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What are you doing here? Investigating on an unexpected association in shallow Mediterranean dark caves sheds light on the diet of *Marionia blainvillea* (Mollusca, Gastropoda, Nudibranchia)

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Abstract: In a shallow dark cave along the coast of Capo Palinuro (Campania, Italy), the finding of an unusual aggregation of individuals belonging to *Marionia blainvillea* (Gastropoda, Nudibranchia) has allowed to identify a population of *Cervera atlantica* (Cnidaria, Anthozoa, Alcyonacea) and to add this latter to the list of the hosts preyed by this tritoniid nudibranch. This association was confirmed by a second observation in a dark shallow cave in the Island of San Pietro (Sardinia, Italy). Moreover, a subsequent internet data mining shed light on the diet of *M. blainvillea* adding useful ecological notes on the scarcely known trophism characterizing *Marionia* species. *Cervera atlantica* is reported for the first time along the continental coast of Italy.

Key words: *Marionia blainvillea*, *Cervera atlantica*, Palinuro cave, S. Pietro Island, Mediterranean Sea

1. Introduction

Marionia blainvillea (Risso, 1818) (Gastropoda, Heterobranchia, Nudibranchia) is a tritoniid mollusc whose distribution spans from the East Atlantic Ocean (Angola, Azores and Iberian Peninsula) to the Mediterranean Sea and from North in the Gulf of Lion to the South in Canarias (Spain), with a doubtful record from Argentina (South-West Atlantic Ocean)[1, 2] (Gofas et al., 1981, Trainito & Doneddu, 2014). *Marionia blainvillea* and *M. gemmii* Almón, Pérez & Caballer, 2018 are up to date the only two Mediterranean species of the genus *Marionia* Vayssière, 1877 (Trainito et al., 2020) that indeed includes 33 accepted species in the world[3]. For all these latter species, a diet associated with Alcyonacea (Cnidaria, Anthozoa) has been reported, but, only for few of them, the prey has been determined based on direct evidence such as documented in situ observations or analysis of the stomach content (Table). In the literature, *M. blainvillea* has been found associated with *Alcyonium acaule* Marion, 1878, *A. palmatum* Pallas, 1766, *A. coralloides* (Pallas, 1766), *Eunicella cavolini* (Koch, 1887), *E. singularis* (Esper, 1791), *Eunicella* sp., *Leptogorgia sarmentosa* (Esper, 1789), *Paramuricea clavata* (Risso, 1826), *P. grayi* (Johnson, 1861) (McDonald & Nybakken, 1999; Calado & Urgorri, 1999; Almòn et al, 2018). The records of *M. blainvillea* on *Callogorgia verticillata* (Bo et al., 2011; Ingrassia et al., 2016) have to be considered misidentifications of the recently described *Tritonia callogorgiae* Chimienti, Furfaro & Taviani, 2020 (Chimienti et al. 2020).

In 2014, one individual of *M. blainvillea* was observed (E.T. unpublished) in a shallow Mediterranean environment (5m deep, North-East Sardinia) with coarse detritus and scattered patches of *Posidonia oceanica* (Linnaeus) Delile, 1813, where the only alcyonacean detected was *Maasella edwardsii* (Lacaze-Duthiers,1888), so far not reported in bibliography as a possible prey. *Cervera atlantica* (Johnson, 1861) (Alcyonacea, Clavulariidae) is a rarely observed species, described from the Atlantic island of Madeira, and whose known distribution spans North to England, South to the Canary Islands and East in the Mediterranean. In the Mediterranean Sea, it has been reported so far in only nine localities (Trainito & Baldacconi, 2016; Torchia et al, 2016). This alcyonacean species lives under stones (Trainito & Baldacconi, 2016), in rock fissures and caves in intertidal and upper infralittoral areas (Weinberg, 1978; Lopez-Gonzaléz, 1995; Williams, 1996). *Cervera atlantica* is hard to be seen in nature being its colonies small and cryptic.

