

Back from presumed local extinction: the case
of *Sargassum hornschurchii* C.Agardh
(Fucales: Heterokontophyta) in
the Spanish Mediterranean

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Back from presumed local extinction: the case of *Sargassum hornschurchii* C.Agardh (Fucales: Heterokontophyta) in the Spanish Mediterranean

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ABSTRACT

We report on a new record of *Sargassum hornschurchii* C.Agardh in the Spanish Mediterranean after having no reports for more than a century. *Sargassum hornschurchii* was found in a deep-water rocky bottom offshore Menorca together with the kelp *Laminaria rodriguezii* Bornet and the rockweed *Ericaria zosteroides* (C.Agardh) Molinari & Guiry. We make an accurate morphological description and provide pictures of the specimens collected. This new record puts into question the assignment of the IUCN “extinct” category for deep-water rare macroalgae as they can go unnoticed for a long time. This also highlights the need to protect remote deep-water spots where biodiversity can still be flourishing.

RÉSUMÉ

De retour après une extinction locale présumée: le cas du Sargassum hornschurchii C.Agardh (Fucales: Heterokontophyta) en Méditerranée espagnole.

Nous rapportons la redécouverte de *Sargassum hornschurchii* C.Agardh dans la Méditerranée espagnole après plus d'un siècle d'absence de signalement. *Sargassum hornschurchii* a été trouvé dans un fond rocheux profond au large de Minorque avec la laminaria *Laminaria rodriguezii* Bornet et le cystoseire *Ericaria zosteroides* (C.Agardh) Molinari & Guiry. Nous faisons une description morphologique précise et fournissons des photos des spécimens collectés. Cette découverte remet en question l'attribution de la catégorie « éteinte » de l'UICN aux macroalgues rares des eaux profondes, car elles peuvent passer longtemps inaperçues. Cela souligne également la nécessité de protéger les zones profondes éloignées des côtes, où la biodiversité peut être encore florissante.

KEY WORDS

Macroalgae,
Mediterranean,
extinction,
Sargassum,
rediscovery.

MOTS CLÉS

Macroalgues,
Méditerranée,
extinction,
Sargassum,
redécouverte.

INTRODUCTION

Marine forests in the Mediterranean Sea are not usually dominated by kelps but by species of the order Fucales (Rodríguez-Prieto *et al.* 2013). Two genera of the order Fucales were considered to be present in the Mediterranean until recently. However, molecular data has supported the division of the previous genus *Cystoseira* C.Agardh into three different genera: *Cystoseira* C.Agardh, *Ericaria* Stackhouse and *Gongolaria* Boehmer (Molinari-Novoa & Guiry 2020), which are the main engineering species of these forests. However, the genus *Sargassum* C.Agardh, with nine species known to inhabit the Mediterranean Sea (Aouissi *et al.* 2018; Blanfuné *et al.* 2022), were also reported to be relevant in the past in these forests. Nevertheless, all but two (the invasive *Sargassum muticum* (Yendo) Fensholt and the native *Sargassum vulgare* C.Agardh) have become extremely rare or even locally extinct (Thibaut *et al.* 2016). Three of the nine species reported are considered to be Mediterranean endemisms and, thus, they require a special attention when dealing with conservation issues: *Sargassum hornschurchii* C.Agardh, *Sargassum ramentaceum* Zarmouth & Nizamuddin, and *Sargassum trichocarpum* J.Agardh (Blanfuné *et al.* 2022).

Sargassum hornschurchii is a species apparently reported from the coastal areas of most Mediterranean regions and countries (Aouissi *et al.* 2018). However, Aouissi *et al.* (2018) did not include Egypt in its distribution, although it has been widely reported, mainly around the coastal area of Alexandria (Fakhry *et al.* 2013; Noaman *et al.* 2013a, 2013b; El-Zabalawy & El-Kenany 2015; Fathy *et al.* 2017; Abdel-Kareem *et al.* 2020; Ghallab *et al.* 2022) but also from other sites west from the Nile Delta (Shams El-Din & El-Sherif 2012). The species seems also to be present in Libya (Alghazeer *et al.* 2019, 2021). *Sargassum hornschurchii* has also been reported from the Black Sea (Karacuha & Okudan 2017). Thus, according to past and present reports, *S. hornschurchii* shows a wide Mediterranean distribution, with the continental coasts of Spain being the only place where the species has never been reported (Gómez-Garreta *et al.* 2000).

