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Uncovering a poorly known Mediterranean species thanks to underwater photography and video: *Ophiacantha setosa* (Echinodermata: Ophiuroidea)

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Abstract

The brittle star species *Ophiacantha setosa* (Bruzellius, 1805) was historically documented only from dredged material and morphological taxonomic accounts, with little information on its live appearance, ecology, or behaviour, and had never been illustrated *in situ*. Here we combine a morphological diagnosis with new underwater observations obtained through scientific and technical diving, high-resolution photography, and citizen science contributions to provide the first comprehensive account of *O. setosa* in life. The species was observed between 25 and 130 m depth at several Mediterranean localities, consistently living as an epibiont on octocorals. Host use varied with depth, shifting from shallow coralligenous gorgonians (*Leptogorgia sarmentosa*, *Paramuricea clavata*, *Eunicella cavolini*) to deeper mesophotic species (*Callogorgia verticillata*) and soft corals (*Alcyonium palmatum*). Despite their abundance, several potential hosts, including *Corallium rubrum*, were never colonized, possibly suggesting active host selectivity rather than random association. Our observations reveal previously unknown aspects of the species' morphology, colouration, depth distribution, and ecological preferences, and highlight the value of underwater imagery and citizen science for documenting overlooked marine invertebrates. This study fills a long-standing knowledge gap for *O. setosa* and illustrates how modern observational approaches can help rediscover and characterize “ghost species” in marine biodiversity databases.

Key words: Octocorallia, mesophotic ecosystems, brittle stars, epizoic, citizen science, host selectivity, Ophiuroidea, Mediterranean sea, biodiversity monitoring

Introduction

Western marine science has a long tradition in the Mediterranean, going as far back as Aristotle's natural history works (Aristotle -343), describing and organizing some hundreds of species, including invertebrates such as echinoderms, continued by Linnaeus two millennia later. Ophiuroidea Gray, 1840, commonly known as brittle stars, currently include 2158 known species (Stöhr *et al.* 2026) with a wide variety of forms and life-styles (Stöhr *et al.* 2012). A considerable number of species live epizoic on a variety of hosts (Stöhr 2025). *Ophiacantha setosa* (Bruzellius, 1805) is an ophiuroid species that has been reported repeatedly since its discovery (Cherbonnier 1962; Koehler 1898; Müller & Troschel 1842), but rarely been collected and saved in museum collections (Supp. file 1). In addition, none of these works included data on the live colouration, ecology, biology or behaviour of *O. setosa*. Tortonese (1965) largely summarized and translated Koehler's (1898) findings into Italian. None of these publications was translated into English (as most of the older ones), which has limited their international dissemination. Since then, *O. setosa*

has rarely been mentioned in the literature, and almost no *in situ* photographs or biological observations have been published until recently (some even misleading, *e.g.* Toma *et al.* 2024). It is absent from modern general field guides or comprehensive works on Mediterranean marine fauna. This lack of visibility has made it almost completely unknown among naturalists, likely resulting in under-reporting of observations and mistakes. Remarkably, *O. setosa* was even unlisted in the French national biodiversity database (INPN) when this work began, despite its previous documentation by divers and its citation in historical literature (Koehler 1898, 1921). The relative lack of modern records has left a gap in our understanding of the species' true distribution, habitat preferences, and ecological interactions. Its taxonomic status and biogeographical range have been generally accepted based on dredged museum specimens, but its life history and microhabitat associations have remained entirely unknown.

A common problem in taxonomy and assessments of species diversity is the high percentage of rare species that have been collected on few occasions and with few specimens (Lim *et al.* 2012). It can be difficult to determine if this rarity is real or reflects sampling bias. In recent years, scientific diving and high-resolution underwater photography have become valuable tools to document deep and cryptic fauna in the Mediterranean Sea. Combined with an increasing number of citizen-science records, these approaches have helped reveal several rare species that are rarely encountered by scientists (Bourjon *et al.* 2018). Using these methods, multiple independent observations of *O. setosa* have been made between 25 and 130 m depth by both professional scientific divers and amateur naturalist underwater photographers, at first without knowing its identity (Fig. 1).



FIGURE 1. *Ophiacantha setosa* photographed *in situ* on *Paramuricea clavata* in Cap Corse (Corsica, France, 55 m depth) by Laurent Ballesta - Andromède Océanologie.

These new data provide the first *in situ* images of the species, revealing its live colouration and its epibiotic association with several octocoral species, including *Paramuricea clavata* (Risso, 1827), *Eunicella cavolini* (Koch, 1887), *Leptogorgia sarmentosa* (Esper, 1791), *Callogorgia verticillata* (Pallas, 1766), and *Alcyonium palmatum* (Pallas, 1766). Here, we present the first comprehensive description of live *O. setosa*, based on multiple underwater observations from different French Mediterranean localities and on freshly collected specimens.

This contribution fills a long-standing gap in the knowledge of a species that has remained virtually unknown for more than a century since its original discovery—despite occasional diver observations that failed to recognize

its identity. We also hope that this approach may encourage other researchers to make use of these emerging sources of visual data to shed light on the many “ghost species” hidden within our biodiversity databases, which are not all inconspicuous. Compared to the few records of preserved specimens in museum collections, observations in the field can contribute considerably more data, provided the animals are correctly identified.

The aim of this study is to better understand the geographic distribution of *O. setosa* and its largely unknown host associations by combining scarce museum collection specimens with field observations. Recent molecular work found that the genus *Ophiacantha* Müller & Troschel, 1842 consists of several clades that should be revised as separate genera (Christodoulou *et al.* 2019). Morphological differences between the type species of *Ophiacantha*, *O. bidentata* (Bruzellius, 1805), and *O. setosa* that may potentially hold genus level signals were observed in lateral arm plates by Thuy & Stöhr (2011). A separate study on the phylogeny of *O. setosa* and its allies is in preparation and outside the scope of the present work.

