Studia Marina 2020, 33 (1): 5-17
Original scientific paper
UDC: 593.4(45:497.16:49)
DOI: 10.5281/zenodo.3932083

All-around rare and generalist: countercurrent signals from the updated distribution of *Calyx nicaeensis* (Risso, 1826) (Porifera, Demospongiae)

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ABSTRACT

New findings of the endemic Mediterranean demosponge *Calyx nicaeensis* in the Tavolara MPA (Sardinia, Italy), in Apulia (Italy) and Montenegro waters are reported and the checklist of its records updated. The rarity of the species is discussed and confirmed. It suggests that greater attention should be paid to rare species in order to understand better their life strategies and environmental role.

Keywords: *Calyx nicaeensis*, Sardinia, Apulia, Montenegro, Mediterranean Sea, rare sponges

INTRODUCTION

The functional roles and the relationships among sponges and benthic communities have been recently highlighted (Cattaneo-Vietti et al., 2000; Wulff, 2006; Bell, 2008, Bertolino et al., 2013). Recently, threats and pressures affecting sponges as a consequence of global warming and human activities have been highlighted (Di Camillo & Cerrano, 2015) and the need for conservation measures has been discussed (Bell et al., 2015).

In the Mediterranean Sea, only 15 species are currently protected under Annex II and III of the Barcelona Convention and Annexes II and III of the Bern Convention: four of them are under Annexes III of both the conventions that list the species whose exploitation is regulated. Protected sponges are a mere 3.2% of the total contingent of the Mediterranean, estimated in 461 accepted sponge taxa (5,4% of the global number of sponges) (Van Soest et al. 2012). The percentage of protected species appears even smaller if we consider that the Mediterranean is the second biogeographical area in the world for sponges diversity (Van Soest et al. 2012). Such a small number of protected species becomes more striking when several regional studies highlight the local diversity, the diffused presence of rare species and the threats pending on sponges assemblages (Gerovasileiou et al., 2018; Costa et al., 2018; Santín et al., 2017; Grenier et al., 2018; Padiglia et al., 2018).

Calyx nicaeensis (Risso, 1826) (Porifera, Demospongiae, Haplosclerida) is an endemic Mediterranean sponge whose locus typicus is the Gulf of Nice (France), as depicted by its

specific name. Unanimously, it is considered a rare species, and the Framework of the EU Marine Strategy (Minambiente, 2017) indicated it as an epi-megazoobenthic structuring species in coralligenous habitats.

In 2013, a checklist of its findings (Cerrano et al. 2013), along the Mediterranean coasts, reported 30 localities where the species has been recorded since its description. The disperse and fragmented distribution (in time and space) highlights the need for stronger research efforts and calls for adequate conservation measures (Cerrano et al. 2013; Barea-Azcòn et al. 2008).

The primary goal of this paper has been to update the existing checklist of this species, both with an updated bibliographic study and with the addition of new findings from the Tavolara Punta Coda Cavallo MPA (Sardinia, Italy), where the species has never been reported, the Jonian coast of Apulia and Montenegro.

MATERIALS AND METHODS

Recurrent surveys on 132 sites have been performed in Tavolara Punta Coda Cavallo MPA and its vicinities in the last 20 years with various goals and in the frame of various monitoring programmes (Trainito, 2007; Trainito & Doneddu, 2015 and 2016; Trainito, 2018; inventory of ASPIM species). All the sites were georeferenced in the frame of GIS of Tavolara MPA. Recurrent surveys have also been performed in the Jonian coast of Apulia during the last 13 years in 32 sites (25 in Taranto and 7 in Lecce coastal stretches). In Montenegro surveys have been performed on 118 sites in more than ten years thanks to various projects both in Boka Kotorska Bay and in the Adriatic Sea (Mačić et al., 2010, RAC/SPA - UNEP/MAP, 2011, RAC/SPA - UNEP/MAP, 2013).

The considered sites have been documented both with images of biocenosis and benthic species, using different high definition digital photographic cameras. Published data have been collected with an in-depth bibliographic study of literature available mainly after 2012. Personal communications by experts and online records have been collected and georeferenced in order to obtain a full and updated knowledge of the species distribution and abundance.

