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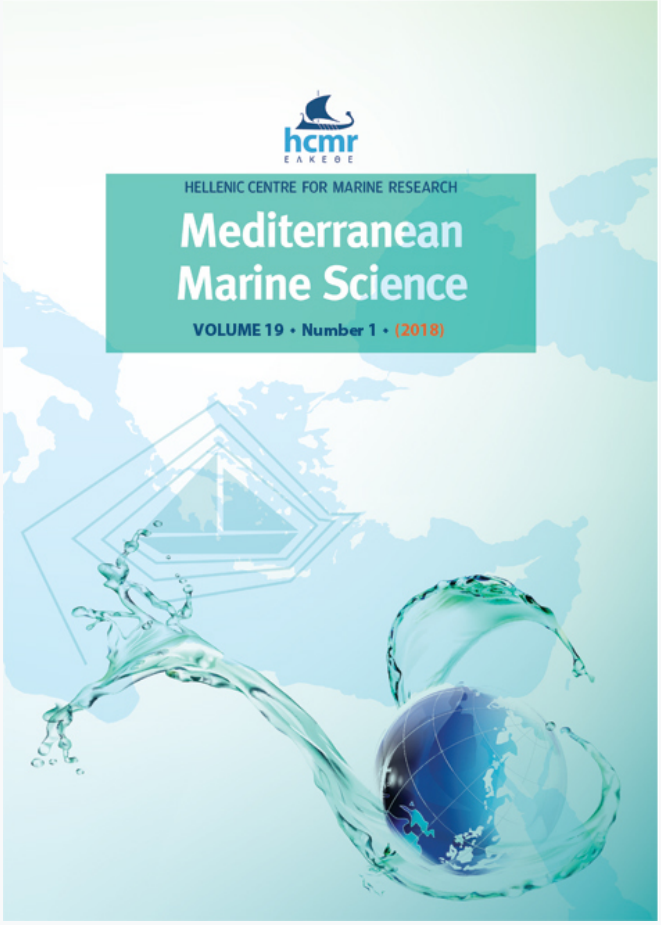

Insights into the species diversity of the genus Sargassum (Phaeophyceae) in the Mediterranean Sea, with a focus on a pre-viously unnoticed taxon from Algeria

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Insights into the species diversity of the genus *Sargassum* (Phaeophyceae) in the Mediterranean Sea, with a focus on a previously unnoticed taxon from Algeria

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Abstract

Nine species of the genus *Sargassum* (Phaeophyceae; kingdom Stramenopiles) are currently accepted in the Mediterranean Sea: *S. acinarium, S. desfontainesii, S. flavifolium, S. furcatum, S. hornschuchii, S. muticum, S. ramentaceum, S. trichocarpum* and *S. vulgare*. *Sargassum desfontainesii* and *S. furcatum* are Atlantico-Mediterranean species. *Sargassum hornschuchii*, *S. ramentaceum* and *S. trichocarpum* are endemic to the Mediterranean. The presence of the Atlantic *S. flavifolium* in the Mediterranean is at least in part based upon a misidentification and therefore requires confirmation. Near Algiers and Annaba (Algeria), a *Sargassum* taxon sharing most characters with *S. flavifolium* was collected. This taxon, referred to as the Algerian *Sargassum* sp., is described and illustrated. Its distribution and ecology in Algeria are presented. This taxon differs from *S. flavifolium* in having costate, small-sized, unbranched leaves and small-sized receptacles, branched in all directions and lacking a branched sterile pedicel at the base. In the absence of genetic data, and a study of the type material of *S. flavifolium*, syntype localities: West Indies (*Antilles*) and Biarritz, a description of a new taxon would be premature.

Keywords: Algeria, Mediterranean Sea, Phaeophyceae, *Sargassum flavifolium*, *Sargassum* spp.

Introduction

The genus *Sargassum* C. Agardh is one of the most species-rich genera among the Fucales (Phaeophyceae, kingdom Stramenopiles; for taxonomic treatment see references in Boudouresque, 2015), with 354 taxa (species and infraspecific taxa) currently accepted (Guiry & Guiry, 2017). Most *Sargassum* taxa are tropical and subtropical. In the Mediterranean Sea, nine species of *Sargassum* have been reported (Table 1): *Sargassum acinarium* (Linnaeus) Setchell, *S. desfontainesii* (Turner) C. Agardh, *S. flavifolium* Kützing, *S. furcatum* Kützing, *S. hornschuchii* C. Agardh, *S. muticum* (Yendo) Fensholt, *S. ramentaceum* Zarmouh & Nizamuddin, *S. trichocarpum* J. Agardh and *S. vulgare* C. Agardh (Ribera *et al.,* 1992; Cormaci *et al.,* 2012). *Sargassum salicifolium* (J. Agardh) J. Agardh *sensu lato* and infraspecific taxa of *S. vulgare* (see e.g. Špan, 2005), which are of uncertain taxonomic status (Ribera *et al.,* 1992), are not taken into consideration here. *Sargassum hornschuchii, S. ramentaceum* and *S. trichocarpum* have only been recorded in the Mediterranean Sea (Guiry & Guiry, 2017) and are putatively endemic to this area.

