

# Recruitment of the Basket Star *Astrospartus mediterraneus* (Risso, 1826) (Ophiuroidea, Gorgonocephalidae)

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**Abstract:** The occurrence and abundance of *Astrospartus mediterraneus* (Risso, 1826) have significantly increased in the last three decades in several areas of the Mediterranean Sea. In the Tavolara–Punta Coda Cavallo Marine Protected Area (NE Sardinia, Tyrrhenian Sea, Mediterranean Sea), 60 specimens were observed mainly on the granitic shoals of the Tavolara Channel, an area characterized by very intense currents and high sedimentation. The basket stars were mainly found living as epibionts of gorgonians (*Eunicella verrucosa*, *Paramuricea clavata* and *Leptogorgia sarmentosa*) and massive sponges (*Spongia officinalis*, *S. lamella*, *Sarcotragus foetidus*). We also documented 21 small specimens (3–20 mm in diameter of the oral disc) observed in June 2024 between 27 and 52 m depth on *E. verrucosa* and *P. clavata* colonies. The bimodal size–frequency distribution of these specimens suggested that, probably, specimens belong to two different reproductive events occurring in spring 2023 and 2024.

**Keywords:** ophiuroid; passive filter-feeder; recruit; longevity; Mediterranean Sea



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## 1. Introduction

During the last decades, the number of observations of the brittle star *Astrospartus mediterraneus* (Risso, 1826) in the Mediterranean Sea has significantly grown, thanks to SCUBA diver and sightings, citizen reports, as well as huge catches by the artisanal fishery [1–4]. Having been generally considered rare in many areas of the basin, such a long-term increase in records might assign to this basket star the putative role of a winner species in the context of climate changes [1,2]. These variations showed a strong correlation with rainfall amounts that, in oligotrophic waters such as those of the Western Mediterranean Sea, represent an important organic matter input for these passive filter feeders, especially in the summertime [1]. The basket star was generally observed as acrophilic species on gorgonians (*Eunicella cavolini* (Koch, 1887), *E. verrucosa* (Pallas, 1766), *Paramuricea clavata* (Risso, 1827), and *Leptogorgia sarmentosa* (Esper, 1791)) and massive sponges (*Aplysina cavernicola* (Vacelet, 1959), *Sarcotragus foetidus* Schmidt, 1862, *Spongia lamella* (Schulze, 1879), and *Axinella polypoides* Schmidt, 1862).

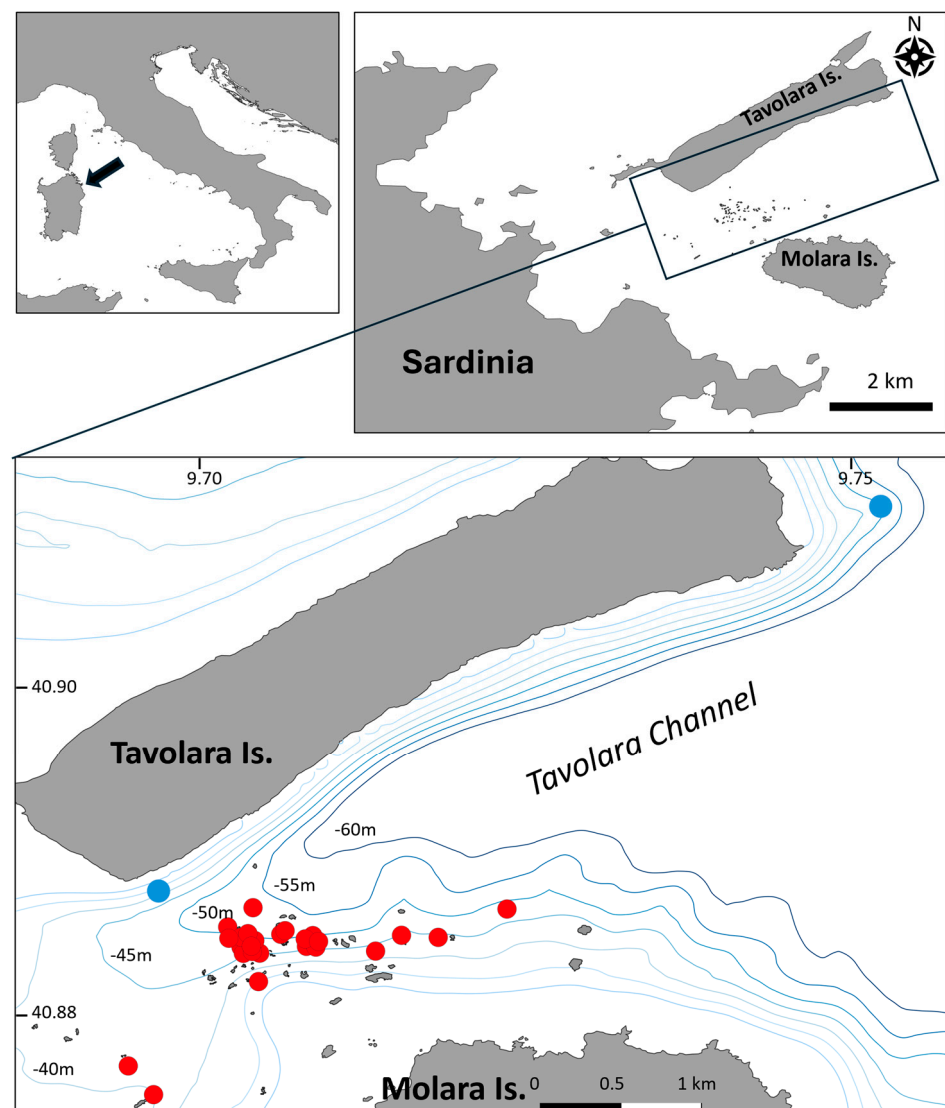
In particular, blooms were observed in 2018 as part of the bycatch of local artisanal fishers in the Cap de Creus area (NW Mediterranean Sea) [3]. Indeed, anglers reported that this species had increased in abundance and expanded its distribution in recent years, ultimately interfering with their fishing activity. Furthermore, they unanimously consider this proliferation a considerable handicap in terms of time and monetary losses [4]. Additionally, the average size of the central oral disks of the specimens present in the bycatch ( $2.67 \pm 0.97$  cm), suggests that this is a young population, which could be linked