RESULTS

The list of the records available in 2013 is reported in Table 1. The updated analysis of the scientific and grey literature (Table 2) has allowed adding 32 new records of *Calyx nicaeensis*. Four new nations were added to the previous checklist: Monaco, Morocco (CAR/ASP-PNUE/PAM, 2013 and 2016), Israel and Lebanon. No information is still now available from the coastal stretches of Malta, Slovenia, Albania, Syria, Palestine, Egypt and Algeria.

The new records from field surveys are ten and summarizied in Table 3. Five specimens were found in the Tavolara-Punta Coda Cavallo MPA in 4 different localities. In 2012, one small individual was found in Isola Cavalli locality, in shallow waters (4 m depth) on a mixed bottom with sand and rock. The other four specimens were observed in 2013, 2016 (Table 4C), 2017 (Table 4B) and 2019 (Table 4A). All specimens were small (10-15 cm), single cup-shaped with a depth range varying from 16 to 43 m in precoralligenous and coralligenous habitats, both on granite and limestone rocks. None of the censused individuals showed signs of decay. These were the first records for Sardinian waters.

Out of the 132 censused sites in MPA Tavolara, 73 were surveyed between October 2016 and January 2020. They are distributed in a substantially homogeneous area with granite rock boulders of limited extension, surrounded by coarse detritus, in a depth range of 35-55 m. The total area of rocky outcrops is 6.4 ha. Only one individual of *Calyx nicaeensis* was found, resulting a density of 0,15 specimens / ha.

In Apulia, the new records were 2: new specimens were observed at Santa Caterina di Nardò in 2013 (at 20 m depth in a photophylic algal environment; Table 4D) and in 2015 in a new site at Santa Maria al Bagno (among algae