Sargassum species can form extensive marine forests that are major components of the underwater seascape and coastal ecosystems (Komatsu & Murakami, 1994; Yatsuya *et al.,* 2007; Komatsu *et al*., 2014; Boudouresque *et al.,* 2016). In some regions, *Sargassum* species are undergoing a very severe decline due to overgrazing by herbivores (a cascading effect of overfishing), invasive species such as the herbivorous teleosts *Siganus* spp., habitat destruction, trawling and net fishing, eutrophication and an increase in water turbidity (Thibaut *et al.,* 2005; Airoldi & Beck, 2007; Tsiamis *et al.,* 2013a; Bianchi *et al.,* 2014; Vergés *et al.,* 2014; Thibaut *et al.,* 2015, 2016; Gatti *et al.,* 2017).

In Algeria, four species have been listed, namely *S. acinarium, S. hornschuchii, S. trichocarpum* and *S. vulgare* (Perret-Boudouresque & Seridi, 1989; Ribera *et al.,* 1992). Here, we report on a species belonging to *Sargassum*, occurring in Algeria (southwestern Mediterranean Sea), which does not correspond to any of the nine species reported from the Mediterranean Sea. We also highlight the likely underestimation of the *Sargassum* diversity in the Mediterranean Sea.

Table 1. Distribution of currently accepted taxa (according to Guiry & Guiry, 2017) of the genus *Sargassum* in the Mediterranean Sea and Black Sea (data from Ribera *et al.,* 1992; and updated as by Ben Maiz *et al.,* 1987; Zarmouh & Nizamuddin, 1991; González García & Conde, 1992; Ribera *et al.,* 1996; Curiel *et al.,* 1998; Flores Moya & Conde 1998; Benhissoune *et al.,* 2002; Cormaci *et al.,* 2012; Verlaque *et al.*, 2015; Guiry & Guiry, 2017). +: present; -: not recorded. Sp: continental Spain; BI: Balearic Islands (Spain); Fr: continental France; CS: Corsica (France) and Sardinia (Italy); WI: Western Italy; Si: Sicily (Italy) and adjacent islands; Ad: Adriatic Sea, including Albania; Gr: Greece; BS: Black Sea and Azov Sea; Tu: Turkey (Sea of Marmara and Mediterranean coast); LS: Levant states (Lebanon, Syria and Israel); Eg: Egypt; Li: Libya; Tn: Tunisia; Ag: Algeria; Mo: Morocco (including Spanish territories, e.g. Chafarinas islands).

Taxon	Sp	BI	Fr	CS	WI	Si	Ad	Gr	BS	Tu	LS	Eg	Li	Tn	Ag	Mo
Sargassum acinarium (Linnaeus) Setchell	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+
Sargassum desfontainesii (Turner) C. Agardh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Sargassum flavifolium Kützing	-	-	-	+ [a]	-	+	-	+	-	-	-	-	-	+	-	-
Sargassum furcatum Kützing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Sargassum hornschuchii C. Agardh	-	+	+	+	+	+	+	+	-	+	+	-	+	+	+	+
Sargassum muticum (Yendo) Fensholt	+ [b]	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-
Sargassum ramentaceum Zarmouh & Nizamuddin	-	-	-	-	-	-	-	-	-	-	-	+ [c]	+	-	-	-
Sargassum trichocarpum J. Agardh	+	-	+ [d]	-	-	+	-	+	-	-	+	-	+	+	+	-
Sargassum vulgare C. Agardh	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

[a] Based upon a misidentification; see text. [b] Only drift material of *S. muticum* has been found. [c] In the framework of the study of the marine benthos of El Dabaa (Egypt) (Campos-Villaça *et al*., 1985; Thélin *et al*., 1985), an unidentified species of *Sargassum* was collected; the specimens have subsequently been referred to as *S. ramentaceum* (Marc Verlaque, unpublished data). [d] Only observed once, in the plume of warm water from a thermal power plant (Verlaque, 1977); this power plant only operates intermittently today, so that the species may be no longer present.

Material and Methods

Specimens belonging to the study species (hereafter the Algerian *Sargassum* sp.) were recorded along the central and the eastern coasts of Algeria, near Algiers and Annaba, in 2014 and 2015.

Near Algiers, dense patches of the studied species were observed in shallow reef habitats, 0-0.5 m depth, within *Cystoseira compressa* (Esper) Gerloff & Nizamuddin forests at El Marsa (36° 48' 41.3" N, 3° 15' 23.5" E; coordinate system: WGS 84); collected specimens (collector: LNS): H8320, H8321 and H8322 (27 June 2015). The depth '0' means the limit between the midlittoral and the infralittoral zones *sensu* Pérès & Picard (1964).