Material and Methods

Physical specimens

Specimens of *O. setosa* were collected in December 2003 by Helmut Zibrowius in the Mediterranean Sea during the cruise “Corti” onboard the R/V *Urania*. They were deposited at the Swedish Museum of Natural History (SMNH) and identified by S. Stöhr after examination in a dissecting microscope. Additional specimens were collected off Corsica by L. Ballesta and J. Deter during diving and sent to SMNH for identification. They will be deposited at the Muséum national d’Histoire naturelle, Paris, when the parallel phylogenetic study has been completed. For species identification Müller & Troschel (1842), Koehler (1921) and Tortonese (1965) were consulted. The holotype of *Ophiacantha scabra* Sars, 1859 was examined from photos to verify its conspecificity with *O. setosa*.

Citizen science observations

Following the first direct records of this species reported on the DORIS forum by Céline Réty and Sylvain le Bris, a call for observations was issued on the same forum (<https://doris.ffessm.fr/Forum/Premieres-observation-in-situ-d-une-ophiure-rare-de-Mediterranee-82740/>), which is followed by >10k French-speaking scuba divers. Other similar naturalist observations sharing programs were also surveyed (but passively), especially iNaturalist (<https://www.inaturalist.org/>) and BioObs (<http://www.bioobs.fr/>). This resulted in collaboration with some of the divers (see below) and ultimately the generation of the present report.

Study sites and diving campaigns

Observations of *Ophiacantha setosa* were recorded at multiple locations in the Mediterranean Sea (Suppl. file 2):

- **Offshore Provence (French Mediterranean)**—shallow rocky reefs and gorgonian-dominated cliffs between 20 and 40 m depth, featuring typical coralligenous assemblages dominated by *Paramuricea clavata*. Several *O. setosa* individuals were observed by recreational and naturalist divers, particularly around Marseille’s Riou islands (Calanques National Park), where the species was photographed on gorgonians.
- **Cap Corse (Corsica, France)**—two distinct habitats were explored during scientific missions led by Andromède Océanologie as part of the *Gombessa* expedition which resulted in the movie “Cap Corse, le mystère des anneaux” in 2024 (Rineau *et al.* 2024) and a monitoring network for coralligenous assemblages:
 - (1) **coralligenous cliffs and banks (40–70 m)**, where *O. setosa* was observed on *Paramuricea clavata* and *Eunicella cavolini*. Part of expedition Gombessa 6+ (Andromède Océanologie 2023) and campaign RECOR (Deter *et al.* 2011);
 - (2) **mesophotic reef slopes (70–130 m)**, characterized by abundant *Callogorgia verticillata* colonies that hosted numerous small individuals of *O. setosa*. Deeper dives (>100 m) revealed that the species could be very abundant locally, sometimes forming clusters of several individuals per host colony. Part of expedition Gombessa 6 (Andromède Océanologie 2022).
- **Bay of Cannes (French Riviera)**—transect dives conducted along sandy-muddy bottoms between 10 and 100 m depth revealed numerous *Alcyonium palmatum* colonies, frequently hosting an individual of *O. setosa*.

All sites are within the French Exclusive Economic Zone (EEZ) and located in areas known for their rich octocoral diversity.

Observer Teams

Amateur and Scientific Divers

- **Céline Réty**—naturalist scuba diver conducting autonomous dives and photographic documentation on the French Mediterranean coast, especially around Marseille. Her first records of *O. setosa* on purple gorgonians (*P. clavata*) were published on the DORIS forum (the naturalist branch of the French diving federation, FFESSM), prompting additional confirmations. She later observed the species on other gorgonian species, including *Leptogorgia sarmentosa* (orange gorgonian, 38–39 m deep), and *Eunicella cavolini* (yellow gorgonian, ~34 m deep).
- **Laurent Ballesta & Andromède Océanologie**—professional underwater photographer, marine biologist, scientific diver, co-founder of the company Andromède Océanologie and leader of the *Gombessa* expeditions. Since 2010 Andromède Océanologie has operated the French monitoring network RECOR for coralligenous assemblages (https://medtrix.fr/portfolio_page/reCOR/). Deep mixed-gas (trimix) dives using standard decompression (RECOR and Gombessa 6+) or autonomous saturation dives (Gombessa 6) and scientific imaging protocols were performed. Observations were made between 50 and 130 m deep, with documentation of both solitary and clustered individuals on gorgonian hosts.
- **Samuel Jégliot & NaturDive**—marine biologist, scientific diver, and co-founder of the conservation association *NaturDive*. On sedimentary bottoms, systematic transects and *in situ* imaging surveys were performed between 10 and 100 m deep in the Bay of Cannes, targeting benthic biodiversity and coral-epibiont interactions.

Survey and recording methods

- **Scuba-based visual surveys** were carried out at depths ranging from **25 to 130 meters** on conventional or technical trimix dives, following established safety and observational protocols for deep reef environments.
- Observations were documented by **high-resolution still photography and video** during dives, providing visual confirmation of species identity, colour patterns, and substrate associations.
- Site selection and survey coverage were guided by local knowledge of gorgonian and alcyonarian coral distribution, with repeated observations to confirm consistency of association patterns.

All observations used here were carried out by divers. Some preliminary video footage was also made by **remotely operated vehicle (ROV) surveys** by Andromède Océanologie before the dives, but not used here as it did not retrieve additional information for our topic. ROV observations were also performed in Toma *et al.* (2024) and Chimienti (2020).

Institutional acronyms

MNHN—Muséum national d'Histoire naturelle, Paris

UiO—Natural History Museum, University of Oslo

SMNH—Swedish Museum of Natural History, Stockholm

Results

Taxonomic account

Class Ophiuroidea Gray, 1840

Superorder Ophintegrida O'Hara, Hugall, Thuy, Stöhr & Martynov, 2017

Order Ophiacanthida O'Hara, Hugall, Thuy, Stöhr & Martynov, 2017

Family Ophiacanthidae Ljungman, 1867

Genus *Ophiacantha* Müller & Troschel, 1842

Ophiacantha setosa (Bruzelius, 1805)

Figs 2–3

Asterias setosa Bruzelius, 1805: 30.

Ophiacantha scabra M. Sars, 1859: 22, pl. 1 fig. 1.—Ljungman (1867): 326.