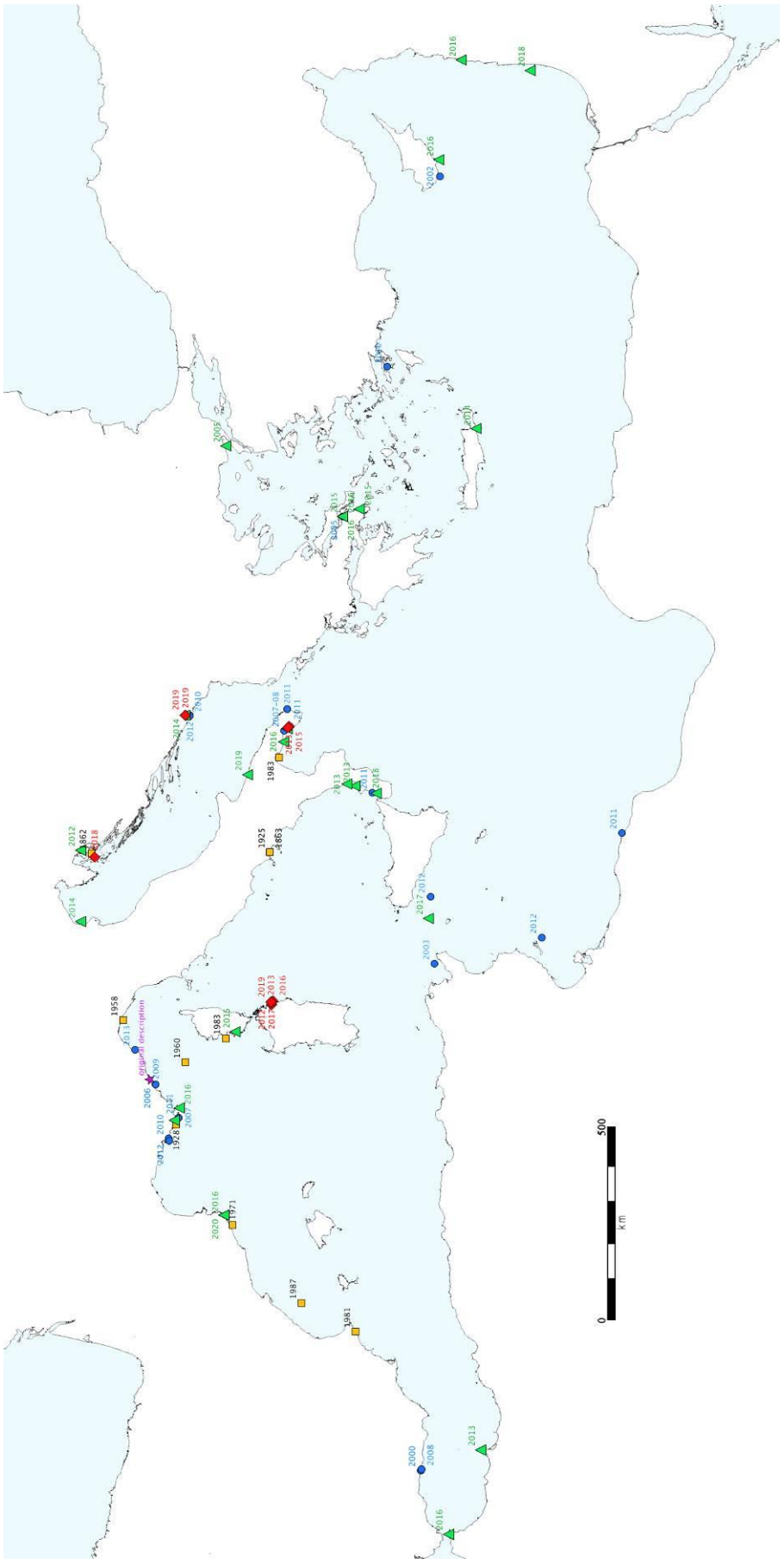


Figure 1. Distribution of old and new records of *Calyx nicaeensis* in the Mediterranean sea, since its description (1822-2020): violet star = original description; yellow squares = old bibliographical records (1862 - 1999); blue dots = old bibliographical records (2000 - 2013): green triangle = new bibliographical records (2005 - 2020); red rhombus = field records (2012 - 2019)

Table 1: Records of *Calyx nicaeensis* from old bibliography

author	year	site	nation	note	x	y
Schmidt	1862	Kvarner Gulf	Croatia		14.600000	44.900000
Balsamo & Crivelli	1863	Naples	Italy		14.274000	40.800000
Topsent	1925	Naples	Italy		14.274000	40.800000
Topsent	1928	Tolon	France	20-50m	5.866549	43.042529
Tortonese	1958	Punta Torretta, Portofino	Italy	30-40m	9.167130	44.312409
Vacelet	1960	Corsica Channel	France	335-367m	7.846961	42.866017
Rubio M	1971	Blanes	Spain		2.850142	41.622460
Benito J	1981	ltea-Calpe-Benidrom	Spain		-0.00977	38.599135
Le Granche Philippe	1983	Anse de Fico, Capo di Feno, Corse	France	wreck	8.601132	41.949318
Juan A	1987	Columbretes	Spain		0.677694	39.893881
Ocana et al	2000	P N Acantilados de Maro-Cerro Gordo	Spain		-3.764552	36.730902
Anonymous	2002		Cyprus	13-14m	32.544925	34.624360
Mustapha	2003	Zembra	Tunisia		10.784834	37.113621
Voultsiadou	2005	Aegean Sea (Kalamos, Attiki)	Greece	3-10m	23.903850	38.290140
Horst Dominique	2006	Cap Antibes	France	13m	7.126804	43.539801
Maran Vincent	2007	Sec de la Jaune Garde, Porquerolles	France	15m	6.095383	43.000728
Baldacconi	2007	Porto Cesareo	Italy	30m buds	17.884883	40.249854
Manuel Maldonado	2008	Punta de la Mona (Andalucia)	Spain		-3.730167	36.716166
Horst Dominique	2009	Cap Antibes	France	13m	7.126804	43.539801
Villechalane Marc	2010	Cap Sormiou, Marseille	France	18m	5.428163	43.202787
Vesna Maci6	2010	Lustica Peninsula	Montenegro	10m	18.633677	42.363898
Vesna Maci6	2010	Lustica Peninsula	Montenegro	10m	18.655541	42.370510
Demir & Okus	2010	Datca Bozburun SPA	Turkey		27.827126	36.700123
Baldacconi	2010	Nardò	Italy	3m	17.959875	40.157674
Anonymous	2011	Al Khums	Lybia		14.273348	32.692884
Andre Frédéric	2011	Sec de la Jaune Garde, Porquerolles	France	18m	6.095383	43.000728
Baldacconi	2011	Palmi	Italy	30m buds	15.833008	38.365444
Vitale	2011	Otranto	Italy	10m	18,517067	40,135342
Vitale	2011	Otranto	Italy	18m	18,517067	40,135342
Andre Frédéric	2011	Sec de la Jaune Garde, Porquerolles	France	18 m (necrotic)	6.095383	43.000728
Molinari & Bernat	2011	Lustica Peninsula	Montenegro	14m	18.654112	42.366764
Lakhrach et al	2012	SE Kerkennah	Tunisia	35-45m	11.460471	34.625222
Hollebecq Celine	2012	ile de Jarre, Marseille	France	8m	5.361528	43.195907
Macic & Molinari	2012	Lustica Peninsula	Montenegro	12m	18.633164	42.362641
Greenpeace	2012	Banco Avventura, Sicily Channel	Italy	47-50 m	12.716112	37.165087
Cerrano C.	2013	Gallinara Island	Italy		8.230426	44.024941