Near Annaba (eastern Algeria), isolated individuals of the Algerian *Sargassum* sp. were found thriving in an exposed photophilic community, at Cap de Garde (entrance of the Gulf of Annaba; 36° 58' 4.34" N, 7° 47' 30.06" E); collected specimens (collector: MA): H8323 (29 August 2014). The species was thriving on shallow reefs, from the sea surface down to 0.5 m depth, associated with *Cladostephus spongiosum* (Hudson) C. Agardh, *Cystoseira amentacea* (C. Agardh) Bory, *Cystoseira compressa, Halopteris scoparia* (Linnaeus) Sauvageau (Phaeophyceae), *Corallina caespitosa* R.H. Walker, J. Brodie & L.M. Irvine, *Chondracanthus acicularis* (Roth) Fredericq, *Jania rubens* (Linnaeus) Lamouroux (Florideophyceae, Rhodobionta, kingdom Archaeplastida) and *Caulerpa cylindracea* Sonder (Ulvophyceae, Viridiplantae, kingdom Archaeplastida).

The material studied has been deposited at the HCOM, the Herbarium of the Mediterranean Institute of Oceanography, Aix-Marseille University. Herbarium abbreviations follow Thiers (2016).

Specimens of the Algerian *Sargassum* sp. were compared with the collection of Mediterranean *Sargassum* species deposited in the HCOM and with the following specimens of genuine *S. flavifolium* deposited in the herbarium of the Muséum National d'Histoire Naturelle, Paris, PC:

- PC0527409, Biarritz, June 1830, coll. Heribaud;
- PC0539255, PC0539256 and PC0458533, Guéthary, 10 July - 30 August 1896, coll. C. Sauvageau;
- PC0527408, Guéthary [France, NE Atlantic Ocean], 17 July 1921, coll. C. Sauvageau;
- PC0527407, Guéthary [France, NE Atlantic Ocean], 25 July 1923, coll. C. Sauvageau;
- PC0458528, Herbier J. Feldmann, Guéthary [France, NE Atlantic Ocean], 3 October 1928;
- PC0458529, Herbier J. Feldmann, between Guéthary and Bidart [France, NE Atlantic Ocean], 15 August 1927;

- PC0458530, Pointe Sainte Barbe, Saint Jean de Luz [France, NE Atlantic Ocean], 16 July 1927, coll. J. Feldmann;
- PC0458531, between Guéthary and Bidart [France, NE Atlantic Ocean], 21 July 1927, coll. J. Feldmann;
- PC0458532 and PC0458534, Pointe Sainte Barbe, Saint Jean de Luz [France, NE Atlantic Ocean], 1st August 1927, coll. J. Feldmann;
- PC0527404, Herbier Rob. Lami, algues marines, col. P. Arné, Guéthary [France, NE Atlantic Ocean], July 1938.

Results and Discussion

The studied specimens of the Algerian *Sargassum* sp. (Table 2) measure between 15 and 30 cm in height, have a short main axis, smooth or scarred, 0.5-1.0 cm in length, fixed to the substratum by a small basal disc; primary and secondary branches cylindrical and smooth, up to 30 cm long and 6 cm long respectively; leaves (foliaceous branches) with a very short (< 1 mm) petiole; they are lanceolate, up to 35 mm long and 3-4 mm wide (Fig. 1), unbranched, with a midrib, an acute extremity and numerous marginal acute teeth. At the base of the leaf gas vesicles (aerocysts) and receptacles can be found; gas vesicles spherical, 2-4 mm in diameter, at the end of a slender pedicel 1-3 mm long, rarely surmounted with a short mucron (Figs 2-4); receptacles are fertile down to close to their base, the sterile pedicel being short or absent. The receptacles are branched in all directions, thickset, short, up to 3-6 mm long, with branches cylindrical, muriculate, warty and sometimes bifurcate at the extremity; some receptacles can show either an air vesicle or a small leaf, inserted between fertile parts (Figs 2-4). The studied specimens were monoecious. Fertile individuals were found from spring to late summer.