Unless *S. hornschurchii* has been widely reported all across the Mediterranean, being very common in the Adriatic Sea (Ercegović 1960; Špan 2005), it has always been considered rare in the Western Mediterranean. In Spain, *S. hornschurchii* has only been reported from the Balearic Islands (Rodríguez-Femenías 1889; de Buen 1916; Garcías 1919; Bellón 1921) but there are no citations and no herbarium specimens collected after 1950 (Gómez-Garreta *et al.* 2000). In France, *S. hornschurchii* was reported to be present along all the French Mediterranean coasts (Thibaut *et al.* 2016), although there are not recent reports of the species, even in the Albères Coast, where according to Feldmann (1937), it was rather frequent in deep water assemblages dominated by *Gongolaria montagnei* (J.Agardh) Kuntze (as *Cystoseira spinosa* Sauvageau). Thibaut *et al.* (2005) considered *S. hornschurchii* extinct from the Albères coast and Thibaut *et al.* (2015) considered it extinct from the French Riviera. The last recorded report from France dates back to 1988 from Galeria, Corsica (Thibaut *et al.* 2016).

However, Verlaque *et al.* (2019), even if the species has not been seen for the last 35 years, consider extinction only as a hypothesis, as *S. hornschurchii* has always been very rare. In the Tyrrhenian Sea (Italy), *S. hornschurchii* has been reported to be present in Giannutri, Gorgona Islands and other Tyrrhenian islands (Piazzi & Cinelli 2002; Piazzi *et al.* 2009; Piazzi & Ceccherelli 2020). *Sargassum hornschurchii* was also reported from different spots in the Sicily Channel (Giaccone *et al.* 1972, 1973). In the Mediterranean western coasts of Africa, *S. hornschurchii* has been reported only from La Galite (Tunisia) (Feldmann 1961), Algeria (Perret-Boudouresque & Seridi 1989) and Morocco (González-García & Conde-Poyales 1994) although it has not been recently seen (Moussa *et al.* 2018). In short, the only twenty first century western Mediterranean records come from the Tyrrhenian islands, while the species has not been recorded in Spain, France, Tunisia, Algeria or Morocco for at least the last 30 years.

Here we provide a recent record of *S. hornschurchii* from Menorca (Balearic Islands). Given the extreme scarcity of this species and the fact that it has not been recorded in Spanish waters for the last 100 years, we also provide a morphological description of the specimens and a short comment on the habitat where the specimens were collected.

MATERIAL AND METHODS

Specimens were collected onboard the fishing vessel *Curniola* based on Ciutadella Harbor (Menorca) on April 26th, 2022. Sampling was performed by trammel nets set in fishing grounds for lobster. Marine biologists were on board to collect macroalgae brought from the seabed by the nets. Location of the collection was given by the GPS and plotter of the fishing vessel. GPS bottom accuracy is low, due to the length of the net and the drift of the boat while recovering the gear. *Sargassum hornschurchii* samples were collected and taken to the laboratory where they were observed and identified. The descriptions were compared with previous descriptions of the species made by other authors (Hamel 1931-1939; Cormaci *et al.* 2012; Aouissi *et al.* 2018; Blanfuné *et al.* 2022). Pictures were taken with an Olympus TG6 camera in the laboratory. Two vouchers specimens were mounted on herbarium sheets.

RESULTS

The locality of collection is a fishing ground known as “Fora de Sa Barra” (40°00′03.0″N, 3°39′23.5″E), placed over rocky substrate and at a depth around 65 meters. Specimens of a species of *Sargassum* were brought to the surface with other erect macroalgae, mainly *Laminaria rodriguezii* Bornet and *Ericaria zosteroides* (C.Agardh) Molinari & Guiry.