at 10 m depth; Table 4E). This record was a large assemblage of distinct cups. In 2019 the same specimen was observed damaged and reduced (F.Vitale, personal communication). Also in Baia di Torre Uluzzu site (Nardò) another specimen previously reported in 2010-12 was documented in 2013 and 2015, offering the opportunity to observe first its growth and, in 2015, its rapid degradation and necrosis in correspondence with an event of mortality which in the vicinity affected numerous specimens of *Petrosia ficiformis* and a broad coverage of *Parazoanthus axinellae* (Table 5).

In Montenegro, three new specimens were recorded in two sites close to each other: one in the first (multi-cup shaped, 18 m depth; Table 4F) and two in the second (one multi-cup shaped, Table 4G; 21 m depth).

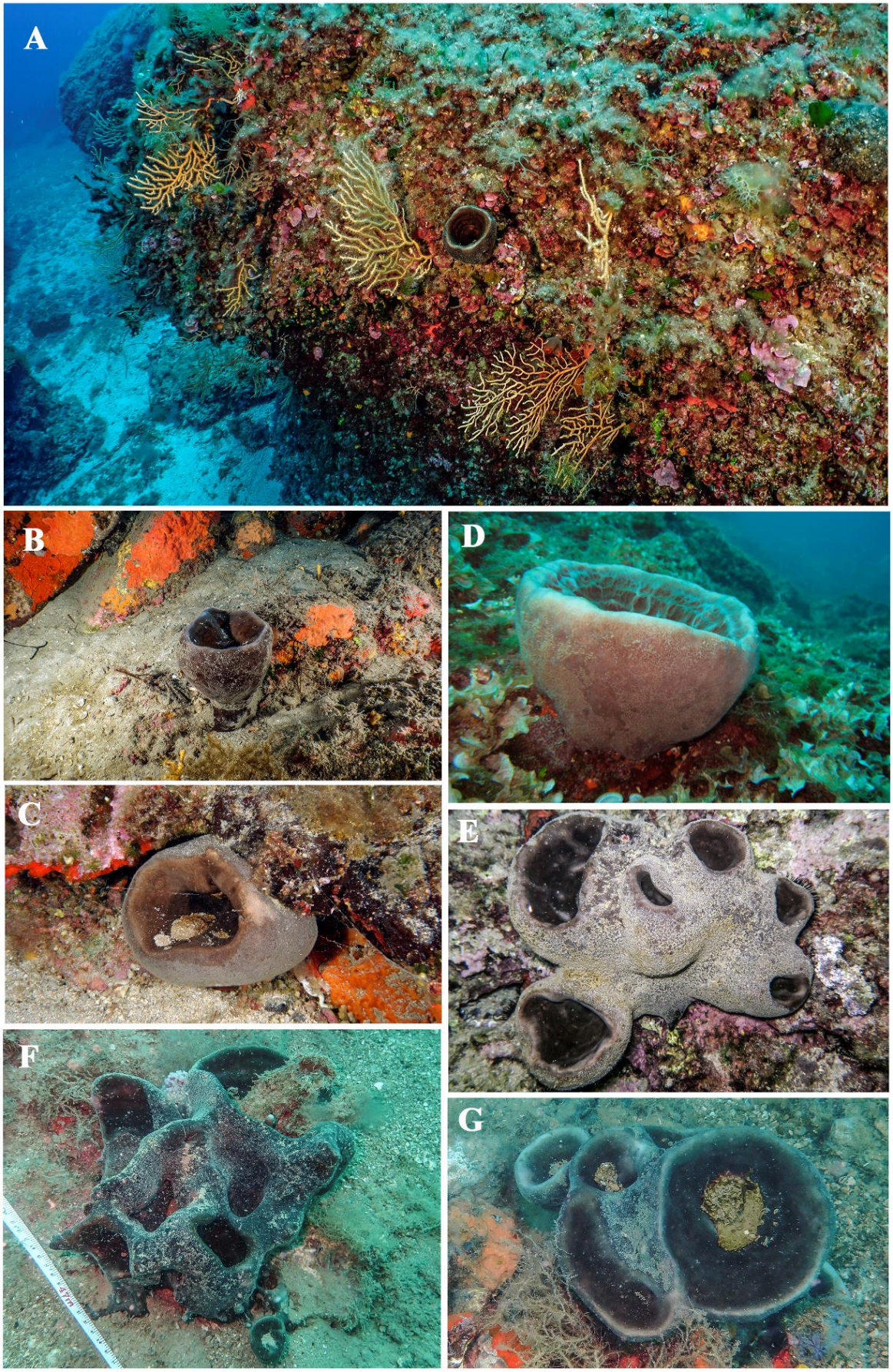
Table 2: New bibliography on *Calyx nicaeensis* up to 2020