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Table. List of worldwide valid species of the genus *Marionia* and the bibliographical associated alcyonacean species with indications on the existence/absence of evidence about predatory relationships among them. The asterisk (*) indicates data from the original descriptions and/or from McDonald & Nybakken (1999).

Species	**Associated species in bibliography**	**Proofs of predation**
Marionia abrahamorum Silva, Herrero-Barrencua, Pola, Cervera 2019	Unidentified gorgonian	No proof
Marionia albotuberculata Eliot, 1904	Not known	----------
Marionia arborescens Bergh, 1890	*Xenia* sp. (Xeniidae) in Gosliner, 1987	No proof
Marionia babai (Odhner, 1936)	Not known	----------
Marionia bathycarolinensis V. G. Smith & Gosliner, 2005	*Paracis* sp. (Plexauridae)	*Analysis of the stomach content
Marionia blainvillea (Risso, 1818)	*Alcyonium acaule*, *A. palmatum, A. coralloides* (Alcyoniidae), *Eunicella cavolinii*, *E. singularis*, *Eunicella* sp., *Leptogorgia sarmentosa*, *Paramuricea clavata, P. grayi* (Gorgoniidae)	*Proof for *Maasella edwardsii* and *Cervera atlantica*, present paper
Marionia cabindae White, 1955	Not known	----------
Marionia chloanthes Bergh, 1902	Red Alcyonarian	*Analysis of the stomach content
Marionia cucullata (Couthouy, 1852)	Alcyonarians	No proof
Marionia cyanobranchiata (Rüppell & Leuckart, 1828)	Soft corals	No proof
Marionia dakini (O'Donoghue, 1924)	Not known	No proof
Marionia distincta Bergh, 1905	Not known	No proof
Marionia echinomuriceae Jensen, 1994	*Echinomuricea indomalaccensis* (Plexauridae)	No proof
Marionia elongoreticulata V. G. Smith & Gosliner, 2007	*Ellisella* sp. (Plexauridae)	*Detection of octocoral sclerites?
Marionia elongoviridis V. G. Smith & Gosliner, 2007	*Ellisella* sp. (Plexauridae)	*Detection of octocoral sclerites?
Marionia gemmii Almón, Pérez & Caballer, 2018	*Leptogorgia sarmentosa*	*Damage on host and stomach content
Marionia ghanensis Edmunds & Carmona, 2017	Not known	No proof
Marionia glama (Rüppell & Leuckart, 1828)	Soft corals	No proof
Marionia hawaiiensis (Pease, 1860)	*Anthelia edmonsoni* (Xenidae) in Angulo-Campillo & Bertsch, 2013	Angulo-Campillo & Bertsch, 2013
Marionia kinoi Angulo-Campillo & Bertsch, 2013	Not known	No proof
Marionia levis Eliot, 1904	*Rhytisma fulvum* (Forskal, 1775) (Alcyoniidae) in Avila, Keldman, Kashman & Benayahu, 1999	Avila, Keldman, Kashman & Benayahu,1999
Marionia limceana De Vasconcelos Silva, De Meirelles 2013	*Stragulum bicolor* Ofwegon & Haddad, 2011 (Clavulariidae)	*Polyps were found, often intact, inside the esophagus and the stomach
Marionia olivacea Baba, 1937	Not known	No proof
Marionia pellucida Eliot, 1904	Not known	No proof
Marionia platyctenea (Willan, 1988)	*Parerythropodium hicksoni* Utinomi, 1972 (Alcyoniidae)	No proof
Marionia pusa Er. Marcus & Ev. Marcus, 1968	Not known	No proof
Marionia pustulosa Odhner, 1936	Not known	No proof
Marionia rubra (Rüppell & Leuckart, 1828)	Soft corals	No proof
Marionia ramosa Eliot, 1904	Not known	No proof
Marionia semperi Jensen, 1994	Not known	No proof
Marionia tedi Ev. Marcus, 1983	Not known	No proof
Marionia vanira Ev. Marcus & Er. Marcus, 1966	Not known	No proof
Marionia viridescens Eliot, 1904	Not known	No proof

The aim of this study is to report for the first time the presence of *C. atlantica* along the continental Italian coast and to document the previously not known trophic relationship between *M. blainvillea*, *M. edwardsii* and *C. atlantica*.