DESCRIPTION

Thallus erect, 20-40 cm high (Fig. 1); holdfast discoid; stipes cylindrical, warty, 1-4 cm high, up to 4 mm diameter, one to three stipes arising from a single holdfast (Fig. 1); primary



FIG. 1. — Specimen of *Sargassum hornschurchii* C. Agardh collected in Menorca. Notice the serrated wings at the base of the primary branches. Scale bar: 4 cm.

branches 20–36 cm long, flattened, with serrated wings at the base, cylindrical at the apex (Figs 1, 2); basal blades 7–10 × 1.0–1.6 cm, upper blades smaller, all lanceolate, wavy, serrated, sessile, with marked central nerve (Fig. 3); air bladders almost spherical 4–5 cm × 5–6 mm, smooth, petiolated 1–3 mm, not mucronated; receptacles pedicellated, situated in ramified branches, 2–4 mm long (Figs 3, 4); receptacles irregularly polyhedral in section, slightly warty, apiculate, up to 10 mm long and 2.0–2.5 mm wide, usually single but sometimes divided (Fig. 5); oogonia spherical (320 to 350 µm) or slightly oval (240–310 × 340–400 µm) (Fig. 6). All these features are consistent with *S. hornschurchii*. Vouchers have been deposited at the Herbarium of the University of Girona (HGI-A 22238 and HGI-A 22239).

DISCUSSION

The morphological features of the specimens collected fit into the description of *S. hornschurchii*. Main characteristics are the flattened and irregularly winged primary branches near the base, the pedicellated receptacles situated in ramified branches, and the big and distinct, apiculate receptacles that are polyhedral in section. In our opinion the flat receptacles usually attributed to *S. hornschurchii* (Hamel 1931–1939; Cormaci *et al.* 2012; Aouissi *et al.* 2018; Blanfuné *et al.* 2022) should come from descriptions based on pressed herbarium material and are probably incorrect. Amongst the Mediterranean species that can be confused with, none of them has winged primary branches. Moreover, reproductive specimens fall



FIG. 2. — Detail of holdfast and stipes. Scale bar: 2 cm.

apart since in *S. vulgare* receptacles are much smaller and in *Sargassum acinarium* (Linnaeus) Setchell and *S. trichocarpum* receptacles are very thin (up to 1 mm wide) and cylindrical (Aouissi *et al.* 2018; Blanfuné *et al.* 2022).

Sargassum hornschurchii is usually reported as a deep-water species at least in the Western Mediterranean and in the Adriatic. It is mostly reported between 15-30 m in the Albères coast (Feldmann 1937), 30 to 60 m depth in most French territories including Corsica (Thibaut *et al.* 2016), 30 to 64 m in Italy (Giaccone 1967, 1972) and 10 to 60 meters in the Adriatic Sea (Špan 2005), with very rare collections from the northern Adriatic at 5 m (Munda *et al.* 2006). Reports from Tunis (La Galite) come from 25-50 m depth (Feldmann 1961). In Menorca it has been reported by Rodríguez-Femenías (1889) between 110 and 150 m depth and in the Adriatic Sea down to 250 m depth (Ercegović 1960), although these ancient records whether belong to drift specimens or depths were measured inaccurately. Excluding these non-reliable depths, our collection at 65 m is, thus, at the lowest reported depth range for the species. The clear waters surrounding the Balearic Islands (Ballesteros & Zabala 1993) are probably responsible for it. Another issue is that most reports from the Levantine Sea come from very shallow water (Shams El-Din &

El-Sherif 2012; Fakhry *et al.* 2013; Noaman *et al.* 2013a, 2013b; El-Zabalawy & El-Kenany 2015; Fathy *et al.* 2017; Abdel-Kareem *et al.* 2020; Ghallab *et al.* 2022), which casts some doubt about their correct identification.