author	year	site	nation	note	x	y
Çayalarba?i Z.,	2005	Saros Bay, North Aegean sea	Turkey		26.536065	40.590010
Frijsinger & Vestjens	2012	Kvarner Gulf, Selce	Croatia	web	14.720522	45.150067
Bertolino et al.	2013	Vibo Marina, Calabria	Italy	90-125m common	16.065282	38.745192
Bertolino et al.	2013	Capo Suvero, Calabria	Italy	90-125m common	16.133988	38.931404
CAR-ASP	2013	Cap des Trois Fouches	Morocco		-2.973544	35.441302
Gerovasileiu et al.	2014	Lasithi, Creta	Grecia	10-30 m necrosis	25.698728	34.999762
Mescalchin P.	2014	Tegnue di Chioggia	Italy	1 es.	12.394444	45.236111
Macic & Trainito	2014	Verige Strait, Boka Kotorska	Montenegro	2 es.	18.686401	42.473903
Rek M.	2015	Porto Pollo, Corse	France	web	8.798511	41.728709
Iliopoulos Y.	2015	Kalamos, Attica	Greece	web	23.903850	38.290140
Iliopoulos Y.	2015	Porto Rafti, Attica	Greece	web	24.032542	37.884454
CAR-ASP	2016	Jebel Moussa	Morocco		-5.429098	35.910558
Oceana	2016	Sayniq Canyon	Lebanon	>10 es. 78-83m	35.333333	33.550000
Iliopoulos Y.	2016	Kalamos, Attica	Greece	buds	23.903850	38.290140
Toumpaniaris	2016	Kalamos, Attica	Greece	buds	23.903850	38.290140
Aristeidou K.	2016	Akrotiri	Cyprus	1 es buds	32.971279	34.568702
Vilanova J.	2016	Palamos, Girona, Catalunja	Spain	1 es	3.131686	41.841255
Riondet JM	2016	Le Pradet, Provence	France	1 es (same in 2019)	6.013099	43.097858
Laterza N.	2016	Campomarino di Maruggio, Apulia	Italy	1 es.	17.563578	40.294821
Quintin C.	2016	Port Cors, La Gabiniere	France	1 es.	6.394905	42.986530
Massi & Titone	2017	Banco Avventura, Sicily Channel	Italy	78-84m	12.095000	37.232667
Idan et al.	2018	Herzliya deep	Israel	95-120 m 35 es.	34.633060	32.17710
Longo et al.	2018	Torre Inserraglio, Apulia	Italy	Shallow	17.925000	40.177600
Vicari D.	2018	Secca di Gramà, Bagnara Calabra	Italy	1 es.	15.798400	38.285500
Terlizzi	2019	Giovinazzo	Italy	14m, coralligenous, buds	16.675173	41.191878
Pescaire B.	2020	Palamos, Girona, Catalunja	Spain	1 es	3.131686	41.841255