The Algerian *Sargassum* sp. can be easily distinguished from most of the nine species previously recorded in the Mediterranean Sea (Table 2), e.g. **(i)** by the presence of leaves (lacking in *S. desfontainesii,* or unconspicuous to costate in *S. ramentaceum*), **(ii**) the presence of a midrib in leaves (absent in *S. muticum*), **(iii)** the small size of the leaves (much longer and wider in *S. hornschuchii,* and up to 10 cm long and filiform in *S. ramentaceum*), **(iv)** the unbranched leaves (branched up to 4 times in *S. furcatum*), **(v)** the absence of a true branched sterile pedicel at the base of the receptacles (present in *S. acinarium* and *S. vulgare*), and **(vi)** the small size of the receptacles (much longer in *S. trichocarpum*). The closest species to the Algerian *Sargassum* sp., on the basis of the morphology, seems to be *S. flavifolium*, a species originally described from the Bay of Biscay and the West Indies (*Antillas*) (Kützing, 1849) (Fig. 5); however, in the latter, leaves and gas vesicles are slightly larger (Table 2). Clear-cut differences concern the receptacles (Figs 2-4 vs. Fig. 5); in the Algerian *Sargassum* sp., these are muriculate (rather than smooth), branched in all directions (rather than complanate and mainly branched in one plane). Small leaves and gas vesicles can be inserted sometimes between the fertile parts ('zygocarpic receptacle'), a feature not mentioned in the descriptions of *S. flavifolium*. On the basis of the latter character, the Algerian specimens would be referred to the sectio *Zygocarpicae* (J. Agardh) Setchell of the genus *Sargassum* and subgenus *Sargassum* (see Mattio & Payri, 2011, for infrageneric delineation of *Sargassum* taxa). However, a few zygocarpic receptacles were observed in some herbarium specimens of *S. flavifolium* collected by Camille Sauvageau at Guéthary (Bay of Biscay, France) (Figs 6-8) and housed at PC (PC0539255, PC0539256). A similar zygocarpic receptacle was also drawn by Gruet (1983) from a specimen of *S. flavifolium* collected in Arcachon Bay (Bay of Biscay, France).

Sargassum flavifolium has long been known from the Bay of Biscay (European Atlantic Ocean) (Kützing, 1861; Sauvageau, 1897; Hamel, 1931-1939; Parriaud, 1959; Gruet, 1983; Casares Pascual, 1989; Gómez Gareta *et al.*, 2001; Fernández & Sánchez, 2002; Gorostiaga *et al.*, 2004; Dizerbo & Herpe, 2007; Cires Rodríguez & Cuesta Moliner 2010). It has also been recorded in Andalusia and Extremadura (Atlantic Spain) (Bárbara *et al.*, 2012; Gallardo *et al.*, 2016), Atlantic Morocco (Benhissoune *et al.*, 2002) and in the Canary Islands (Børgesen, 1926; Sangil *et al.*, 2015; Gallardo *et al.*, 2016). In the Mediterranean Sea, *S. flavifolium* was first reported from Corsica (Verlaque & Boudouresque, 1981; Boudouresque & Perret-Boudouresque, 1987). The species has also been mentioned from different Mediterranean regions: Provence, France (Verlaque & Boudouresque, 1981; Thibaut *et al.*, 2016), Italy (Giaccone, 1969; Giaccone *et al.*, 1985), Greece (Tsekos *et al.*, 1982) and Tunisia (Ben Maiz *et al.*, 1987). However, it has never been recorded in Algeria (see e.g. Perret-Boudouresque & Seridi, 1989; Ould-Ahmed *et al.*, 2013). Outside the European and African NE Atlantic Ocean, and possibly (see below) the Mediterranean Sea, *S. flavifolium* has been reported (as *Sargassum flavefolium* – sic) from the Saudi Arabian coast of the Persian Gulf (Abdel-Kareem, 2009); in the absence of an accurate description of the collected specimens, this record requires confirmation. The identity of the West Indies specimens mentioned in the protologue requires further investigation.

Mediterranean records of *S. flavifolium* are questionable. A re-examination of specimen HF.1184 from Corsica (Lavezzi Islands), recorded and described by Verlaque & Boudouresque (1981) and housed at the HCOM herbarium, shows that it actually belongs to *S. vulgare*. For the other Mediterranean records of *S. flavifolium* (Giaccone, 1969; Tsekos *et al.,* 1982; Giaccone *et al.,* 1985; Ben Maiz *et al.,* 1987), no description is available. The presence of *S. flavifolium* in the Mediterranean Sea therefore requires confirmation.

All in all, *S. flavifolium* would appear to be a north-eastern Atlantic species, known from the Bay of Biscay to the Canary Islands. Along the Algerian coast, a previously unrecorded species of the *Sargassum*, mor-

Table 2. Morphological and reproductive characters of the Mediterranean species of the genus *Sargassum* (according to Hamel 1931-1939; Gómez Garreta *et al*., 2001; Cormaci *et al.,* 2012), and of the Algeria *Sargassum* sp. When details come from other authors, this is mentioned in a footnote. Leaves are often named 'foliaceous branches' (e.g. by Gómez Garreta *et al.,* 2001; Cormaci *et al.,* 2012).

