

MARINE RECORD

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# First record of *Rhodymenia holmesii* (Rhodymeniaceae, Rhodophyta) for the Mediterranean Sea from Morocco

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## Abstract

**Background:** The rhodymenialean red algal species *Rhodymenia holmesii* was collected in the lower intertidal zones from Dalya and Al-Hoceima (Northern Morocco, Mediterranean Sea). This represents the first record and description in the Mediterranean Sea.

**Results:** Moroccan material was studied in detail and compared with other closely related species. Descriptions of the morphological features reveal thalli with flaccid blades, 8 cm long, regularly dichotomously branched and attached with stoloniferous holdfast. Anatomically, cortical region composed of 2–3 cell layers and medulla composed of 3–5 cell layers.

**Conclusions:** This finding indicates that the biodiversity of the related sites is probably richer than generally thought, and other phycological studies will increase the known algal biodiversity of the region.

**Keywords:** First record, Mediterranean Sea, Morocco, Red algae, *Rhodymenia holmesii*

## Background

The genus *Rhodomenia* (*sic*) was proposed by Greville in 1830 and included 16 species. Later, other species were added by J. Agardh (1841) who changed the concept of the genus to adopt the suggestion of Montagne (1839) regarding the ratification of the orthography *Rhodymenia* (J. Agardh 1851). The latter spelling has been conserved over the original “*Rhodomenia*”.

*Rhodymenia*'s species have often been confused with other genera. The reason for which several authors (Agardh 1851, 1876; Dawson 1941) divided the genus into five sections or subgenera based on reproductive structures, especially tetrasporangia. Regarding the vegetative morphological features, Guiry (1977) gave a useful comparison of the cortical cells in surface view of three species of *Rhodymenia* and nine species of other genera with a similar morphology, which help to distinguish between them.

Irvine (1983) described *Rhodymenia* as thallus with erect or prostrate, usually stipitate fronds, arising from a

basal disc or stolons, blades flattened, simple or divided dichotomously, palmately or irregularly; sometimes with marginal or apical proliferations; structure multiaxial, medulla compact, pseudoparenchymatous, with large axially elongated cells, cortex of radial filaments of 2–5 smaller cells. Gametangial plant dioecious; spermatangia in small subapical sori or large irregular patches scattered over blade, produced superficially from outer cortical cells; carpogonial branches 3–4-celled, supporting cell also bearing 2-celled auxiliary cell branch, gonimoblast developing outwards often with 2–3 lobes, almost all cells forming carposporangia, enveloping filaments absent; cystocarps hemispherical, large and protruding, with a pore, formed apically or scattered; tetrasporangia in subapical sori or scattered throughout blade, intercalary in unmodified cortex, cruciate.

The genus *Rhodymenia* consists of some 62 species worldwide, which have been recognized as currently accepted taxonomically, distributed through warmer waters from the lower intertidal to depths of about 100 m (Guiry and Guiry 2015). Among these 62 species, only 8 taxa have been reported from the Mediterranean Sea (Rodríguez y Femenías 1889; Giaccone 1969; Huvé and Huvé 1971; Rindi et al. 2002; Rodríguez-Prieto et al.

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2013). On the Moroccan Mediterranean coast, the genus is only represented by the type species *Rhodymenia pseudopalmata* (J.V. Lamouroux) P.C. Silva and *R. caespitosa* P. Dangeard (Kazzaz and Riadi 2000).

In recent years, there has been an interest increasing in the Moroccan algal biodiversity. Inventories began with that of Riadi and Kazzaz (1998), Riadi et al. (2000) and Kazzaz and Riadi (2000), who assign to the country 455 taxa at specific and intraspecific level, this followed soon afterward by the publication of Benhissoune et al. (2001; 2002a, b; 2003) which were more detailed and confirmed 612 species and intraspecific taxa, 15 *taxa excludenda* and 35 *taxa inquirenda* of the benthic marine algal flora of Morocco. More recently, we added 23 species (Riadi et al. 2011, 2013; Hassoun et al. 2014; 2015a, b, 2016; Moussa et al. 2015). Despite these advances, much work remains to be done on the marine benthic flora of Morocco as relatively few habitats have been extensively studied.