Ophiura rosularia Grube, 1840: 20. (non Lamarck)

Ophiacantha setosa—Müller & Troschel (1842): 106, fig. 2; Ljungman (1867): 326; Lyman (1882): 198; Koehler (1898): 57, pl. 8, figs 37, 38; Koehler (1921): 69, fig. 3.

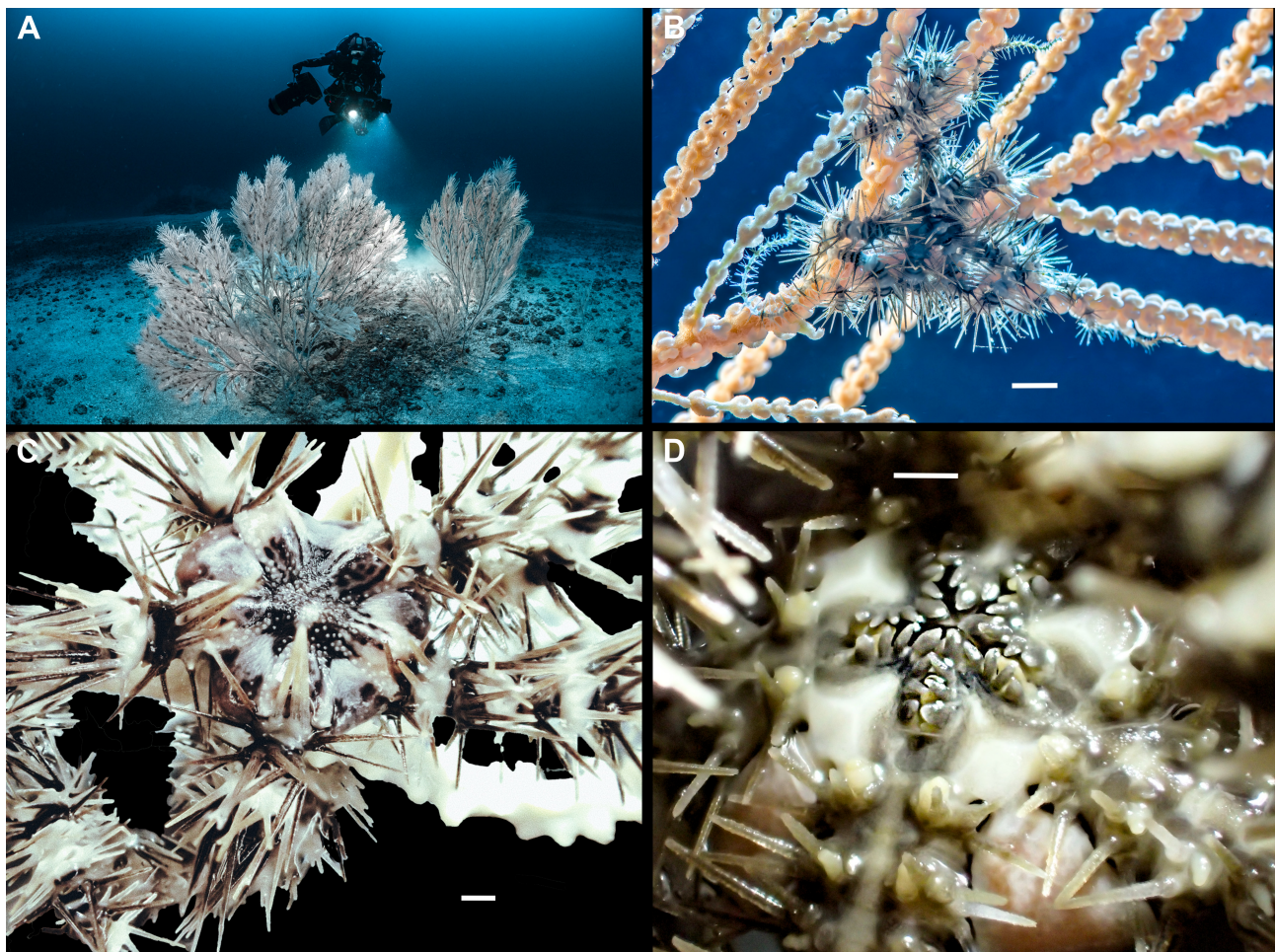


FIGURE 2. *Ophiacantha setosa* on *C. verticillata* off Cap Corse, 120 m. A. Underwater image of *C. verticillata*, black dots are brittle stars. B. Live *O. setosa* on *C. verticillata*. C. Alcohol preserved *O. setosa*, dorsal aspect (MNHN). D. Same specimen as C, ventral aspect. A–B by L. Ballesta, C–D by S. Stöhr. Scale bars: B = 5 mm, C–D = 1 mm.

