, 15. Arza cape and 16. Ponta Veslo (2).

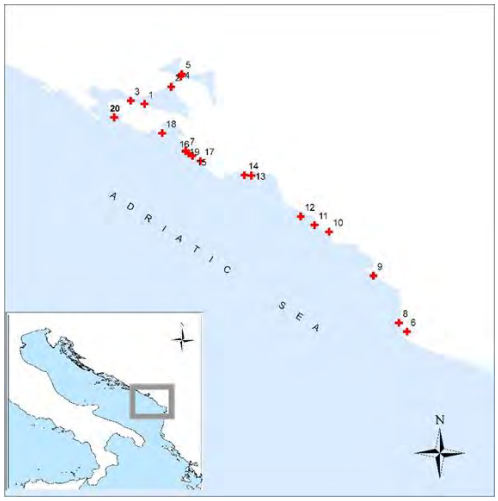

Figure 5. Distribution of the *A. verrucosa* along the Montengrin coast (locations are: 1. Krašići, 2. Sv. Nedjelja, 3. Kumbor, 4. Verige, 5. Sv. Đorđe isle, 6. Valdanos, 7. Seka Albaneze, 8. Rep cape, 9. Mikovića cave, 10. Čanj, 11. Dubovica cape, 12. Donkova seka, 13. Mogren, 14. Jaz, 15. Nerin, 16. Zli potok, 17. Žukovac cape, 18. Kočište cape, 19. Seka Albaneze and 20. Mamula island (personal communication Egidio Trainito)

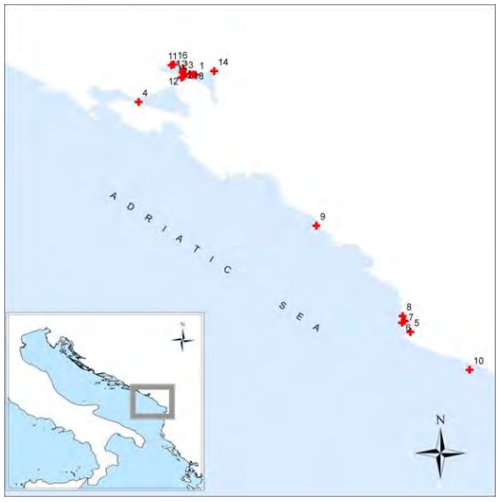

Figure 6. Distribution of the *A. cannabina* along the Montengrin coast (locations are: 1. Dražin Vrt, 2. Verige Gospa od Anđela, 3. Sv. Đorđe isle, 4. Spiljice, 5. Valdanos, 6. Rep cape, 7. Kruče, 8. Stari Ulcinj isle, 9. Dubovica cape, 10. seka Đeran, 11. Strp, 12. Verige 13. Banj, 14. Orahovac, 15. Gospa od Škrpjela, 16. Strp(2), 17. Perast and 18. Dražin Vrt(2).

Table 2. Deatils of findings of *A. damicornis*

No.	Location	North	East	Date of survey	No. of individuals
1	Čanj	42.160072°	18.995196°	08. 05. 2011	2
2	Jaz cape	42.273191°	18.802365°	31. 05. 2011	3
3	Kočište cape	42.363878°	18.654122°	12. 03. 2011	4
4	Marjan cape	41.980806°	19.141298°	28. 10. 2011	1
5	Kruče	41.990009°	19.142042°	29. 10. 2011	1
6	Skočiđevojka cape	42.216899°	18.910687°	26. 06. 2010	2
7	Spiljice	42.428931°	18.589475°	24. 02. 2012	2
8	Perast	42.493276°	18.690920°	02. 11. 2011	2
9	Žanjice	42.399046°	18.574867°	29. 06. 2012	1
10	Mogren	42.273278°	18.829417°	29. 08. 2012	1
11	Kočište cape	42.362870°	18.653609°	09. 06. 2011	3
12	Ponta Veslo	42.365138°	18.612294°	02. 09. 2012	2
13	Žukovac cape	42.321972°	18.706706°	28. 06. 2012	1
14	Stari Ulcinj	41.991718°	19.139124°	25. 06. 2012	2
15	Arza cape	42.390572°	18.571328°	29. 06. 2012	2
16	Ponta Veslo	42.365273°	18.613272°	26. 06. 2011	3

It must be underlined the high abundance of *A. cannabina* in the inner part of the Boka Kotorska Bay and especially in the areas with strong inflow of fresh water. In almost all of these locations some other protected species like *Cladocora caespitosa, Aplysina* spp. and *Savalia savaglia* were also present. That's why a particular attention in further research and protection measures should be dedicated to this area.