In this study, we report on the occurrence of a rhodymenialean species, *Rhodymenia holmesii* Ardissonne, from Morocco and the Mediterranean Sea for the first time.

## Materials and methods

Samples were collected from Dalya (35°54'24"N, 5°28'19"W) and Rmoud (35°09'25.1"N, 4°20'01.6"W) from the occidental shores of the Mediterranean Sea. Samplings were performed in 2013 and 2014, in the upper subtidal (0.5–1 m depth) and low intertidal of wave exposed rocky shores. Fresh algae samples were transported to the laboratory in plastic bags with seawater. Studies were carried out on samples preserved in 5 % formalin-seawater solution; anatomical sections were made by hand with a razor blade. The specimens studied were deposited in the Phycological Herbarium of the Phycology and Mycology Laboratory, Faculty of Sciences, Abdelmalek Essaâdi University, Tetouan, Morocco (HTET; 823 and 830: *Rhodymenia holmesii*). Photomicrographs were taken with a color camera Olympus XC50 (Tokyo, Japan) coupled to Olympus Bx43 microscope. For the nomenclatural purposes, following taxonomic databases were used: Index Nominum Algarum (Silva 2015) and AlgaeBase (Guiry and Guiry 2015).

## Results and discussion

### Systematics

Order RHODYMENIALES F. Schmitz in Engler, 1892

Family RHODYMENIACEAE Harvey, 1849

Genus *Rhodymenia* Greville 1830

*Rhodymenia holmesii* Ardissonne, 1893 (Fig. 1)

Basionym: *Halymenia palmetta* var. *ellisiae* Duby, 1830

Synonyms: *Rhodymenia palmetta* var. *ellisiae* (Duby) Bornet 1892 (as *elisiae*)

*Rhodymenia pseudopalmata* var. *ellisiae* (Duby) Guiry 1975

### Geographic distribution

The type locality of this species is Sussex, England (Athanasiadis 1996), the species appears to be limited to the North Atlantic (Hardy and Guiry 2003; Bárbara et al. 2006; Dizerbo and Herpe 2007) and the utmost localities in the South Atlantic Ocean (Stegenga et al. 1997; Rull Lluch 2002; John et al. 2004). The closest previous records are those of Bárbara et al. (2012), Cires Rodriguez and Cuesta Moliner (2010), both from the Iberian Peninsula; Haroun et al. (2002), John et al. (2004) and Afonso-Carrillo (2014), all from the Canary Islands.

### Habitat and collection

Specimens recorded at Dalya in February 2013 growing in association with *Gelidium attenuatum* (Turner) Thuret and May 2013; also collected at Rmoud in May 2013 and August 2014. In both sites, the species grows on shaded rocky between upper subtidal and low-intertidal substrata.