The collection of *S. hornschurchii* in Menorca was accompanied by *L. rodriguezii* and *E. zosteroides*. The same three species were also found growing together in Banco Appolo (Ustica, Tyrrhenian Sea) between 42 and 64 m depth (Giaccone 1967) and in La Galite (Feldmann 1961). According to Giaccone & Bruni (1973), *S. hornschurchii* characterizes erect macroalgal assemblages from the lower infralittoral and upper circalittoral zones subjected to a high unidirectional water movement and light intensity ranging from 20 to 0.01% of the surface light. These include assemblages dominated either by *G. montagnei* (as *Cystoseira spinosa*), by *E. zosteroides* (as *Cystoseira zosteroides*), by *L. rodriguezii* and, only in the Alboran Sea and the straits of Messina, by *Gongolaria usneoides* (Linnaeus) Molinari-Novoa & Guiry (as *C. usneoides*), *Laminaria ochroleuca* Bachelot Pylae and *Saccorhiza polyschides* (Lightfoot) Batters. Feldmann (1937) reported *S. hornschurchii* from the assemblage dominated by *E. zosteroides* and *G. montagnei* at the Albères coast, the same kind of assemblage where it appears in some islands of the Tyrrhenian Sea (Piazzi *et al.* 2009; Piazzi & Ceccherelli 2020).



FIG. 3. — Upper portion of the thalli with receptacles. Scale bar: 2 cm.

Sargassum hornschurchii may be restricted to rocky bottoms since it has never been reported from Balearic Islands' coastal detritic assemblages, where *L. rodriguezii*, *E. zosteroides* and *G. montagnei* are usually common (Joher *et al.* 2012, 2015, 2016, 2023).

Sargassum hornschurchii has suffered an important regression in the western Mediterranean (Gómez-Garreta *et al.* 2000; Thibaut *et al.* 2005, 2015, 2016; Ould-Ahmed *et al.* 2013; Moussa *et al.* 2018) and it seems to be also disappearing in areas of the Ionian (Cecere *et al.* 1996) and the Adriatic seas (Sidari & Bressan 1992; Cormaci & Furnari 1999; Munda 1993, 2000; Cecere *et al.* 2001; Curiel *et al.* 2009; Falace *et al.* 2010; Perkol-Finkel & Airolidi 2010). There are no experimentally tested factors accounting for this decrease although increased turbidity, hyper-sedimentation, trawling, anchoring and uprooting by fishing nets have been blamed by Thibaut *et al.* (2015) and Verlaque *et al.* (2019). In fact, our samples come from trammel net fishing, pointing to fishing gear as a real cause of harm. Because of the current rate of decrease, *S. hornschurchii* is considered as “Endangered” at the Mediterranean level according to the IUCN classification (Verlaque *et al.* 2019). It was also included in the first internationally recognized and accepted list provided under the umbrella of the Barcelona Convention in 1996 in the Annex to the protocol concerning Specially Protected Areas

and Biological Diversity in the Mediterranean that was lately updated in 2009 (Verlaque *et al.* 2019). This list has been roughly transcribed into some national legislations (e.g. France: Decree no. 2002-1454, December 2002 amended by Decree no. 2014-1195 of 16 October 2014; Spain: Law 42/2007 amended by Order AAA/75/2012) or has been used as a base to produce more accurate local checklists (e.g. Catalonia: Decree 172/2008 of 26 August 2023).

Considering everything stated regarding *S. hornschurchii*'s rarity and decrease, this new record from Menorca acquires great relevance. This collection is the only one in the last 35 years from the westernmost part of the Western Mediterranean sea and the first one after more than a century in Spain. We agree with Verlaque *et al.* (2019) that it is almost impossible to give the IUCN “Extinct” category to deep-water algal species such as *S. hornschurchii*, since they are naturally scarce and it is extremely difficult to look for new populations. In fact, unequivocally detecting the extinction of a species is not an easy task (Diamond 1987; Akçakaya *et al.* 2017; Lee *et al.* 2017) and specialists debate about the criteria to be considered (Butchart *et al.* 2006; Roberts *et al.* 2023). Uncertainty increases if extinction is local, since recolonisation coming from individuals from other distant populations is possible and random in space and time. But we do not expect that recolonisation could be the case for *S. hornschurchii* in Menorca



FIG. 4. — Detail of the pedicellated receptacles. Scale bar: 1 cm.