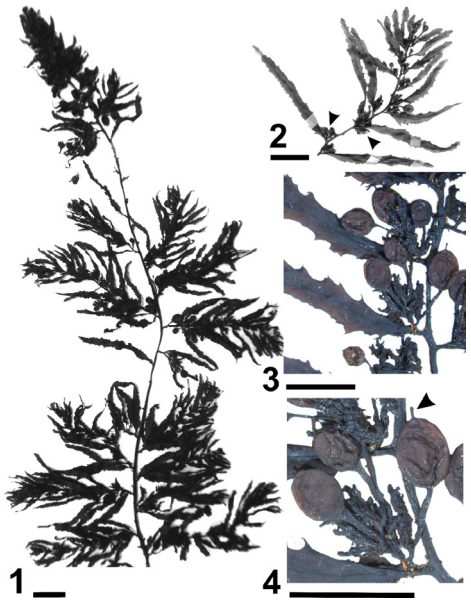
Characters	***S. acinarium***	***S. desfontainesii***	***S. flavifolium***	***S. furcatum***	***S. hornschuchii***	***S. muticum***	***S. ramentaceum***	***S. trichocarpum***	***S. vulgare***	**Algerian *Sargassum* sp.**
Basionym (if different from the accepted name)	*Fucus acinarius* Linnaeus	*Fucus desfontainesii* Turner	-	-	-	*Sargassum kjellmanianum* Yendo f. *muticum* Yendo	-	-	-	-
Type locality	'Italia & Oceano australiori'	Canary Islands	Biarritz (Bay of Biscay) [a]	St Thomas, Virgin Islands	'In mari Adriatico prope Parenzo Istriae'	Izumo, Wakayama Prefecture, Japan	Guilliana-Benghazi, Libya	'E Gadibus' (today: Cádiz, Spain)	(Ad litora Oceani Atlantici; ex India Occidentali'	-
Size (height) in cm	Up to 100	Up to 100	Up to 50	Up to 35	Up to 50	Up to 200, sometimes more	Up to 91	Up to 50	Up to 70	Up to 30 (Fig. 1)
Main axis (above the basal disc)	Several centimetres long	(1)3-8(15) main axes, cylindrical, 0.5-4.7 cm long, 2-4(7) mm in diameter, verrucose	1-2 cm long, smooth or with scars	Numerous short axes, smooth [b]	2-5 cm long, cylindrical, verrucose	Single axis, up to 2 cm long, 2-3 mm in diameter, smooth [c]	Up to 6.0 cm long, compressed, up to 6 mm in cross section, with smooth apex	Up to 3.5 cm [d]	2-4 cm long	0.5-1.0 cm long, smooth or with scars
Primary branches	Well developed, cylindrical, rough-muriculate	Cylindrical, 1-2 mm in diameter, up to 50 cm long, smooth	Well developed, cylindrical, smooth or rarely spinose	5-7 cm long, muriculate	10-50 cm long, flattened or winged near the base	Cylindrical	Cylindrical, up to 6 cm long, 3-4 mm in diameter	Cylindrical, smooth, rarely muriculate	Well developed, cylindrical, 2 mm in diameter, smooth or muriculate in the young parts	Up to 30 cm long, cylindrical and smooth
Leaves: present or absent	present	absent	present	present	present	present	present	present	present	present
Leaf midrib: present or absent	present	-	present	present	present	absent	Unconspicuous to costate	present	present and very prominent	present
Leaf size (length x width)	30-80 mm x 3-8 mm	-	30-70 mm x 2-6 mm	15-50 mm x 2-5 mm	40-80 mm x 5-15 mm	30 mm x 3-4 mm in basal parts, much smaller in upper parts	Up to 100 mm x 3 mm	30-50 mm x 2-4(10) mm	15-40 mm x 2-4 mm	30-35 mm x 3-4 mm
Leaf shape	Acute, with serrated margin	-	Acute, with wavy and toothed margin	Branched up to 4 times, with or without teeth	With or without very small teeth	Lanceolate, without teeth or slightly toothed	Sessile, linear, narrow, lanceolate, strongly serrato-dentate	Wavy or toothed margin	Lanceolate, serrate or slightly wavy margins	Lanceolate, acute, with toothed margins and a short petiole
Gas vesicles (aerocysts)	Spherical, 4-6 mm in diameter, pedicel 3-5 mm long, without mucron [e]	Spherical-oblong, 2-6 mm in diameter, with a mucron	Spherical, 4-6 mm in diameter, pedicel 3-5 mm long, sometimes with a mucron	Spherical, 3-4 mm in diameter, pedicel 1-2 mm long, without a mucron	Spherical, 3-8 mm in diameter, short pedicel, sometimes with a short mucron	Spherical, 3 mm in diameter, short pedicel, sometimes with a short mucron	Spherical, without mucron, up to 6 mm in diameter, pedicel compressed and spinose, up to 7 mm long	Spherical or slightly elongated, 4-5 mm in diameter, pedicel 3-5 mm long, with mucron [f]	Spherical, 3-5 mm in diameter, with a short pedicel and without mucron	Spherical, 2-4 mm in diameter, a slender pedicel 1-3 mm long, sometimes with a short mucron
Receptacles with or without (i.e. sessile) a sterile pedicel	with a pedicel	with a pedicel	without pedicel	without pedicel	with a branched pedicel	with a short pedicel	with a branched pedicel	without pedicel (or a very short pedicel)	with a cylindrical, branched pedicel	without (or with a very short) sterile pedicel