### Description

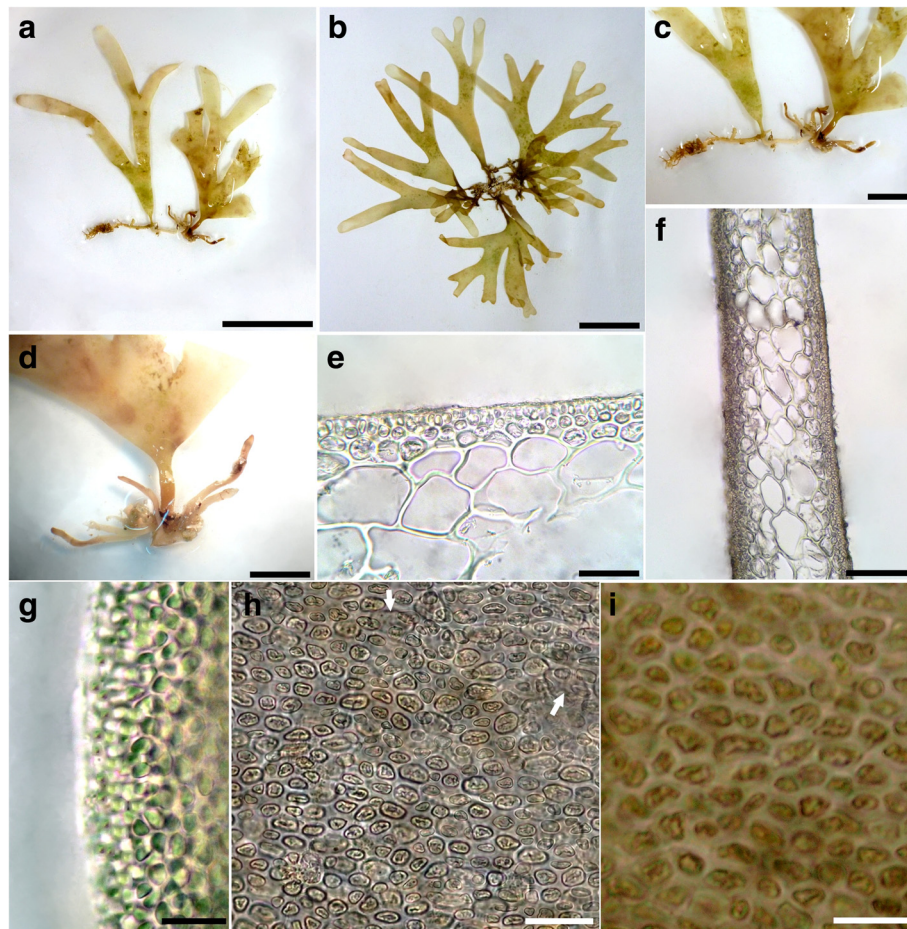
Thalli are up to 8 cm tall, brown-red, arising from an extensive branched stoloniferous holdfast (Fig. 1a–c), becoming extensively branched in soft rock, giving rise to erect and flaccid blades. Fronds with a short stipe to 10 mm long (Fig. 1d); expand gradually into a fan-shaped, somewhat cartilaginous blade with parallel sides 70 mm long, 5 mm broad and 120–190 µm thick. Blades regularly dichotomously branched; usually with 3–4 orders of branches and with narrow angles in the forks. Marginal proliferations occur from base of plants, often reattaching to the substrate.

Pseudoparenchymatous medulla composed of 3–5 layers of axially elongated to ovoid cells (Fig. 1e), 40–60 µm in periclinally in transversal section and 95–105 µm axially in longitudinal section. Cortical region composed of 2–3 layers of progressively smaller cells (Fig. 1f). Cortical cells fairly spaced in optical section; measuring 3–5 × 5–6.5 µm in the apical parts, 6–7 × (8) 9–10 µm in the median parts of the blade and 7–8 × 12–13 µm in the stipe in surface view (Fig. 1g–i). Subcortical cells regularly arranged, visible from the surface. Reproductive structures were not seen.

### Remarks

Benhissoune et al. (2002b) report bibliographically the presence of this species based on Bornet's citation (1892), Debray (1897), Gattefossé and Werner (1935) and Dangeard (1949) for the Atlantic coast of Morocco.

Bornet (1892, p. 285–286) described briefly a specimen as *Rhodymenia palmetta* var. *elisiae* with narrow linear fronds which internal cells are more elongated and



**Fig. 1** *Rhodymenia holmesii* Ardissonne, 1893: (a–b) habit; (c) thalli with stoloniferous growth giving rise to flattened blades; (d) stipe; (e) transverse section of the blade showing 3–4 layers of medullary cells; (f) transverse section, showing layers and arrangement of cortical cells; (g) surface view of the cortical cells from the apex; (h) cortical cells from the median part and subcortical cells (arrows) in surface view; (i) cortical cells from the stipe in surface view. Scale bars: a–b, 3 cm; c–d, 1 cm; e, 30  $\mu$ m; f, 100  $\mu$ m; g, 20  $\mu$ m; h–i, 30  $\mu$ m