2. Materials and methods

Two scuba dives were conducted by M.F. in July 2020 at Capo Palinuro (Campania, Italy) into a cave named 'La Cattedrale 1' at 1.5 m depth (Bianchi & Morri, 1994; Cicogna et al., 2003; Catasto Grotte Campania n° 55) (Figure 1). Benthic and vagile faunas were observed and photographed with a Sea & Sea 2G camera equipped with Sea & Sea YS D1 strobes and Nauticam CMC1 macro lens. Snorkelling surveys were conducted by E.M. in 2021 into an unnamed and unregistered cave near Punta dei Cannoni at San Pietro Island (Sardinia, Italy) at 0.8 m depth. The cave is always semi-submerged, and the narrow entrance leads to the internal cavity that goes into the rock for about 30 m, with a maximum width of about 15 m. The depth is 30–50 cm at the entrance and reaches its maximum in the central area where it is just over 1 m. The bottom is covered with rounded boulders and ends in the innermost area with a small beach of dark sediment. Benthic and vagile faunas were observed and photographed with the Olympus TG6 camera equipped with a mini strobe. In addition to the bibliographic research to identify the trophic relationships of *M. blainvillea*, an in-depth internet and social media data mining was conducted using the keywords *Marionia* and *Marionia blainvillea* to identify the possible existence of images documenting a direct and obvious predator-prey relationship of the nudibranch with the substrate. Post-production on photos has been performed with Photoshop CS 6 and Camera Raw.

3. Results

In Palinuro, at a distance in a range of 20–40 m from the entrance into 'La Cattedrale 1' cave, seven individuals of *Marionia blainvillea* were found in the typical biocenosis of the caves and tunnels in total darkness (Peres & Picard, 1964; Morri & Bianchi, 2003) (Figure 2). The cave corresponds to the type B in the morphological typing in Gerovasileiou & Bianchi (2021). All the nudibranchs observed were crawling on the walls, in a benthic community characterized by few small sponges, polychaete serpulids, bryozoans, brachiopods and foraminifera, all of which with very low coverage. None of the species so far considered as component of the diet of *M. blainvillea* were detected (Figure 3). Photographs of the nudibranchs and of the surrounding environment revealed the presence of the stolons of *Cervera atlantica*