continued

continued

Characters	*S. acinarium*	*S. desfontainesii*	*S. flavifolium*	*S. furcatum*	*S. hornschuchii*	*S. muticum*	*S. ramentaceum*	*S. trichocarpum*	*S. vulgare*	Algerian *Sargassum* sp.
Shape of the receptacles	Fertile branch up to 50 mm, receptacles cylindrical, 10-20 mm long, unbranched or branched once	Fertile branch up to 27 mm, branched, bearing up to 12 receptacles	Receptacles alternately branched in one plan, 3-8 mm long, non muriculate	Receptacles branched, up to 30 mm long, upper branches cylindrical	Fertile branch up to 50 mm, receptacles flattened or triangular in section, with toothed margin	Receptacles not-branched (sometimes dichotomous), cylindrical, 10-12 mm long, 1-2 mm in diameter	Receptacles simple or branched, cylindrical, verrucose, submoniliform, up to 6 mm long, 1-2 mm in diameter	Receptacles cylindrical, branched, 10-20 mm long and 1 mm in diameter	Receptacles branched, 3-10 mm long, fusiform	Receptacles branched in all directions, thickset, some branches developing small leaves and gas vesicles, cylindrical, muriculate, 3-6 mm long
Male vs female receptacles	Data missing	Receptacles with both male and female conceptacles more irregular than only male receptacles.	Plants monoecious	Data missing	Plants monoecious	Plants monoecious	Data missing	Plants monoecious	Plants dioecious (rarely monoecious)	Plants monoecious
Conceptacles	Data missing	Female conceptacles larger than male ones	Conceptacles unisexual	Data missing	Conceptacles unisexual, more rarely hermaphrodite	Unisexual male and female conceptacles present within a given receptacle	Unisexual	Conceptacles unisexual	Conceptacles unisexual	Conceptacles unisexual or hermaphrodites

[a] Kützing (1849) mentioned 'Ad Antillas; in sinu Biscayense ad Biaritz'; afterwards, he only mentioned 'Ad Biaritz in sinu Biscayensis' (Kützing, 1861), probably correcting his earlier) error. [b] Smooth: from Kützing (1843). [c] Smooth: from Gerbal (1986). [d] Measured on the herbarium specimen H.6683, from Martigues-Ponteau (Provence, France), HCOM. [e] Measured on herbarium specimens H.6636-H.6640 from Santorini Island, Greece, HCOM. [f] Observed on the specimen PC0459635 from Naples (Italy), PC.



Figs 1-4: Pressed specimen H8320 of the Algerian *Sargassum* sp., collected by L.N. Sellam at El Marsa, Algiers, 27 June 2015. Fig. 1. Habit; bar = 1 cm. Fig. 2. Upper part of a fertile branch (arrow heads = receptacles); bar = 1 cm. Fig. 3. Detail of the arrangement of gas vesicles (aerocysts) and receptacles on a branch; bar = 5 mm. Fig. 4. Detail of a composite receptacle with fertile branches and gas vesicles (arrow head = terminal mucron); bar = 5 mm.