with the beginning of a massive outbreak [4]. This putative outbreak could be related to the intense reproductive activity of the species. Nevertheless, until now, no evidence about the reproduction and recruitment of *A. mediterraneus* has been documented.

This study aimed to describe the distribution of this basket star in the Tavolara-Punta Coda Cavallo Marine Protected Area (TPCCMPA) (NE Sardinia, Tyrrhenian Sea, Mediterranean Sea) with the record of a recruitment episode occurring during June 2024.

## 2. Materials and Methods

The presence of *Astrospartus mediterraneus* was reconstructed in the TPCCMPA by the data obtained by the exploration of 89 rocky shoals arising from the detritic bottom of the Tavolara Channel between 27 and 54 m depth (Figure 1) [5]. The shoal surface varied from 150 to 1403 m<sup>2</sup> (Table 1). SCUBA diving explorations were conducted between 2017 and 2024 to explore each granitic outcrop thoroughly. A single shoal was explored and documented during each dive by photographic sampling. All the specimens of *A. mediterraneus* were counted and their host was recorded. Finally, the gastral content of two collected specimens was studied.



**Figure 1.** Location (black arrow) of the study area within the Tavolara-Punta Coda Cavallo Marine Protected Area and the distribution of *Astrospartus mediterraneus* (red dots, granitic sites; blue dots, limestone sites).

**Table 1.** Explored sites with records of the presence of *Astrospartus mediterraneus* and the number of specimens found per host.