cortical cells are larger than those of *Phyllophora palmettoides* var. *niccæensis* (Lamouroux ex Duby) J. Agardh; known currently as *Schottera nicaeensis* (J.V. Lamouroux ex Duby) Guiry & Hollenberg (Guiry and Hollenberg 1975). This report decline all taxonomical features confirming the species supported by Guiry (1977) who examined Bonet's materiel and concluded that "the material cited by Bornet (1892, p. 285) from Tangiers under the name *Rhodymenia palmetta* var. *ellisiae* are probably not representative of this variety". Similarly, Dangeard (1949, p. 169) mention *R. palmetta* var. *elisiae* without illustrations and/or descriptions of the morphological features useful for species identification. Otherwise, he described another variety such as: "*Thallus repetiter dichotomus flabellatus sessilis, evidenter stoloniferous, fusco-purpureus, usque ad 8 cm. altus, 200  $\mu$  crassus.*" corresponding to *R. palmetta* var. *fusco-purpurea* (P.J.L. Dangeard) S. Benhissoune, C.-F. Boudouresque, M. Perret-Boudouresque, & M. Verlaque.

Guiry (1977) affirm that "the material cited by Bornet (1892, p. 285) from Tangiers under the name *Rhodymenia palmetta* var. *ellisiae* are probably not representative of this variety to judge from specimens (BM). Dangeard (1949) recorded specimens of this variety from the Atlantic coast of Morocco but his material has not been examined". Furthermore, there is no description belonging to Debray (1897) and Gattefossé and Werner (1935) inventories. Nevertheless, *R. holmesii*, under its synonym entities, is only reported in both checklists.

The Moroccan distribution of this species was ambiguous; but with this study, we record and confirm its presence on the Moroccan and the Mediterranean shores.

Our observations are in agreement with general vegetative features previously described by Guiry (1977) as *R. pseudopalmata* var. *ellisiae* and Irvine (1983). It is also clearly conforms to the illustrations given by Pérez-Cirera et al. (1989) and the ecology data given by Hiscock and Maggs (1984).



The most conspicuous characters defining *Rhodymenia holmesii* are the evidence in shape and size of the external cortical cells in surface view and the presence of the stoloniferous basal part. The combination of these characters makes this species clearly distinct from all other Moroccan and Mediterranean species, such as *R. caespitosa*, *R. delicatula* P.J.L. Dangeard, *R. pseudopalmata* and *R. pseudopalmata* var. *fuscopurpurea* (Conde et al. 1996; Kazzaz and Riadi 2000; Benhissoune et al. 2002a, 2002b; Antolić et al. 2013). Besides the fact that all these species are characterized by an erect thallus attached to the substrata by a single basal part except *R. ardissoni*, which have a prostate habit, other characters help to distinguish them from *R. holmesii*.

This species bears similarity to *R. coespitosella* L'Hardy-Halos, a species endemic to the French coast in Baie de Morlaix, having a short stipe ending in a small disc and surrounded by many stoloniferous filaments (L'Hardy-Halos 1976). Whereas *R. holmesii* grows from stoloniferous holdfast with a short stipe, up to 10 mm long. Furthermore, besides the dichotomous branching which is characteristic of almost all the *Rhodymenia* species; *R. coespitosella* present blades with 2 to 3 mm in width, although *R. holmesii* forms a linear frond which maintained more or less the same width for most of its length (5 mm broad). The most conspicuous difference is the external cortical cells dimensions. In *R. holmesii*,

cortical cells are approximately  $3-5 \times 5-6.5 \mu\text{m}$  in the apical parts,  $6-7 \times (8) 9-10 \mu\text{m}$  in the median parts of the blade and  $7-8 \times 12-13 \mu\text{m}$  in the stipe, when in *R. coespitosella*, the cortical cells are in fact smaller according to the descriptions made by L'Hardy-Halos (1976).