Furthermore, coastal locations where *Axinella* species were not registered are shown in Table 5. No presence of *Axinella* spp. was expected for the locations Kotor, Igalo, Žukotrlica and Port Milena because of not favourable conditions (small depth and sandy, sandy-muddy bottom). But on the other three locations (Platamuni, Kamenovo and Ratac cape) after small pebble beach the sea bottom is mostly rocky and covered by mosaic Posidonia meadows, and on these locations it was expected to find *A. damicornis* and/or *A. verrucosa.* We must consider that diving on these locations was performed with the aim of monitoring *Posidonia oceanica* meadows, so, one of the possible reasons for no records of *Axinella* species on these three locations could be overlooked presence of these sponges in deeper areas. We hope that some future surveys of deeper areas on these locations will give light to this theory and contribute to more accurate knowledge of their distribution.

Table 3. Deatils of findings of *A. verrucosa*

No.	Location	North	East	Date of survey	No. of individuals
1	Krašići	42.415623°	18.633623°	21. 03. 2014	1
2	Sv. Neđelja	42.458518°	18.674733°	27. 04. 2011	1
3	Kumbor	42.432778°	18.600812°	02. 04. 2014	2
4	Verige	42.476268°	18.688583°	24. 02. 2012	3
5	o. Sv. Đorđe isle	42.485116°	18.691087°	28. 06. 2011	4
6	Valdanos	41.959260°	19.157871°	29. 10. 2011	1
7	Seka Albaneze	42.327577°	18.699392°	27. 10. 2011	2
8	Rep cape	42.163387°	18.984170°	30. 10. 2011	1
9	Mikovića cave	42.073311°	19.087527°	27. 10. 2011	1
10	Čanj	42.160112°	18.995743°	26. 06. 2012	2
11	Dubovica cape	42.172999°	18.965087°	08. 05. 2011	1
12	Donkova seka	42.193322°	18.936869°	23. 10. 2011	1
13	Mogren	42.273750°	18.830385°	27. 06. 2010	1
14	Jaz	42.275395°	18.825379°	29. 08. 2012	2
15	Nerin	42.306787°	18.731042°	04. 04. 2014	2
16	Zli Potok	42.312997°	18.719319°	31. 08. 2012	1
17	Žukovica cape	42.321972°	18.706706°	21. 03. 2014	1
18	Kočište cape	42.366133°	18.654077°	28. 06. 2012	2
19	Seka Albaneze	42.327954°	18.700390°	05. 06. 2011	2
20	Mamula island (pers. comm. E.Trainito)	42.393946°	18.558617°	15. 08. 2013	1

Table 4. Deatils of findings of *A. cannabina*

No.	Location	North	East	Date of survey	No. of individuals
1	Dražin Vrt	42.48322°	18.716078°	04. 09. 2011	>5
2	Verige	42.477612°	18.691650°	28. 06. 2011	>5
3	Sv. Đorde isle	42.484985°	18.691352°	01. 11. 2011	>5
4	Spiljice	42.428931°	18.589475°	24. 02. 2012	>5
5	Valdanos	41.959260°	19.157871°	27. 10. 2011	3
6	Rep cape	41.976824°	19.140039°	27. 10. 2011	>5
7	Kruče	41.980806°	19.141298°	28. 10. 2011	2
8	Stari Ulcinj isle	41.991718°	19.139124°	29. 10. 2011	1
9	Dubovica cape	42.172999°	18.965087°	23. 10. 2011	1
10	seka Đeran	41.883897°	19.274372°	23. 06. 2012	5
11	Strp	42.502583°	18.666025°	23. 06. 2011	>5
12	Verige	42.476307°	18.688747°	10. 04. 2013	>5
13	Banj	42.493276°	18.690920°	12. 10. 2011	>5
14	Orahovac	42.488865°	18.752387°	03. 08. 2012	>5
15	G. od Škrpjela	42.488215°	18.687558°	08. 04. 2012	>5
16	Strp (2)	42.502986°	18.667238°	02. 08. 2014	>5
17	Perast	42.483681°	18.707121°	05. 09. 2012	>5
18	Dražin Vrt (2)	42.483562°	18.719510°	01. 11. 2011	>5

Table 5. Details for the locations where *Axinella* species were not found

No.	Location	North	East	Date of survey
1	Kotor (Inst. of mar. biol.)	42.436616°	18.763821°	21. 06. 2013
2	Igalo	42.449604°	18.505979°	18. 01. 2012
3	Platamuni	42.268731°	18.783163°	08. 04. 2011
4	Kamenovo	42.273415°	18.887394°	19. 01. 2012
5	Ratac cape	42.121553°	19.066822°	16. 01. 2012
6	Žukotrlica	42.105182°	19.087719°	28. 04. 2011
7	Port Milena	41.905433°	19.235512°	26. 04. 2011

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