Table 3: New records of *Calyx nicaeensis* from field research (2012-2019)

author	year	site	nation	note	x	y
Trainito	2012	Isola Cavalli, Tavolara MPA	Italy	1 es. 4m detritic	9.639492	40.886384
Baldacconi	2013	Santa Caterina, Nardò, Apulia	Italy	0h 20m 0s	17.976618	40.140533
Trainito	2013	Occhio di Dio, Tavolara MPA	Italy	1 es. 18m precoralligenous	9.707200	40.896533
Baldacconi	2015	Santa Maria al Bagno, Apulia	Italy	10 m, photophylous algae, buds	17.994058	40.127972
Baldacconi	2015	Baia di Torre Uluzzu, Nardò, Apulia	Italy	2 m, necrotic	17.959875	40.157674
Trainito	2016	Secca Aquarius, Tavolara MPA	Italy	1 es. 43m	9.752614	40.850809
Trainito	2017	Secca NEW106, Tavolara MPA	Italy	1 es. 40m	9.716857	40.883703
Faresi	2018	Orlec, Kres island	Croatia	1 specimen	14.462762	44.834080
Trainito	2019	Occhio di Dio, Tavolara MPA	Italy	1 es. 16m precoralligenous	9.707200	40.896533
Macic	2019	Opatovo	Montenegro	2 specimen 18 m	18.682083	42.461841
Macic	2019	Opatovo	Montenegro	1 specimen 21 m	18.682538	42.461424

Table 4 : A-B-C Tavolara MPA; D-E Apulia; F-G Montenegro



In Orlec, Kres Island (Croatia) a single individual was recorded in 2018 (L. Faresi personal communication). In total, the new records highlighted from bibliographic and field research reached 42 specimens (Figure 1).

Necrotic individuals were reported only in recent years: in 2011 in Porquerolles, France (Cerrano et al., 2013)), in 2014 in Lasithi, Greece (Gerovasileiu et al. 2018) and in 2015 in Baia di Torre Uluzzu, Italy (this paper).

A decrease of the species was reported in the Ligurian Sea in the years 1950-1990, but unsupported by reliable data (Morri & Bianchi, 2001). Bertolino et al. (2013) reported a mass mortality event of *C. nicaeensis* within 50 m depth in the Eastern Ligurian Sea, but not supported by data. In turn, on the web referring to no diseased specimens were reported in 2018 in the Turkish waters on the web (Oztuerk, 2018), unlike in previous years, but without further indications.

The species is commonly considered rare and rarefying at a general and local scale (Cerrano et al. 2013; Cinque Terre MPA, 2017; Grenier et al, 2018); in turn it was considered common in the whole Mediterranean (Topsent, 1928; Riedl, 1991) and recently in two sites in the Gulf of S. Eufemia (Bertolino et al. 2013).

Where the spatial distribution has been measured the results are quite different: in the Levantine Sea, at 95-120 m depth, 0,5 specimens m^{-2} were recorded (Idan et al., 2018), while in Tunisia they were 0,15 specimens ha^{-2} (El Lakhrak et al. 2012), a value which is consistent with the data from Tavolara MPA here reported.

The depth range at which the species was found varied from 2 m to 367 m: 33 records were in the range 2-40 m (infralittoral zone) and seven were in the range 41-200 (circalittoral zone). The deeper record down to 200 m (bathyal zone) was observed on a deposition bottom with ripped off algae and most animals not in place (Vacelet, 1960). Most of the records reported single-cup specimens and only six records were referred to multi-cup specimens.

Table 5 : Growth and decay of the specimen from Baia di Torre Uluzzu (Apulia) in lateral and front view

DISCUSSION

Old and new data allowed to trace an identikit of *Calyx nicaeensis* in the Mediterranean Sea which can be summarized as follows:

1. **Chronically rare**: it was confirmed by the lack of concentration sites, by the exiguous number of individuals both at local and basin scale. This was confirmed by the distribution of the records in time and space. The substantial correspondence in density between Tunisia and AMP Tavolara at a similar depth range confirmed the rarity. Together with its main distribution in the infralittoral zone, its rarity makes it difficult to understand how the species can be defined as structuring to assess the status of coralligenous habitats (Minambiente, 2017).

Being a charismatic species for enthusiast divers, we could have expected a growth of records in recent years. In fact, the diffusion of recreational diving in a broader range and the increase in documentation debt to technological factors (i.e. digital underwater photography), to the use of social media and the diffusion of programs of citizen science have brought important contributes to the knowledge of biology and distribution of poorly known groups of organisms (Cosquer et al., 2012; Bodilis et al. 2013; Gerovasileiu et al., 2018; Kleitou et al., 2019; Earp and Liconti, 2020; Furfaro et al., 2020). This not occurred for *Calyx nicaeensis*: only 20 records in ten years come from the web by enthusiast divers.