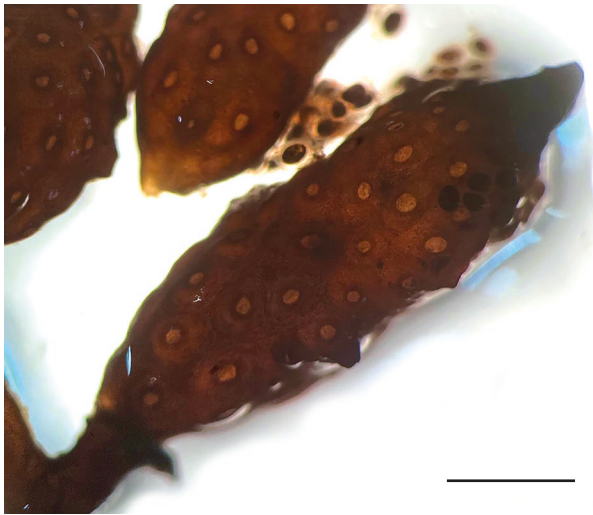


FIG. 5. — Close-up of a warty apiculate receptacle showing some extruded oogones. Scale bar: 2 mm.

as we are very confident that it has never disappeared from the location we collected it. Remote, non-accessible areas are a good place to search for potentially extinct species as local anthropogenic impacts (*i.e.*, fishing and associated impacts of fishing gear) are presumed to be lower and species persistence to be higher. Thus, protection to fishing of these areas is highly recommended. In fact, the area we collected *S. hornschurchii* is inside a Site of Community Importance (SCI) within the Natura 2000 network since 2014, and it was designated as a trawl-fishing protected zone in 2016 (Farriols *et al.* 2022). Moreover, all the area affecting the rocky bottoms known as “Fora de Sa Barra” has been proposed as a no-take area (Ballesteros 2022), which would greatly increase the chances of survival of the remaining specimens of *S. hornschurchii* as well as many more endangered species that are known to thrive in the area (Barberá *et al.* 2012; Joher *et al.* 2012, 2015; Farriols *et al.* 2022).

CONCLUSION

In conclusion, this recent unexpected finding of *S. hornschurchii* in Spanish waters, after more than one century of not being reported, is good news for Spanish marine biodiversity. It also tells us the lack of knowledge about the hidden diversity that still exists below the normal depths surveyed by SCUBA and

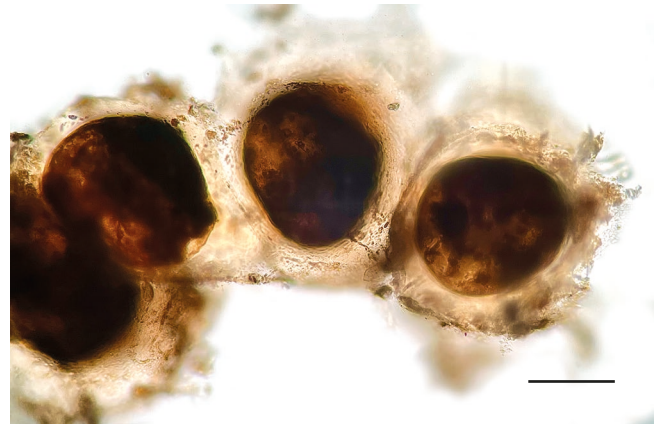


FIG. 6. — Oogonia extruded from receptacles. Scale bar: 150 µm.

the necessity of investing resources to fill this gap if we really care about conservation. Finally, it highlights the emergency of creating marine protected areas in places other than recreational diving spots where biodiversity can still be flourishing.

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This work is dedicated to the memory of Dr. Enric Ballesteros, whose contributions to the study of Mediterranean macroalgae have left a lasting mark on the field. It was an honor to collaborate with him on what became our final joint contribution – the rediscovery of *Sargassum hornschurchii* in the Spanish Mediterranean. Although Enric is no longer with us, his influence continues to guide our work, and we like to think that this will not be our last contribution together.

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