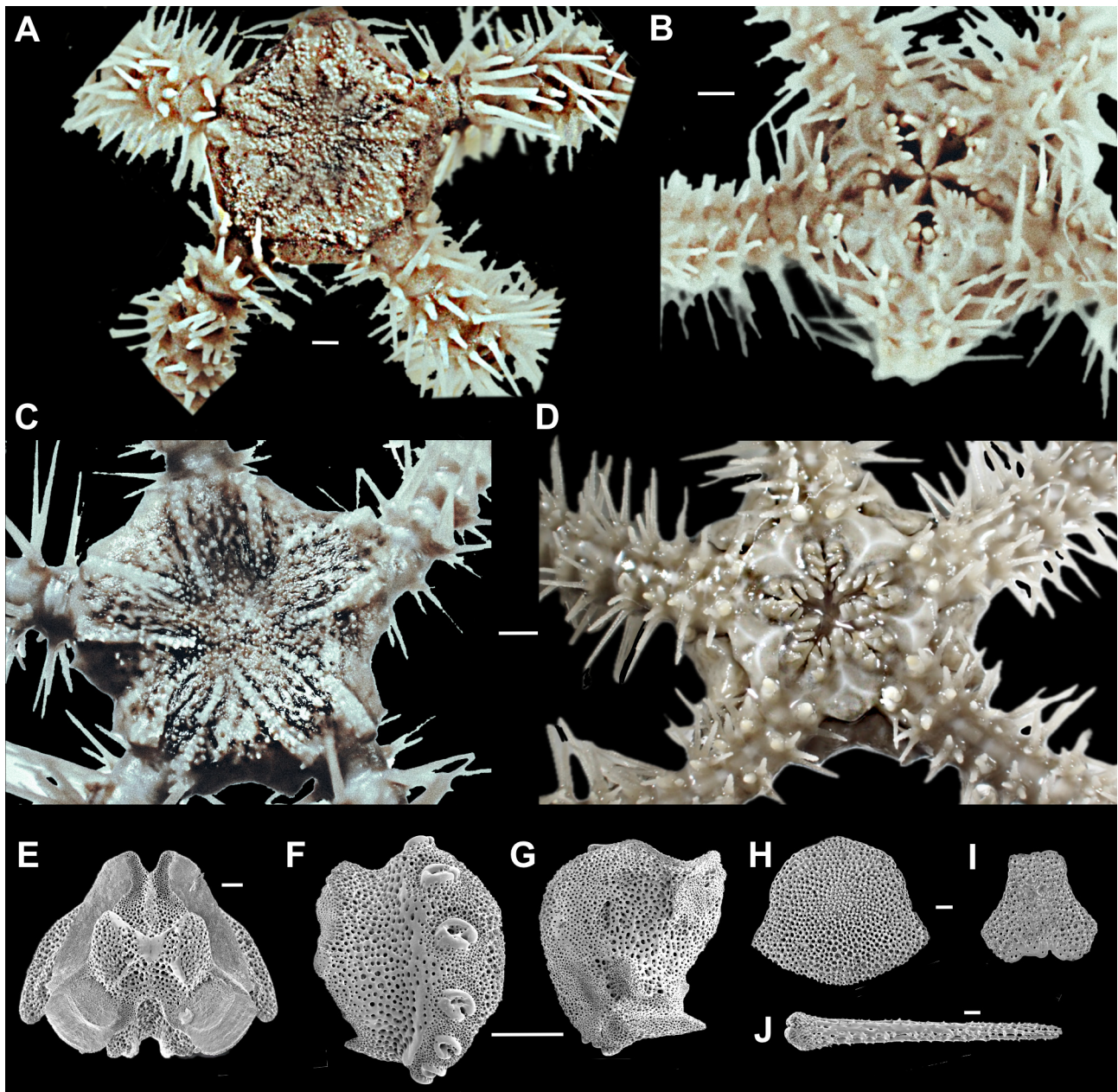


FIGURE 3. A–B. *Ophiacantha scabra*, Holotype (UiO E730; by Å. Wilhelmsen), dried. A. Dorsal aspect. B. ventral aspect. C–D. *Ophiacantha setosa* (SMNH-223251, SMNH-90263, SMNH-90276, SMNH-232774), Tuscan Archipelago, E of Capraia, 113.6–146 m, in ETOH. C. Dorsal aspect. D. Ventral aspect. E. Arm vertebra, distal aspect. F. Lateral arm plate external aspect. G. Lateral arm plate, internal aspect. H. Dorsal arm plate, external aspect. I. Ventral arm plate, external aspect. J. Distal arm spine. F–G by B. Thuy. Scale bars: A–D = 1 mm, E, H–J = 0.1 mm, F–G = 0.5 mm.

Type locality: Mediterranean Sea.

Type material (photos)

MEDITERRANEAN SEA • **Italy, Naples**; holotype of *Ophiacantha scabra*; 40.83°N, 14.25°E; depth 94 m; M. Sars leg.; UiO, E730.

Other material examined

MEDITERRANEAN SEA • **Italy, Tuscan Archipelago, E of Capraia**; 10 spec.; 42°59'N, 9°50'E; depth 113.6–146 m; 21 Dec 2003, URANIA cruise Corti, sta. 8; Helmut Zibrowius leg.; epibenthic dredge; in ETOH and ossicles on

SEM stubs, gold coated; SMNH, SMNH-223251, SMNH-90263, SMNH-90276, SMNH-232774. **Italy, Corsica, Capo Corso**; 2 spec.; 43°18.79'N, 9°29.62'E; depth 154–303 m; 30 Dec. 2003; URANIA cruise Corti, sta. 55; Helmut Zibrowius leg.; epibenthic dredge; SMNH, SMNH-223253. **Italy, Tuscan Archipelago, NW of Capraia**; 6 spec.; 43°05.15'N, 9°47.7'E; depth 112–124 m; 29 Dec 2003; URANIA cruise Corti, sta. 46; Helmut Zibrowius leg.; epibenthic dredge; SMNH, SMNH-223254. **Italy, Naples, Zoological Station**; 5 spec.; 1921; Zoological Station leg.; SMNH, SMNH-170877. **N of Corsica**; 7 spec.; depth 120 m; 29 Jul 2022; Gombessa VI, sta. 27 S1; L. Ballesta leg.; on *Callogorgia verticillata*; MNHN. **N of Corsica**; 1 spec.; depth 120 m; Gombessa VI, sta. 25 S13; L. Ballesta leg.; on *Callogorgia verticillata*; MNHN.

Description

The disc is pentagonal, interradially constricted, 8.2 mm in disc diameter, dorsally covered with very fine scales obscured by a thick integument (Figs 2C–D). The long bar-like radial shields are obscured by integument, forming elevated ribs (Fig. 3C), almost as long as the disc radius, covered with one or two rows of tiny granules, but no spines. Scattered disc granules are found also on the disc centre. The arms are notably long, thin, distinctly noded, about eight to ten times the diameter of the disc (sometimes more in big mesophotic specimens). The dorsal arm plates are triangular and distally convex, the ventral plates are squarish to pentagonal. The lateral arm plates carry up to nine thin tapered spines, the two to three dorsalmost spines are as long as three arm segments, ventralwards decreasing. The arm spines are hollow and lined with fine denticulations. The ventralmost tooth is large and blunt, there are three to four finger-like conical and pointed lateral oral papillae, arranged in a single row. The oral shield is rhombic, about twice as wide as long. The adoral shields are large, crescent-shaped and limited to the proximal edges of the oral shield. There is a single, pointed tentacle scale.