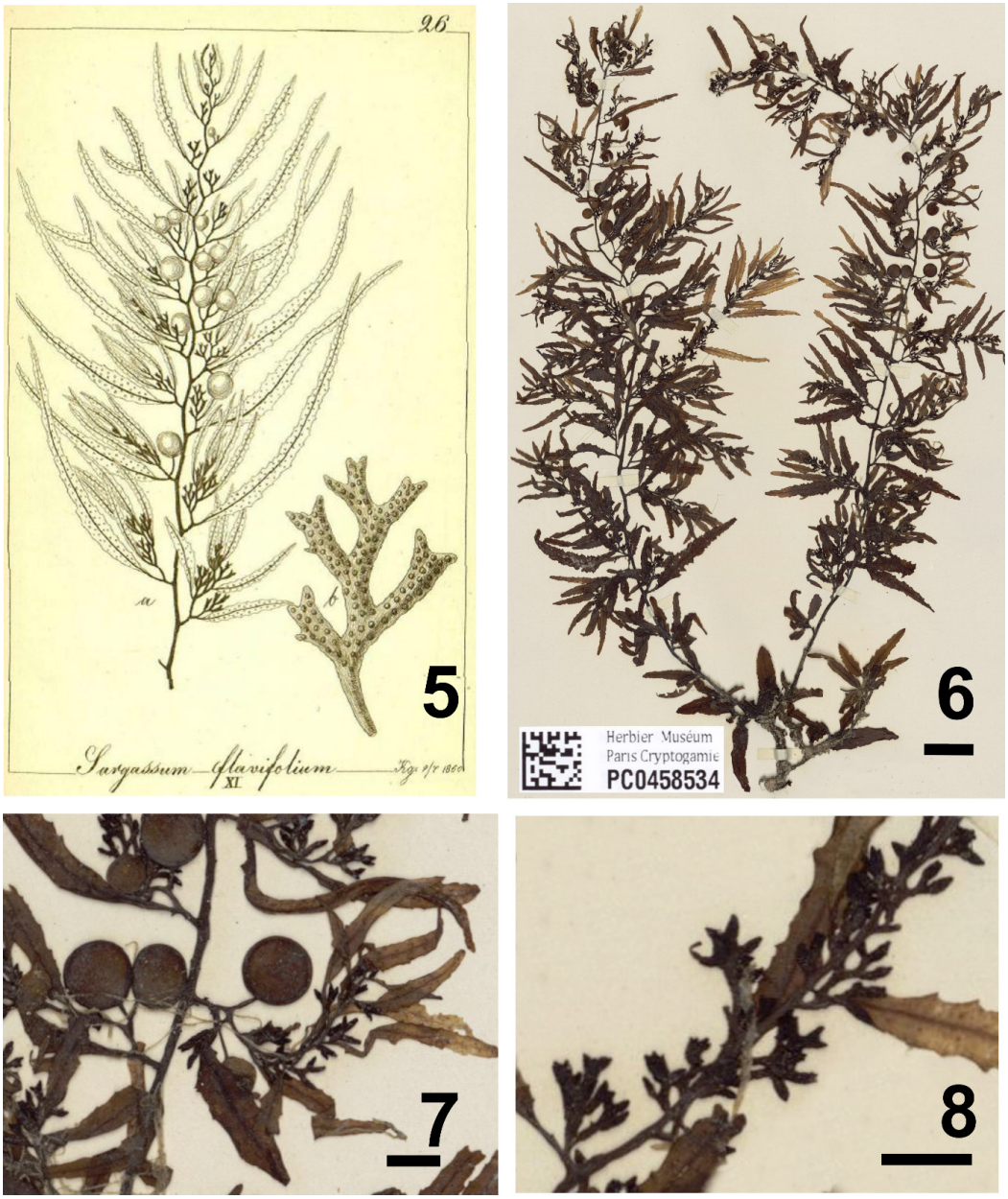


***Fig. 5*:** Illustrations of *Sargassum flavifolium* Kützing from Kützing (1861, plate 26), Biarritz, Bay of Biscay, France: a. Habit; b. Receptacle.

***Figs 6-8*:** Pressed specimen PC0458534 of *S. flavifolium* collected by J. Feldmann at Saint Jean de Luz, Bay of Biscay, France, 1st August1927, and deposited at the the Muséum National d'Histoire Naturelle, Paris; bar = 2 cm. Fig. 7. Details of gas vesicles; bar = 5 mm.

***Fig. 8*:** Details of receptacles; bar = 5 mm.

phologically close to *S. flavifolium* but presenting some unequivocal differences, is widely distributed and not uncommon.

With a few exceptions (e.g. Garreta *et al.* 2001; Špan, 2005), the species diversity of the genus *Sargassum* in the Mediterranean Sea has been poorly studied, since the pioneering work of Hamel (1931-1939). In the southern and eastern Mediterranean Sea, there are only checklists that name taxa without proper taxonomic identification (i.e. description or illustrations) (e.g. Diannelidis *et al.,* 1977; Taşkın & Öztürk, 2013; Tsiamis *et al.,* 2013a, 2013b, 2014). In their Mediterranean Flora of Phaeophyceae, Cormaci *et al.* (2012) only reproduce previous descriptions and illustrations from Kützing (1849, 1861) and Hamel (1931-1939).

In fact, in the Mediterranean Sea, a warm-temperate sea, the species diversity of the genus *Sargassum,* a genus with warm affinities, might be expected to be far greater than as currently assessed.

Within the genus *Sargassum*, nearly 350 taxa are currently accepted worldwide (Guiry & Guiry, 2017). Yet most taxonomic characters are elusive, often overlapping

among species, so that species delineation is a difficult, uncertain, and even scientifically hazardous task (Mattio & Payri, 2011). Genetic tools are therefore particularly welcome. On the basis of genetic studies, a reappraisal of the *Sargassum* taxonomy is now available in e.g. western and central Pacific islands, Korea, the Oman Sea, Australia and South Africa (Zhao *et al.,* 2007; Mattio *et al.,* 2008, 2009, 2010; Mattio & Payri, 2011; Noormohammadi *et al.,* 2011; Cho *et al.,* 2012; Dixon *et al.,* 2012, 2014; Dixon & Huisman, 2015; Mattio *et al.,* 2015). Unfortunately, this is not yet the case for the Mediterranean.