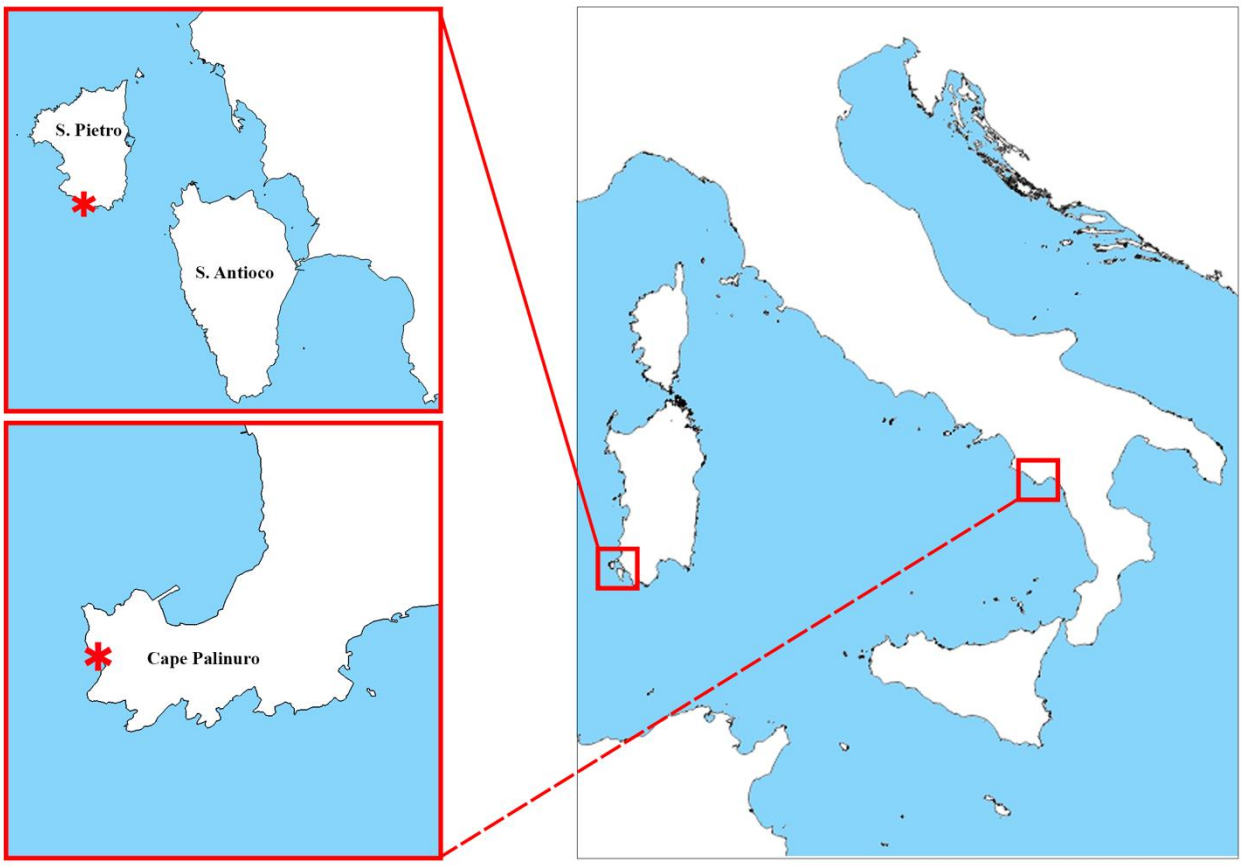

Figure 1. Geographical framework. On the left: top, the San Pietro Island; bottom, the Capo Palinuro Peninsula. Red stars indicate the locations of the caves.

with retracted polyps, whose shape and colour are characteristic and allow distinguishing it from other Clavulariidae species unequivocally. In fact, the presence of *C. atlantica* was clearly documented (Figure 3d) as well as the trophic association with *M. blainvillea*, found on the stolons and polyps of this alcyonacean (Figure 3c).

In San Pietro, at the distance of 25 m from the entrance of the cave [type B, Gerovasileiu & Bianchi (2021)], one individual of *Marionia blainvillea* was found in the typical biocenosis of the caves and tunnels in total darkness (Figure 2b). The nudibranch was in the proximity of the stolons and the retracted polyps of *C. atlantica*, cryptically mingled with small calcareous sponges and polychaete serpulids. Also in this second observation, examining the photos of the surrounding environment, none of the species so far considered as component of the diet of *M. blainvillea* were detected (Figure 3e).

The analysis of the images found on the internet[4] made it possible to identify one photograph[4] that portrays the nudibranch *M. blainvillea* in the unequivocal act of preying on *Maasella edwardsii* (Figure 3b), in south France, at 9 m depth.

4. Discussion

The members of the Tritoniidae family feed on octocorals (Smith & Gosliner, 2003), and, among them, only the species of the genus *Marionia* have the midgut gland, which forms two complexes and a stomach with a series