Variations. The density of the dorsal disc granules varies from a bare disc centre to a sparse all over cover. The smallest specimen had a disc diameter of 2.1 mm, no granules on the disc, scales obscured by thickened skin, three oral papillae, more slender and pointier than in adults, four long arm spines, crossed over disc. At 3.8 mm disc diameter, there were some granules on the disc, oral papillae similar to an adult and five arm spines. The colouration was similar to adults in all sizes.

Ossicles (Figs. 3E–J). The arm vertebrae are of streptospondylous (hourglass) type. The lateral arm plates are dorsoventrally constricted; with spine articulations placed on an elevated wide band separated from the proximal part by a slightly wavy ridge. The spine articular structures are formed by two curved horizontal lobes, a sigmoidal fold is weakly expressed, nerve and muscle opening are separated by a narrow ridge. The inner side of the lateral arm plates bears a ridge that is separated into two parts (the vertebral articular structures). The dorsal arm plate is bell-shaped, distally slightly wider than long. The ventral arm plate is proximally half as wide as distally, distally as wide as long, the proximal edge is straight, the lateral edges are concave, the distal edge is concave. Arm spines are finely denticulated.

Colouration. In living specimens, the dorsal disc is usually white or light grey, usually with a darker star-like pattern in the disc centre, extending outwards along the radial shields, but sometimes totally white. The arms are banded (brown, purplish brown, dark grey) at irregular intervals, two or three segments apart (sometimes two dark segments following each other). The oral face is whitish on both arms and disc, with only the mouth forming a distinct dark star. In alcohol, the dark colour fades in time.

Remarks

The largest specimens recorded in the literature measured up to 12 mm in disc diameter (Koehler 1921). The ossicle morphology differs from the generic type species *O. bidentata*, which has zygospondylous vertebrae (Stöhr 2012) and a continuous ridge on the inner lateral arm plate, as well as unconstricted lateral arm plates and vertical striations separating the articulation bearing part from the rest of the plate (Thuy & Stöhr 2011). Streptospondylous vertebrae allow for greater vertical movement of the arms and are typically found in epizoid ophiuroid species that curl the arms around their host (Goharimanesh *et al.* 2022). These differences possibly support a generic difference between *O. setosa* and *O. bidentata*, but further examination including molecular data is needed.

Ophiacantha setosa shows limited morphological variability and is not easily confused with other species of Ophiacanthidae (although superficially it may be confused with *Ophiothrix fragilis* (Abildgaard in O.F. Müller 1789), see Toma *et al.* (2024)). The short list of synonyms attests to that. The name *Ophiura rosularia* has a convoluted history. It was used by Grube (1840), attributed to Lamarck and compared to Linck's (now invalid) name *Stella scolopendroides rosula scolopendroides* (Linck 1733: 52, pl. 26 fig. 42), a species that was later adopted by Lamarck (1816) as *Ophiura rosularia*. However, Linck and Lamarck clearly described and depicted *Ophiothrix fragilis* ("dorsal face almost fully covered with spines forming five petals"), while Grube's description rather corresponds to *O. setosa* ("...Disc ist weichhäutig, oben mit 5 Paaren von kurzstachlichen, (fast knotigen) Kämmen sternartig besetzt, welche in der Mitte des Rückens nicht zusammenstossen...") [translated by us as "on the soft dorsal disc 5 pairs of combs of low spines, almost gnarly"]. The synonymy between *O. rosularia* Lamarck, 1816 and *O. fragilis* was acknowledged by Blainville (1834: 244), and confirmed by Milne-Edwards in the posthumous second edition of Lamarck's book (Lamarck 1840). Grube's *O. rosularia* is thus a misapplication of the name that has historically been treated as a homonym to Lamarck's name, neither as a subjective nor objective synonym of *O. setosa*. In contrast, Bruzelius (1805) attributed his new species *A. setosa* to Linck's *Stella scolopendroides bracteata exilissima* (Linck, 1733: 50, pl. 37 fig. 68). His description mentions raised ribs on the disc, disc granules and noded arms.

Sars (1859), aware of Müller & Troschel's diagnosis of *O. setosa*, described the closely related species *O. scabra* M. Sars, 1859 from Sicily, which differed mainly in the disc granules not being limited to the radial shields, but distributed all over the disc. Both species were listed by Ljungman (1867). However, Lyman (1882) subsequently placed *O. rosularia* (*sensu* Grube) and *O. scabra* in synonymy with *O. setosa*, without further justification, and this treatment has been followed by subsequent authors to the present. After Sars, the species was not thoroughly re-examined until Koehler (1898, 1921) provided a detailed redescription based on an extensive collection of dredged specimens, together with some first bathymetric information, new line drawings (1898) and black and white photographs (1921). He also updated its alleged distribution, extending from the Mediterranean Sea to the East Atlantic, from the Bay of Biscay along the West African coast as far as Angola (later confirmed by Cherbonnier (1962)), including the East Atlantic archipelagos (Azores, Canaries and Cape Verde). It has not been possible to verify the extra-Mediterranean records through specimen examinations within the scope of this project, but there is no evidence that would cast doubt on them. Cherbonnier (1962) illustrated the ventral disc and the drawing is consistent with *O. setosa*.

Distribution and host associations

Museum records

Very few museum specimens seem to be recorded: a total of fewer than 40 curated museum specimens of *Ophiacantha setosa* could be traced in public collections worldwide (Supp. file 1). Mediterranean material is mainly represented by historical and early 20th century specimens from Naples and by a small series collected during the R/V *Urania* cruise "Corti" in the Tuscan Archipelago and off Cap Corse (SMNH). The material housed at the SMNH represents the most extensive curated series of *Ophiacantha setosa* currently traceable in museum collections, and partially overlaps geographically with material previously cited from other institutions, but provides more precise station data, specimen counts, and preservation details. However, all of these lack mention of a host species. Additional isolated Mediterranean specimens are housed in the Natural History Museum (London), the Museum of Comparative Zoology (Harvard University), the Field Museum of Natural History (Chicago), and the Gothenburg Natural History Museum. The holotype of *Ophiacantha scabra*, found in the region of Naples, represents the oldest available type specimen linked to this taxon, since the type material of *O. setosa* has been lost as all of the material by Bruzelius (Stöhr *et al.* 2020).