What is the status of the studied *Sargassum* species from Algeria? (i) a species hitherto ignored or confused with another Mediterranean taxon; (ii) an Atlantic species extending its range area and entering the Mediterranean Sea through the Strait of Gibraltar, in the context of the current global warming; (iii) a recently introduced species? The Mediterranean Sea is the marine area that harbours the highest number of introduced species worldwide (Ribera & Boudouresque, 1995; Galil, 2000; Boudouresque & Verlaque, 2002; Galil, 2008; Boudouresque *et al.,* 2011; Zenetos *et al.,* 2012, 2017). A set of criteria can be used to consider whether or not a species is probably introduced (Ribera & Boudouresque, 1995; Boudouresque, 1999); these criteria are not met by the Algerian *Sargassum* sp. populations.

Before describing a new species, we must examine the type material of *S. flavifolium* and of the other Mediterranean taxa belonging to the genus *Sargassum,* which although inadequately known, are at present regarded as synonyms. We also need to check the relationships between the Algerian *Sargassum* sp., the Atlantic species and the other species of the sectio *Zygocarpicae*, including putative synonyms, using both genetic markers and morphological characters (see e.g. Tseng & Baoren, 1988; Ajisaka *et al.,* 1995; Fujii *et al.,* 2014)

As far as the geographical distribution of the nine Mediterranean *Sargassum* species is concerned, a variety of different origins exist. *Sargassum flavifolium* seems to be restricted to a range from the Bay of Biscay to the Canary Islands, while the protologue also includes material from the Antilles; it is the species of *Sargassum* reported furthest northwards in Europe (Gruet, 1983); Mediterranean localities (Table 1) could result from misidentifications (see above). *Sargassum acinarium* is known from the western (Caribbean) and eastern (tropical West Africa and Canary Islands) Atlantic Ocean, and from the Mediterranean (Ribera et al., 1992; Littler & Littler, 2000; Gómez Garreta et al., 2001; John et al., 2004). This range of distribution is consistent with the dissemination of drift specimens of *Sargassum* by transoceanic currents, such as the Gulf Stream. *Sargassum desfontainesii* is present occurs on both sides of the North Atlantic Ocean, including the Canary Islands and the Azores, and is present only a short distance into the western Mediterranean (Alboran Sea, close to the Strait of Gibraltar) (Taylor, 1976; Price et al., 1978; González García & Conde, 1992). *Sargassum furcatum* has a very similar pattern of distribution (Taylor, 1960; Flores-Moya & Conde, 1998; Benhissoune et al., 2002; Cruz-Reyes et al., 2003; Freitas Ferreira, 2011; Wynne, 2011). *Sargassum hornschuchii*, *S. ramentaceum* and *S. trichocarpum* are assumed to be endemic to the Mediterranean (Hamel, 1931-1939; Ben Maiz et al., 1987; Perret-Boudouresque & Seridi, 1989; Zarmouh & Nizamuddin, 1991; Ribera et al., 1992; Gómez Garreta et al., 2001). *Sargassum muticum* is native to Japan and has been introduced, via oyster aquaculture, to north-western America, western Europe and the Mediterranean Sea (Critchley et al., 1983; Knoepfler-Peguy et al., 1985; Ribera & Boudouresque, 1995; Verlaque et al., 2007). Finally, *S. vulgare* seems to be a cosmopolitan species, reported on both sides of the Atlantic Ocean, in the Mediterranean Sea, the Indian Ocean, Polynesia, Japan, Taiwan and other Pacific Ocean areas (Taylor, 1960; Price et al., 1978; Ribera et al., 1992; Silva et al., 1996; Gómez Garreta et al., 2001; Tsuda & Walsh, 2013; Phang et al., 2016; Guiry & Guiry, 2017). True cosmopolitan species are often species originating from a given area of the world ocean, which have subsequently been transported by man and introduced into all the other areas of their current world range (see e.g. Carlton, 1996). Nevertheless, most of the so-called cosmopolitan species are actually complexes including several cryptic species (see e.g. Belton et al., 2014; Dijoux et al., 2014; Zanolla et al., 2014), and *S. vulgare* could be such a case.

Conclusions

Nine species of *Sargassum* are currently accepted in the Mediterranean Sea. This is probably an underestimation, as this genus, highly diversified in most warm and tropical seas, has been poorly studied in the Mediterranean, especially in the eastern and southern Mediterranean. Here, we have reported an undescribed species from Algeria that differs from the currently accepted taxa. Until further studies can be undertaken, including molecular analyses and thorough exploration of herbarium materials that contain early and poorly understood taxa (often regarded as synonyms), it seemed premature to formally describe it as a new species. Nevertheless, we thought it important not to delay drawing the attention of researchers to this plant), potentially present in other Mediterranean areas too. In addition, we have highlighted the possible underestimation of the diversity of the genus Sargassum in the Mediterranean, pending the achievement of the long-term objective of disentangling the taxonomy of the genus in the Mediterranean as a whole.

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