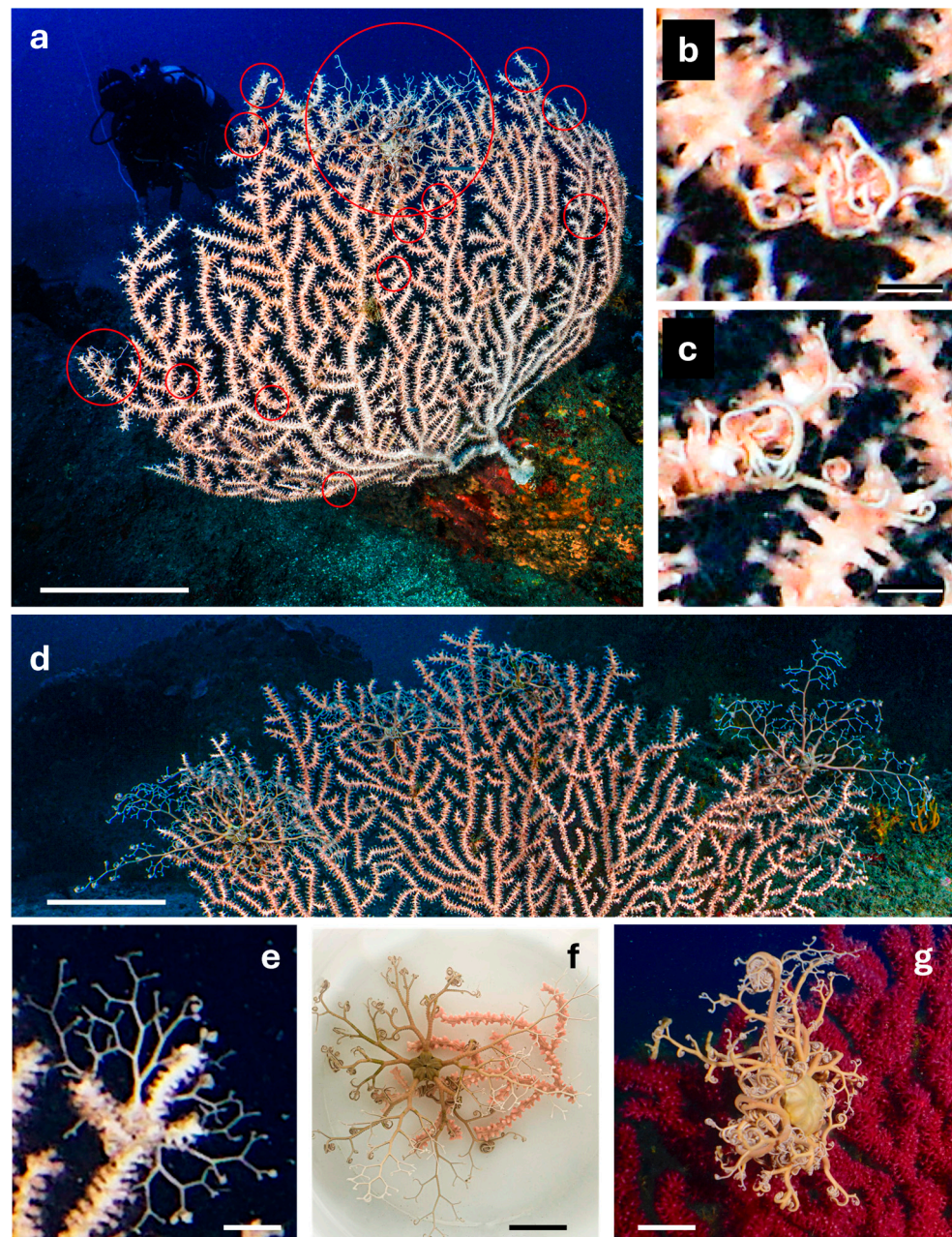
Site ID	Lat (N)	Long (E)	Area (m <sup>2</sup> )	Depth Range (m)	<i>E. cavolini</i>	<i>E. singularis</i>	<i>E. verrucosa</i>	<i>L. sarmentosa</i>	<i>P. clavata</i>	<i>S. foetidus</i>	<i>S. lamella</i>
Picchi Mandria Shoal	9.6952	40.8872	450	27–39	1						
NEW26	9.7027	40.8826	464	36					1		
NEW27	9.7013	40.8830	868	39					2		
NEW28	9.7003	40.8845	1403	43					1	2	1
NEW29	9.7023	40.8835	432	42					1		
NEW32	9.7042	40.8840	165	46			1			1	
NEW37	9.6930	40.8743	987	35		1					
NEW50	9.7158	40.8837	475	36–45				1			
NEW64	9.7026	40.8805	153	27–39	1						
NEW75	9.7015	40.8826	410	40				1			
NEW41C	9.6949	40.8722	930	45				1			
NEW99	9.7013	40.8838	901	45–52			20		1		
NEW100	9.7021	40.8827	853	38			1				
NEW104	9.7131	40.8839	1151	40–45		1					
NEW108	9.7209	40.8858	490	40–46					2		
NEW110	9.7484	40.9157	137	48					4		
NEW117	9.7004	40.8837	250	46					1		
NEW118	9.7018	40.8840	370	47		1	1			1	1
NEW140	9.7061	40.8831	496	42			1				
NEW148	9.7022	40.8859	132	48–54		1			1		
NEW150	9.7021	40.8831	92	43–49					1		
NEW151	9.7068	40.8830	114	38–46					1		
NEW159	9.7045	40.8842	207	48–54			1				
NEW160	9.7066	40.8839	716	44–49					1		
NEW161	9.7060	40.8836	130	44–49		1					
NEW165	9.7070	40.8835	150	44–48						1	
NEW179	9.7112	40.8827	40	40–45						1	