2. **Ecologically versatile:** records come from a large range of habitats, from photophilic algae to coralligenous, from shallow caves to deep sedimentation bottoms. In Tavolara MPA, the records were both from granite and limestone substrata.

3. **Indifferent to depth**: its depth range varies from 2 m to 367 m; circalittoral records are reported with a higher density than those from the infralittoral zone. The data available in the literature is not sufficient to define whether this estimation is objective or whether it depends on the monitoring scale (Hartley & Kunin, 2003).

4. **Indifferent to geography**: its distribution range spans all over the basin, from North to South, from East to West. The apparent presence of local concentrations (S. Eufemia Gulf, Israel) may be dependent on the monitoring scale.

5. Indifferent to global warming: new records are equally distributed between cold and warm areas and the few necrosis crises were episodic or not better defined.

6. Declining or not?: at the basin scale, the lack of recent records in historical sites seems to be balanced by new records in areas previously unrecorded, and this happens in different parts of the basin without any geographical prevalence.

In summary, the species is a rare all-around generalist, with a high ecological tolerance range. Its widespread distribution may be related to its size (Idan et al. 2018): large-bodied species tend to be more widespread than smaller ones (Blackburn & Gaston, 1997). Or, it may be related to its reproductive biology in term of larval dispersion, which is poorly known at all.

The records of a few specimens formed by an assemblage of several cups and the lack of finds of specimens with detachment of parts or large specimens surrounded by other smaller ones confirm the need to deepen the knowledge on the biology of the species, also to evaluate possible and effective conservation measures.

CONCLUSIONS

Usually, rarity is associated with extinction risk, and it is a tool for conservation policies to identify species to be protected. Nevertheless, if we assess that a rare species is not vulnerable to extinction, should we consider it as negligible on the conservation side? If this was the conclusion, we would affirm a grading between the species, accentuating the anthropocentric vision that prevails not only in the western cultural mainstream but also in the communication concerning the conservation.

Local or diffusive rarity are common status for species, they may be related to chronic or transient conditions, and they may seem to play no ecological role, or, better, a role that we do not know or that we are not able to understand. What we know is that any living species has an evolutionary role (Piraino et al., 2002). We also

know that investigating the conditions for common species to be abundant is equally important as understanding the dynamics of rare species (Connolly et al., 2013).

Thus, knowledge should not have children and stepchildren and this is even more true from a conservation point of view.

The rarity combined with the contrasting and peculiar ecological characteristics of *Calyx nicaeensis*, typical of species with a high ecological tolerance range, confirm the need for its inclusion in the conservation protocols of international treaties and the importance of further in-depth studies.

AKNOWLEDGEMENTS

Fieldwork in MPA Tavolara-Punta Coda Cavallo has been possible thanks to the permission of use of GIS data by the Consorzio di Gestione. A special thank is debt to Lisa Faresi for the communication of her observation in Kres; to Mario and Maria Munaretto, Mario Romor, Miho Tsuruoka (Slow Dive) and Andrea Severino (Aquarius Diving Centre) for their help in diving activities; to Martina Canessa (University of Genoa) for her precious advices. Authors also thank Riccardo Cattaneo-Vietti (University of Genoa) for the in-depth discussion on the controversial parts of the paper and for his help in improving the manuscript. Finally, the manuscript has been improved thanks to the two propositive reviewers.

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Received: 10. 05. 2019.
Accepted: 08. 06. 2019.

All-around rare and generalist: countercurrent signals from the updated distribution of *Calyx nicaeensis* (Risso, 1826) (Porifera, Demospongiae)

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SAŽETAK

Predstavljeni su novi nalazi endemičnog mediteranskog sunđera, demospongije *Calyx nicaeensis* u zaštićenom području u moru Tavolara (Sardinia, Italia), u Pulji (Italia) i Crnoj Gori, a ček lista je dopunjena. Diskutovana je i potvrđena rijetkost vrste. Sugerisano je da bi se veća pažnja trebala posvetiti rijetkim vrstama kako bi se bolje razumjele njihove životne strategije i uloga u životnoj sredini.

Ključne riječi: *Calyx nicaeensis*, Sardinia, Pulja, Crna Gora, Sredozemno more, rijetki sunđeri