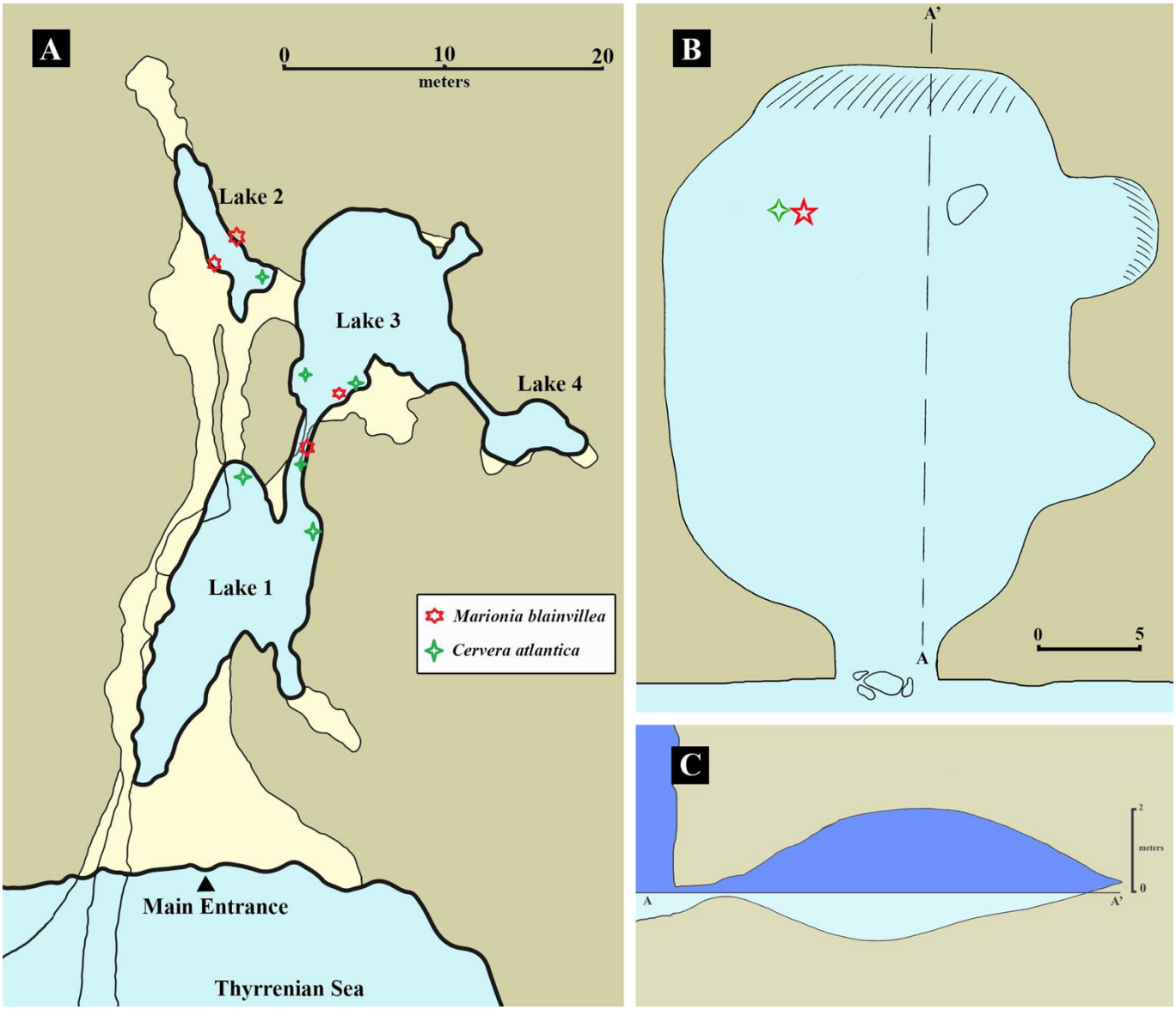

Figure 2. a. Simplified plan of the 'Cattedrale 1' cave. The limits of the submerged cave are indicated in light yellow, and the aerial chambers of the cave are in light blue (Modified and simplified from Alvisi M. and Barbieri F., 1994); **b.** Simplified plan of the San Pietro cave; **c.** longitudinal section of the cave. Records of *M. blainvillea* are pointed out by red stars and *C. atlantica* by green stars.

[4] Bielecki JP (2001). Website http://www.seaslugforum.net/message/5786 [accessed 20 07 20].