*Rhodymenia holmesii* shares a prostrate stoloniferous portion with *R. leptophylla* J.Agardh known from New Zealand (Adams 1994) and *R. natalensis* Kylin from South Africa (Silva et al. 1996). It differs from the first in that the thalli of this species is thinner with compressed blades 40–150  $\mu\text{m}$  in diameter and from the second by its smaller size and narrower blades (Wynne 1986; Rull Lluçh 2002; N'Yeurt and Payri 2010).

As shown in Table 1, one of the most relevant morphological characters to distinguish Moroccan *Rhodymenia* species *R. holmesii*, *R. caespitosa*, *R. delicatula*, *R. pseudopalmata*, *R. pseudopalmata* var. *fuscopurpurea* and the related species *S. nicaeensis* is the persistent presence of stolons. Both, *R. holmesii* and *S. nicaeensis* share this feature unless they differ by the arrangement of cortical cells. Moreover, the dimensions and the appearance of the cortical and medullary cells of *R. holmesii* are remarkably different especially the appearance of superficial cells of the stipe. Furthermore, in *R. holmesii*, specimens attained heights of 80 mm while other *Rhodymenia* exceed 100 mm high, except the diminutive species *R. delicatula* which never exceed 22 mm high. The

**Table 1** Morphological characters used to distinguish *Rhodymenia holmesii*, *R. caespitosa*, *R. delicatula*, *R. pseudopalmata*, *R. pseudopalmata* var. *fuscopurpurea* and *Schottera nicaeensis*

	<i>R. holmesii</i>	<i>R. caespitosa</i>	<i>R. delicatula</i>	<i>R. pseudopalmata</i>	<i>R. pseudopalmata</i> var. <i>fuscopurpurea</i>	<i>S. nicaeensis</i>
Height	To 80 mm	To 300 mm	To 22 mm	To 120 mm	To 80 mm	To 100 mm
Width of fronds	To 5 mm	5–12 mm	0.5–3 mm	To 10 mm	≥10 mm	To 10 mm
Thickness of fronds ( $\mu\text{m}$ )	100–188	170–300	(30) 40–70 (100)	(60) 100–200 (250)	190–250	110–200
Stolons	Present	Absent	Sometimes formed	Occasionally formed	Occasionally formed	Present
Cortical cells ( $\mu\text{m}$ )					Not reported	
From apex	4–7 × 3–5	3–5 × 2–3	(4) 8.0–14.2 (20.5)	5–7 × 3–4		2–5 × 2–3
From median part	9–14 × 5–7	3–6 × 2–3	(4) 9–16	9–15 × 6–9		4–9 × 3–5
From stipe	8–20 × 5–8 Irregularly arranged	Not reported	Not reported	4–8 × 3–4 Irregularly arranged		4–7 × 3–4 Arranged in longitudinal rows in transverse section
Medullary cells ( $\mu\text{m}$ )					Not reported	Not reported
in transverse section	(24) 41–53 (63)	Not reported	(15) 25–58 (73)	(20) 41–51 (61)		
in longitudinal section	(98) 102–133 (137)	Not reported	(48) 67–100 (108)	(65) 102–133 (153)		
References	L'Hardy-Halos 1976; Guiry 1977; Irvine 1983	Dangeard 1949; L'Hardy-Halos 1976	Dangeard 1949; Guiry 1977; Irvine 1983	L'Hardy-Halos 1976; Guiry 1977 (as <i>R. pseudopalmata</i> var. <i>pseudopalmata</i> ); Irvine 1983	Dangeard 1949	Guiry and Hollenberg 1975; L'Hardy-Halos 1976; Rodríguez-Prieto et al. 2013; Guiry and Guiry 2015

width of the fronds is also an important feature: *R. holmesii* is never more than 5 mm broad at the median part of the blade while *R. pseudopalmata*; *R. caespitosa*; *R. pseudopalmata* var. *fuscopurpurea* and *S. niccaensis* frequently attain 10 mm (Table 1).

## Conclusion

This is the first reference of the occurrence of this species in the the Mediterranean Sea. The recent studies have concluded that present knowledge of the Moroccan and Mediterranean marine flora is still incomplete and indicate that the biodiversity is probably richer than generally thought, because the finding of new records is still relatively frequent. Further phycological studies in that Sea may further increase the known algal biodiversity of the region.