Extra-Mediterranean records are scarce and geographically scattered, including specimens from the Bay of Biscay and West Africa (Morocco, Canary Islands, Sierra Leone, Gulf of Guinea, Congo estuary, Angola), deposited in institutions such as the University Museum of Bergen, the Royal Belgian Institute of Natural Sciences, the Museu Nacional de História Natural e da Ciência (Lisbon), the Natural History Museum of Los Angeles County, and others. Most of these specimens date from mid-20th century expeditions. Overall, the number of curated museum lots remains remarkably low in comparison with the local abundance observed in situ in Mediterranean coralligenous habitats, highlighting the historical underrepresentation of this species in collections.

In situ observations

In the **shallow coralligenous** cliffs off Marseille and Corsica (25–50 m), isolated individuals of *O. setosa* were observed occasionally, living on three distinct gorgonian species: primarily on *Paramuricea clavata* (Fig. 4A) and secondarily on *Leptogorgia sarmentosa* and *Eunicella cavolini* (Table 1). Citizen science observations were consistent with these results, all observations being on *Paramuricea clavata* and *Leptogorgia sarmentosa*, mostly below 30 m. Although other abundant octocorals such as *Corallium rubrum* (Linnaeus, 1758) and *Eunicella singularis* (Esper, 1791) co-occurred in the same area, *O. setosa* was never found on these.

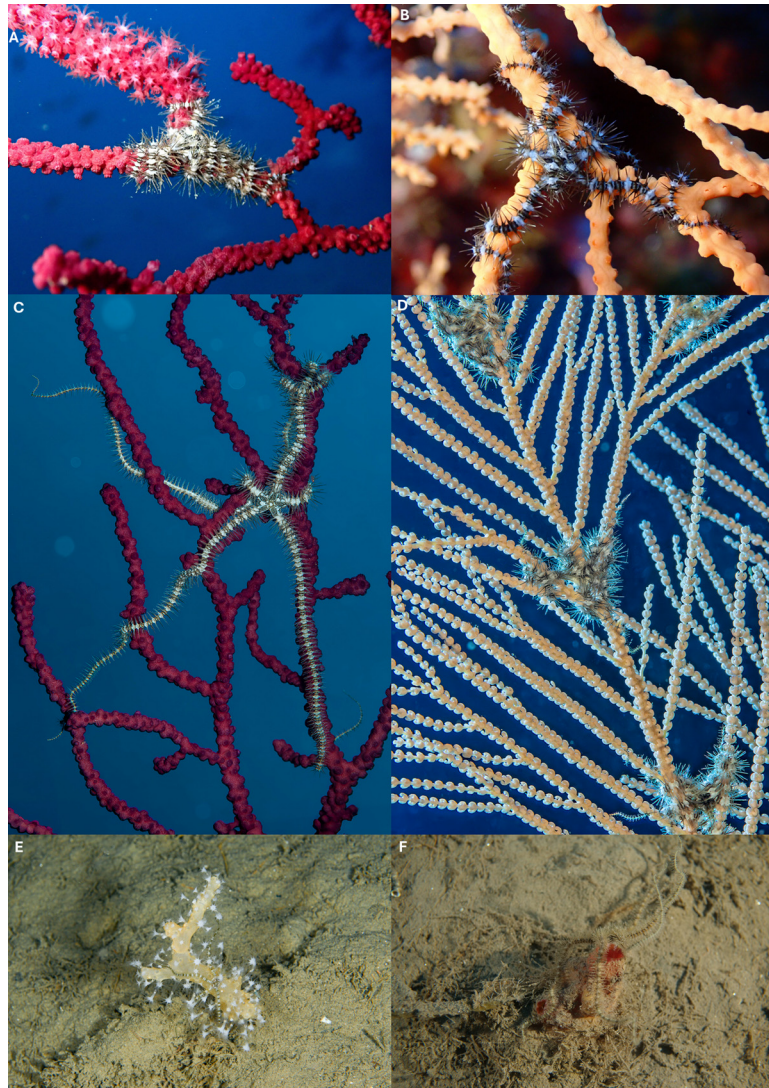


FIGURE 4. *In situ* observations of *Ophiacantha setosa*. A. Curled on *P. clavata*, [Moyades (Marseille), 30 m, C. Réty]. B. On *E. cavolini*, [Impériaux du milieu (Marseille), 34 m, C. Réty]. C. Big and extended individual on a mesophotic *P. clavata*, [Cap Corse, 50 m, L. Ballesta]. D. Several small individuals curled around *C. verticillata*, [Cap Corse, 120 m, L. Ballesta]. E. On *A. palmatum*, [Cannes, 71 m]. F. One of the two only observations on a non-cnidarian host (tunicate *Pyura microcosmus* Savigny, 1816), [Cannes, 65 m].

TABLE 1. Mediterranean octocorals on which *Ophiacantha setosa* was observed, depth range and frequency (= number of corals that had symbionts) of observations.

Host species	Depth (m)	Frequency	Remarks
<i>Eunicella singularis</i>	-	None	This octocoral occurs on shallow coralligenous assemblages, but less on cliffs: habitat may not suit <i>O. setosa</i> .
<i>Leptogorgia sarmentosa</i>	38–95	< 10	Shallow coralligenous cliffs; two records by C. Réty (Marseille, 2021–2025). Also 1 record in Toma <i>et al.</i> at 95 m.
<i>Paramuricea clavata</i>	25–32	< 10	Shallow coralligenous cliffs, sympatric with <i>L. sarmentosa</i> . <i>O. setosa</i> recorded on four colonies by C. Réty (Marseille); isolated individuals.
<i>Eunicella cavolini</i>	34–165	< 10	One confirmed shallow association observed by C. Réty (Marseille, 34 m). Some more records in deeper transects by L. Ballesta (Corsica), and 54 specimens recorded between 70–165 m by Chammem <i>et al.</i> (2019).
<i>Eunicella verrucosa</i>	57–70	< 10	No diver observation of association in shallow waters unless one in Cannes at 57 m. Deeper observations reported in Chimienti (2020): recurrent association in some <i>E. verrucosa</i> forests around 60 m deep.
<i>Alcyonium palmatum</i>	52–96	> 10	Main host in deeper sandy bottoms according to S. Jégnot (Cannes); 10/28 colonies observed hosting individuals.
<i>Callogorgia verticillata</i>	115–130	Almost all	Major host in mesophotic zone according to L. Ballesta (Cap Corse); large colonies, almost all hosting multiple individuals.
<i>Corallium rubrum</i>	-	None	Never recorded as host despite high local abundance (and photographic records); likely avoided.
<i>Acanthogorgia hirsuta</i>	-	None	Abundant in mesophotic zones but no association is recorded.
<i>Viminella flagellum</i>	-	None	Co-occurs in deep slope communities; unoccupied.
<i>Parantipathes larix</i>	-	None	Occasional in mesophotic assemblages. They never host <i>O. setosa</i> .