In June 2024, unusually small specimens of *A. mediterraneus* were observed at three sites within the TPCCMPA, particularly at the shoal “NEW99” at 52 m depth in the Tavolara Channel. The rocky substrate at NEW99 is formed by a central relief that extends for about 62 m in NE-SW direction with long fractures oriented in the same direction, sometimes filled with sediment and sparse small rocky blocks. The animal component of the elevated layer is mainly composed of large sponges (*Sarcotragus foetidus*, *Spongia lamella*, and *S. officinalis*) together with several colonies of *Paramuricea clavata* and 6 specimens of *Eunicella verrucosa*. The gorgonians hosting juveniles were photographed together with a centimetric reference. The images were analyzed using the ImageJ free software 1.53k version to obtain the specimen disk size, as the distance from the distal tip of the radial to the opposing disc interradius edge on the aboral side.

### 3. Results

At TPCCMPA, *Astrospartus mediterraneus* occurred in the Tavolara Channel between 27 and 52 m depth. The species was found in 27 shoals (30% of the explored sites) (Figure 1); in total, 60 individuals were recorded, mainly living as epibionts of the gorgonians *Paramuricea clavata* (17 specimens) and *Eunicella verrucosa* (25 specimens), more rarely on *E. cavolini*, *Leptogorgia sarmentosa*, and the demosponges *Sarcotragus foetidus* and *Spongia lamella* (Table 1; Figure 1). A colony of *L. sarmentosa* recorded in the shoal NEW75 was monitored for eight years and showed a specimen of *A. mediterraneus* always in the same position.

At the shoal NEW99 between 21 and 24 June 2024, we found four colonies of *E. verrucosa* (one, partially broken and covered by *Alcyonium coralloides* (Pallas, 1766)) and one of *P. clavata* hosting 21 small specimens (3–20 mm in diameter of the oral disc) of the basket star (Figure 2a).



**Figure 2.** Recruitment event of *Astrospartus mediterraneus*. (a) *Eunicella verrucosa* (EV1) hosting numerous small specimens of the basket star (red circles); (b,c) small juveniles with arms coiled around the gorgonian branches; (d) large juveniles settled in the upper part of the sea fan (EV2); (e,f) enlargement of these specimens; (g) a specimen on a colony of *Paramuricea clavata* (PC1). Scale bars: a, d = 5 cm, b, c, 0,5 cm, e–g = 3 cm.

The size of the gorgonians, the number and the size classes of the basket stars on each colony are reported in Table 2. The colony EV1 hosted a large juvenile (oral disc about 26 mm) together with other thirteen small specimens (4.0–9.6 mm); the colony EV2–EV4 hosted specimens of a very similar size (10–20 mm) while an adult specimen (38 mm) was recorded on *P. clavata*.

**Table 2.** Morphometric parameters of *Eunicella verrucosa* and *Paramuricea clavata* colonies hosting adults and recruits of *Astrospartus mediterraneus* at NEW99 site. Specimens were classified on the basis of their oral disk diameter.

Colony ID	Height (cm)	Fan Surface (cm <sup>2</sup> )	Oral Disk		
			>20 mm (N)	10–20 mm (N)	<10 mm (N)
EV1	54.4	2270	-	1	13
EV2	69.3	3915	-	4	-
EV3	52.2	1800	-	1	-
EV4	covered by <i>Alcyonium coralloides</i>		-	1	-
PC1	46.5	2459	1	-	-

While the smaller specimens (<10 mm) had the arms coiled around the gorgonian branches with the oral side of the disc in contact with the coenenchyme (Figure 2b,c), the largest specimens showed their arms completely expanded and usually settled in the upper portion of the sea fan (Figure 2 d–g).

The gastral content of two collected specimens with an oral disc of about 7 mm was made by a homogeneous substance, perhaps organic sediment, without chitinous remains.

Finally, the dissection of 50 polyps of *E. verrucosa*, did not allow the observation of ophiuroid recruits within the coelenteron (see Discussion).