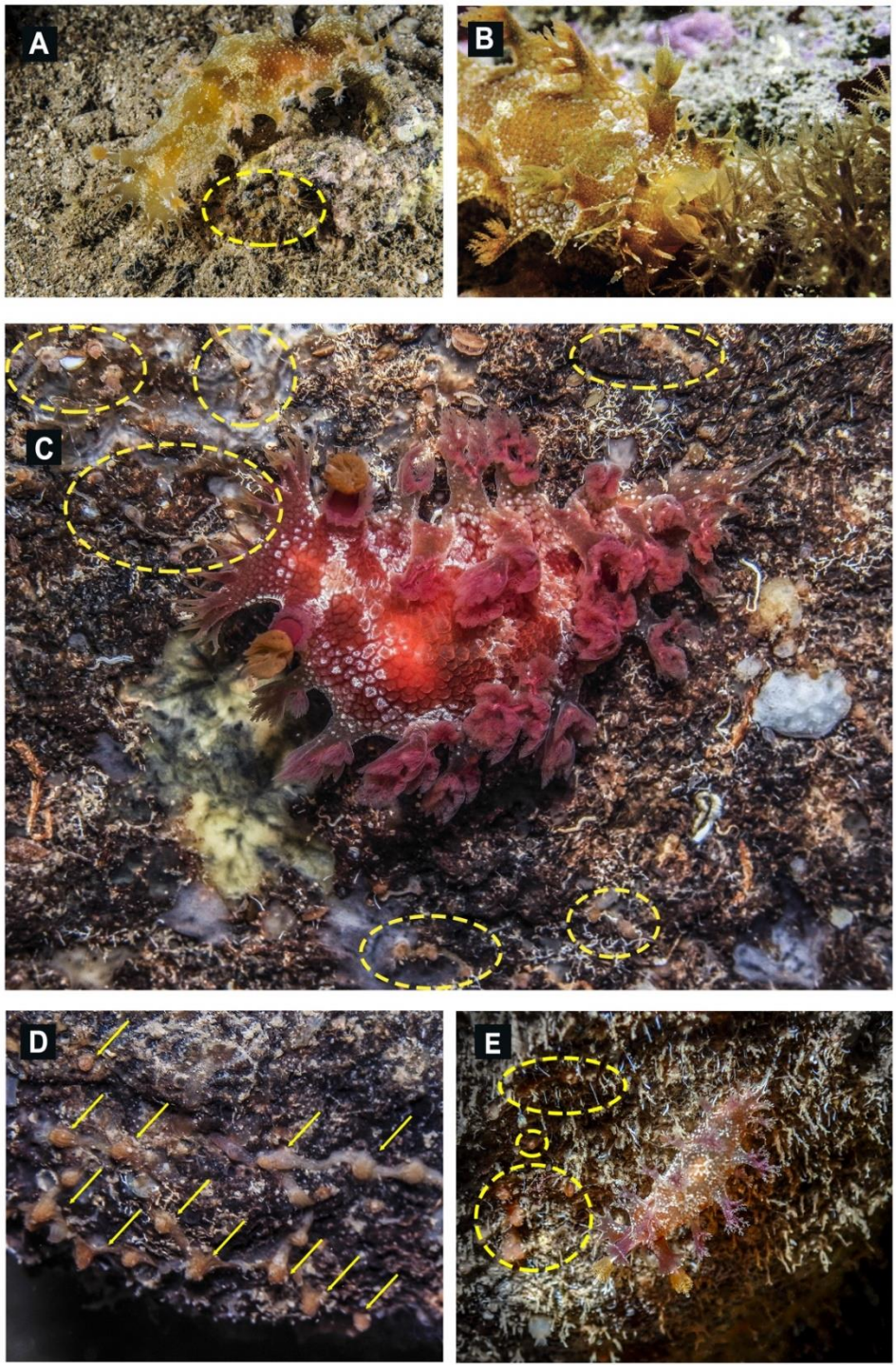

Figure 3. a. *Marionia blainvillea* in proximity of *Maasella edwardsii* (yellow circles) (Mediterranean, Golfo Aranci, Sardinia, Italy, photo E.T.); **b.** *M. blainvillea* in the act of preying *M. edwardsii* (Mediterranean, La grande Motte, France, photo J.P. Bielecki); **c.** *M. blainvillea* on stolons and polyps of *C. atlantica*, surrounded by other colonies of the alcyonacean (yellow circles) (Mediterranean, 'Cattedrale 1' cave, Capo Palinuro, Campania Italy, photo M.F.); **d.** Stolons and polyps (yellow arrows) of *Cervera atlantica* (Mediterranean, 'Cattedrale 1' cave, Capo Palinuro, Campania, Italy, photo M.F.); **e.** *M. blainvillea* preying on stolons and polyps (yellow circles) of *C. atlantica* (Mediterranean, San Pietro cave, Sardinia, Italy, photo E.M.).