Sedimentary bottoms are less favourable to hard-skeleton cnidarians, and even *Eunicella singularis* cannot develop on a completely soft bottom; one very small colony of *E. verrucosa* was observed, hosting one *O. setosa*. As a consequence, *Alcyonium palmatum* seems to be the main host in such environments, hosting important populations of *O. setosa*, as nearly half the colonies observed hosted an individual between 50 and 70 m depth (Fig. 4E, Table 1). Some specimens were also observed on other types of support than cnidarians: one on the ascidian *Pyura microcosmus* (Savigny, 1816) (Fig. 4F), and one on a piece of plastic garbage. Sea pens (Pennatuloida Ehrenberg, 1834) were also common, but did not host any brittle stars.

In the **mesophotic zone** off Corsica (115–130 m), *Callogorgia verticillata* dominates, hosting dense aggregations of brittle stars, mostly small individuals (Fig. 4D, Table 1). Some specimens were also observed on *E. cavolini*, and even more (54) in Tunisia between 70 and 165 m by Chammem *et al.* (2019). One specimen was also pictured on *L. sarmentosa* at 95 m off Vibo Marina (Italy) in Toma *et al.* (2024), and several ones in *E. verrucosa* forests off Sanremo (Italian Riviera). Although other structurally suitable corals were present in these habitats, such as *Corallium rubrum*, *Acanthogorgia hirsuta* Gray, 1857, *Viminella flagellum* (Johnson, 1863) or *Parantipathes larix* (Esper, 1788), *O. setosa* was never recorded on any of these. Table 1 highlights a bathymetric succession of host association by *O. setosa*.

Discussion

Ecological preferences

Apart from trawled-and-released specimens, as observed in southern Spain (Jesus Sanchez, *pers. comm.*), the shallowest record of *O. setosa* was made by Réty at 25 m depth at Moyades (island south of Marseille, France), on *P. clavata*. The shallowest depth cited in the literature was so far “40 to 50 m” in Koehler (1921), hence our new findings introduce this species in the depth range of recreational diving. Despite abundant populations of suitable

gorgonians (*P. clavata*, *L. sarmentosa*, *E. cavolini*, *E. verrucosa*) at several sites, *O. setosa* remained always rare on shallow cliffs above 60 metres depth, and the population consisted of small isolated individuals, tightly curled around their hosts.

The depth optimum for this species seems to start around 50–70 m depth, associated with two main hosts: *Alcyonium palmatum* on sandy bottoms, *Callogorgia verticillata* on deep coralligenous bottoms (very specific ones: see Andromède Océanologie (2022)) and, less frequently, in mesophotic gorgonian forests, *Paramuricea clavata*, *Eunicella verrucosa* (according to Chimienti (2020)) and *Eunicella cavolini* (in western Tunisia according to Chammem *et al.* 2019). All sites where the species was observed showed a high density of planktotrophic fauna, suggesting abundant suspended food availability. Deep (>50 m) sedimentary bottoms, at least in Cannes bay, seem particularly suitable for the brittle star, although not for its hosts: these were the only habitat where the density of *O. setosa* seemed to exceed the availability of hosts, half of available hosts there bearing at least one individual, and some individuals living without a cnidarian host, notably one observed on an ascidian (*Pyura microcosmus*, Fig. 4F), and another one on human garbage. However, *O. setosa* was not observed in this area between 30 and 50 m despite a similar faunistic assemblage, with higher density of *A. palmatum*.

In Angola, Cherbonnier (1962) reported that “Most of the samples had their arms wrapped around the branches of the yellow gorgonian *Trichogorgia flexibilis* Hickson [now *Trichogorgia flexilis*, Hickson, 1904], except for those at station 94, which were supported by the small pinkish-white gorgonian *Eunicella verrucosa*”, showing an association with other host species in another bioregion.

The lower depth limit for this species remains unknown: Koehler reports it as deep as 655 m, “even down to 1480 m” (Koehler 1921).

Host preferences and avoidance

The absence of *O. setosa* on several potentially suitable coral species could possibly be due to selective choice of host species, potentially driven by surface microtexture, feeding position, biological repulsion or microcurrent exposure rather than mere availability. There could perhaps exist an ecological misfit: *C. rubrum* lives mainly on sloping ceilings, often in caves, and *Eunicella singularis* prefers sedimentary bottoms and calm, shallow waters, which may not suit *O. setosa* (it is rarely sympatric with these gorgonians). *Viminella flagellum* is a non-branching species and may not provide sufficient protection, and *Parantipathes larix* also exhibits a non-gorgonian, bottlebrush-shaped morphology (and belongs to a different group, Antipatharia). It may also suggest a biological incompatibility, such as a low tolerance from the host (*C. rubrum* seems to have very few associated symbionts) or an active avoidance of certain host species by the brittle star. No individuals were observed either on sea pens (Pennatuloidae, Octocorallia) despite their abundance on the soft bottoms of the Bay of Cannes, but their ability to retract into the sand may not suit such a symbiont.

The museum records analysed here mention no host and regarding the “Corti” samples, the collector H. Zibrowius confirmed that *O. setosa* was collected free-living. The recently discovered population of *O. setosa* on *C. verticillata* off Corsica may be the first specimens that have been collected clinging to their host.