#### 4. Discussion

As already observed in several parts of the Western Mediterranean Sea [1,2,4], the presence of *Astrospartus mediterraneus* in the TPCCMPA is clearly increasing. One of us (ET) has conducted dives in the area of the Tavolara Channel for about forty years and in this long span of time *A. mediterraneus* was recorded very few times before 2017.

The basket stars are virtually exclusively settled in the central shoals of the Tavolara Channel where the current flow and sedimentation rate are maximal [5–7]. As already stated, all the specimens were recorded under 27 m depth as epibionts of gorgonians, taking advantage of the filter-feeding activity. In this area, Canessa et al. [7] described a colony of *Leptogorgia sarmentosa* monitored from 2017 for six years and always hosting a basket star. The same gorgonian observed again during the study continues to host an ophiuroid specimen. Obviously, it is impossible to affirm that the same specimen occupied the same position on the same gorgonian for more than eight years; nevertheless, this constant presence allows us to suppose an extremely long host–epibiont fidelity. Assuming the hypothesis that in these eight years we have always documented the same specimens, high longevity can be supposed for *A. mediterraneus*. Although small ophiuroids have a short life span [8,9], some cold-water species show slow growth and high longevity [10].

The recent recruitment event is the first documented for *A. mediterraneus* in its entire distribution area. Additionally, in the same period, a very small specimen (2 mm in diameter) was collected on a colony of *L. sarmentosa* on the outer side of the Genoa harbor breakwater at about 50 m depth (Laura Castellano, pers. comm.), while another one was observed on a colony of the same species on the rocky cliff of the Portofino Promontory at 30 m depth (Francesco Enrichetti, pers. comm.). In the Costacuti Shoal (Latium, Italy, Tyrrhenian Sea) the presence of small *A. mediterraneus* on a single colony of *L. sarmentosa* was recorded between May and June (Alessandro Diotallevi, pers. comm.). Finally, in a detailed paper dedicated to the basket star population of Cap de Creus, a small specimen with a diameter of about 10 mm was recorded and attached to the disk of an adult specimen in June [4].

The bimodal size distribution of the specimens observed at the NEW99 shoal in the Tavolara Channel strongly supports the idea that they derive from two separate reproductive events, putatively 2023 and 2024. Biel-Cabanelas et al. [4] stated that the specimens recorded at Cap de Creus, with an average oral disc diameter of about 3 cm, have an age of

about 4 years. This datum could be in accordance with a diameter of 1 cm for a specimen 1 year old.

The presence of recruits in June in TPCCMPA, as well as in other localities of the Ligurian Sea, indicates that reproduction likely occurs in spring.

The recruits of the Tavolara MPA were always observed on gorgonian colonies, mainly *Eunicella verrucosa*, highlighting the strong association between these species. The relationships between basket stars and octocorals have come to be understood several times. In 1970, Patent [11] described the life cycle of *Gorgonocephalus eucnemis* (Müller and Troschel, 1842) finding very small (<1 mm in disk diameter) specimens living inside polyps of the alcyonacean of the genus *Gersemia*. On this base, she suggested that embryonic development occurs inside *Gersemia* polyps. After emerging from the polyps, young basket stars live on the surface of *Gersemia* colonies for a variable span of time. They leave the colony to attach themselves to adults and eventually assume an independent existence.

More recently, a study about the functional roles of Nephtheidae soft corals in the NW Atlantic and the Arctic produced evidence that several species of octocorals (*Drifa glomerata* (Verrill, 1869), *Duva florida* (Rathke, 1806), *Gersemia* spp., and *Pseudodrifa racemosa* (Studer, 1891)) act as habitat for juveniles of *Gorgonocephalus* sp. [12]. These authors agree that soft corals passively ingest basket star embryos and develop within polyps. Our findings support the strong affinity of *A. mediterraneus* recruits for octocorals, although gorgonian polyps are probably too small to ingest juvenile basket stars.

Basket stars are generally considered filter feeders [13] but, in several species, according to Rosemberg [14], the robust and armoured arms of *G. caputmedusae* (Linnaeus, 1758) most probably form too crude a filter apparatus for microscopic food and the structure rather suggests that macrophagy prevails. Experimental studies demonstrated that the arm tips of this species could trap krill; then the arm tips coiled around the prey, and the krill was subsequently moved to the mouth. A similar procedure was described for other species of the genus [11,15]. No specific observation in this way was performed for *A. mediterraneus*; nevertheless, we have not found any chitinous remains in the gastral content of young specimens. Moreover, the position of very small recruits suggests that they putatively feed on the mucus coating the gorgonian branches.

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