of inwardly projecting, parallel chitin plates. These latter typical morphological structures seem to be related to the diet, but only few authors have deepened the feeding habits of the different species of the genus (Table). In particular, as highlighted in Table 1, there is evidence of direct predation of the octocoral host only for a few *Marionia* species. Smith and Gosliner (2003, 2005, 2007) remarked the feeding specificity of tritoniids as limited to a single or a small group of species. Because of this specificity, Angulo-Campillo & Bertsh (2013)

Figure 4. Updated distribution of *Cervera atlantica* in Mediterranean. Yellow dots: records of *C. atlantica* from literature; red star: present paper.

distinguished *M. kinoi* from *M. hawaiiensis* and *M. bathycarolinensis* pointing out, among other characters, the absence of their prey from the area of distribution of the former.

The feeding specificity of tritoniids, in more recent times, has been discussed and seems more an exception, than a rule (García-Matucheski & Munian, 2011, Furfaro et al., 2017) possibly due to a gap in the knowledge of such small and cryptic organisms. In the case of the species of the genus *Marionia*, the determination of the prey has been based on analysis of the stomach content in only four species, while, for all the others, the prey is indirectly inferred based on the association with octocorals or not stated at all (Table 1).

M. blainvillea, as previously reported, has been associated with eight different alcyonaceans, and *M. edwardsii* (Alcyonacea, Paralcyonidae) was not included among them: the in situ picture (Bielecki, 2001) depicting *M. blainvillea* in the act of preying allows to unequivocally define *M. edwardsii* as part of the nudibranch's diet. It is relevant that both the Sardinian and the French specimens, associated with *M. edwardsii*, show the same lighter color than the more common red one, suggesting that color may depend on the diet.

The discovery of a small population of *M. blainvillea* in the shallow cave in Palinuro, corroborated by the finding of an individual in S. Pietro shallow cave, both in the totally dark environment, is evidence of the association between this tritoniid and *C. atlantica* that was the only possible food resource for the nudibranchs, which indeed have been photographed on it. No other octocorals were detected inside the caves; outside the Palinuro cave, only few *Eunicella cavolini* were spotted at a great distance, thus, confirming the absence of other potential preys and confirming the assessment that *C. atlantica* is a trophic resource of *M. blainvillea.*

5. Conclusion

The direct observations and the photographs taken during this study show that there is a trophic relationship between *Marionia blainvillea* and the octocorals, *Maasella edwardsii* and *Cervera atlantica,* and, therefore, both species are to be added to the list of preys associated with this tritoniid nudibranch. For *Cervera atlantica,* the records reported here also suggest that it is much less rare than previously believed. The scarcity of records reported until now could depend not only on being difficult to be spotted with the naked eye, but also on the extreme fragility of its tissues, the absence of spicules, and the marginality of the habitats where it is usually located. Furthermore, the observations reported here confirm for the first time the presence of *C. atlantica* in the Italian mainland coast, since it was previously reported only from the North-Eastern coast of Sardinia (Tyrrhenian Sea) (Trainito & Baldacconi, 2016); furthermore, its distribution along the coast of Sardinia is expanded, and the biocenosis of dark caves and tunnels is added to the elective habitats of the species. This report and the one from North Tunisia (Torchia et al., 2016) fill a further knowledge gap in the Mediterranean distribution of the species (Figure 4). Finally, social media data mining is confirmed as a powerful tool for the collection of decisive information on topics that tend to be neglected in mainstream research fields (Manunza et al., 2020).

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