Life history traits

This species appears to live mostly as an epibiont on gorgonians, using gorgonian colonies to elevate itself above the substrate to better capture suspended food particles, which is common among Ophiacanthidae, especially deep species. Gorgonians also provide a safe shelter, as they have few predators and a hard skeleton. *Ophiacantha setosa* is generally found curled around the branches of its host in a way similar to what can be observed in some shallow species such as *Ophiothela venusta* (de Loriol, 1900) (Peyghan *et al.* 2018). However, this behaviour seemed to differ according to depth: shallow individuals were small and isolated, always tightly coiled against their host. On the other hand, mesophotic specimens seemed to reach larger sizes (Fig. 3C), with more extended arms, and only loosely hanging on to the host, but more specimens need to be collected from all localities to verify this hypothesis; on the deep bottoms (>100 m), several specimens were frequently observed on the same host specimen (which may just be related to more abundant populations, as in Fig. 4D). Exceptionally, and only on the sedimentary bottoms of Cannes (where the population of *O. setosa* is large and host individuals are scarce), some brittle star individuals were observed on non-cnidarian (Fig. 4F) or even non-living supports, such as human garbage, suggesting that the

octocoral association is preferred but not completely exclusive. It is also still completely unknown if the presence of the brittle stars is beneficial, harmful or neutral to the corals (but for *C. verticillata*, this is being studied by Andromède Océanologie).

One individual of *O. setosa* was photographed repeatedly off Marseille (Moyades) over a three-year period on the same *L. sarmentosa* colony at the exact same place. Assuming that this was indeed the same individual, this observation could indicate stable host association, low mobility once settled and a lifespan of several years, quite similar to what is observed with the much larger planktotrophic basket star *Astrospartus mediterraneus* (Risso, 1826), with which it shares most of its bigger hosts (Réty, pers. obs.). More observations under controlled conditions are needed to verify this hypothesis.

Mesophotic observations also show that whereas *O. setosa* is clearly most abundant on *Callogorgia verticillata*, these specimens tend to be smaller than the individuals photographed by the same team on *P. clavata* and *E. cavolini* at similar or slightly shallower depths. However, more material needs to be collected and measured to quantify this. If true, this could indicate different recruitment events and thus different age of the brittle stars. As size is not always related to age in echinoderms, this observation remains difficult to interpret, and could be due to food availability, predation, competition or even reproductive strategy. Small specimens of the Mediterranean basket star *A. mediterraneus* seem to be found mostly on *Eunicella cavolini* and *Leptogorgia sarmentosa* while larger individuals are found on *P. clavata* (Réty, pers. obs.): both species may experience a host species shift with growth, but this hypothesis would need further research.

It is still unknown how *O. setosa* finds its hosts, which life stage settles on them, or whether individual brittle stars can switch between host individuals/species or change between epizoic and free-living life-styles. Nothing is known about reproduction and larval type of *O. setosa*, except that it is not a brooder and does not show any signs of asexual reproduction by fission. Ophiuroids generally rely on planktonic larvae for dispersal, with lecithotrophic larvae having a much shorter development than planktotrophic larvae and thus more limited dispersal range before the metamorphosed postlarvae need to settle on the bottom. It is known in the brittle star *Ophiothrix fragilis* (Abildgaard, in O.F. Müller, 1789) that postlarvae find adult congeners by olfactory means and settle on them (Morgan & Jangoux 2004). A species closely related to *O. setosa* is *Ophiacantha abyssicola* G.O. Sars, 1872, which has been recorded in large aggregations on beds of two deep-water coral species, *Primnoa resedaeformis* (Gunnerus) and *Paragorgia arborea* (Linnaeus, 1758), off Nova Scotia (Metaxas & Giffin 2004).

Conclusion

For more than two centuries, *Ophiacantha setosa* has remained an enigmatic Mediterranean brittle star, known almost exclusively from historical dredged material and brief taxonomic accounts—often only a name in lists. By combining a critical review of early literature with new *in situ* observations obtained through scientific diving, underwater photography, and citizen science contributions, this study provides the first comprehensive characterization of the species in life and especially *in situ*.

Our results reveal that *O. setosa* is a specialized epibiotic species, closely associated with octocorals across a wide bathymetric range, sometimes shallower than previously estimated. Host use appears to vary with depth, reflecting both the vertical distribution of available corals and possibly host (species and individual) selectivity, although *O. setosa* accepts a wide variety of host species. The species may perhaps display long-term host fidelity, but more data are needed. It has morphological adaptations to an epizoic life-style (streptospondylous vertebrae) and the ability to form dense aggregations on certain mesophotic hosts.

Beyond the case of *O. setosa*, this work highlights the scientific value of underwater imagery and participatory observation networks for documenting overlooked marine invertebrates. Many species currently regarded as rare or poorly known may in fact be locally conspicuous but remain undocumented due to methodological limitations. Integrating historical taxonomy with modern observational approaches offers a powerful framework to rediscover such “ghost species” and to refine our understanding of Mediterranean benthic biodiversity. An approach based largely on essentially random observations and photographic information does of course have its limits. Species identification was made easy in this case by the unique colour pattern and key characters of *O. setosa* that do not overlap with any other Mediterranean species. Species with a less conspicuous colouration or a more cryptic life-style would be more difficult to observe in the same fashion. Long-term observational series in the same spots would

be needed to better understand host preferences and population development. This is often prohibitively costly for researchers, but enthusiastic naturalists and recreational divers could contribute better structured data under guidance.

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SUPPLEMENTARY MATERIALS. The following supporting information can be downloaded at the DOI landing page of this paper

Supp. file 1. List of museum specimens of *Ophiacantha setosa*. Data extracted from GBIF, edited for standardized vocabulary. Formatted using DarwinCore terms. CSV file format. <https://doi.org/10.5281/zenodo.20592929>.

Supp. file 2. Details of observation records of *Ophiacantha setosa* from diving. The RECOR reports can be accessed at https://medtrix.fr/portfolio_page/reCOR/. Formatted using DarwinCore terms. CSV file format. <https://doi.org/10.5281/zenodo.20592929>.