## Abbreviations

Not applicable.

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## Availability of data and material

Not applicable.

## Authors' contributions

GS collected the samples and participated in the identification of *Rhododymenia holmesii*, measured specimens, elaborate the manuscript and drafts the illustrations. MH participated in the drafting of the manuscript and processed the illustrations. HM contribute to the collecting of samples and participate in the organization and final version of the manuscript revised by HZ. HR made a substantial contribution to the identification of the species. All authors read and approved the final manuscript.

## Competing interests

The authors declare that they have no competing interests.

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## References

- Adams NM. Seaweeds of New Zealand. An Illustrated Guide. Christchurch: Canterbury University Press; 1994.
- Afonso-Carrillo J. Lista actualizada de las algas marinas de las islas Canarias. Las Palmas: Elaborada para la Sociedad Española de Ficología (SEF); 2014.
- Agardh JG. In historiam algarum symbolae. Linnaea. 1841;1–50:443–57.
- Agardh JG. Species genera et ordines algarum, seu descriptiones succinctae specierum, generum et ordinum, quibus algarum regnum constituitur. Volumen secundum: algas florideas complectens. Part 1. Lundae: C.W.K. Gleerup; 1851.
- Agardh JG. Species genera et ordines algarum, seu descriptiones succinctae specierum, generum et ordinum, quibus algarum regnum constituitur. Volumen tertium: de Florideis curae posteriores. Part 1. Lipsiae: C.W.K. Gleerup; 1876.
- Antolić B, Špan A, Žuljević A, Nikolić V, Grubelić I, Despalatović M, Cvitković I. A checklist of the benthic marine macroalgae from the eastern Adriatic coast: IV. Rhodophyta 2: Ceramiales excluded. Acta Adriat. 2013;54:41–66.
- Athanasiadis A. Taxonomisk litteratur och biogeografi av Skandinaviska rödalger och brunalger. Göteborg: Algologia; 1996.
- Bárbara I, Díaz P, Araujo R, Peña V, Berecibar E, Cremades J, et al. Adiciones corológicas y correcciones a la flora bentónica marina del norte de la Península Ibérica. N Acta Cient Compostel (Biología). 2006;15:77–88.
- Bárbara I, Díaz Tapia P, Peteiro C, Berecibar E, Peña V, Sánchez N, et al. Nuevas citas y aportaciones corológicas para la flora bentónica marina del Atlántico de la Península Ibérica. Acta Bot Malacit. 2012;37:5–32.
- Benhissoune S, Boudouresque CF, Verlaque M. A check-list of marine seaweeds of the Mediterranean and Atlantic coasts of Morocco. I. Chlorophyceae Wille s. l. Bot Mar. 2001;44:171–82.
- Benhissoune S, Boudouresque CF, Verlaque M. A checklist of the seaweeds of the Mediterranean and Atlantic coasts of Morocco. II. Phaeophyceae. Bot Mar. 2002a;45:217–30.
- Benhissoune S, Boudouresque CF, Perret-Boudouresque M, Verlaque M. A checklist of the seaweeds of the Mediterranean and Atlantic coasts of Morocco. III. Rhodophyceae (excluding Ceramiales). Bot Mar. 2002b;45:391–412.
- Benhissoune S, Boudouresque CF, Perret-Boudouresque M, Verlaque M. A checklist of the seaweeds of the Mediterranean and Atlantic coasts of Morocco. IV. Rhodophyceae-Ceramiales. Bot Mar. 2003;46:55–68.
- Bornet E. Les algues de P.-K.-A Schousboe récoltées au Maroc et dans la Méditerranée de 1815 à 1829 et déterminées par M. Edouard Bornet. Mém Soc Nat Sci Nat Cherbog. 1892;28:165–378.
- Cires Rodriguez E, Cuesta MC. Checklist of benthic algae from the Asturias coast (North of Spain). Bol Cienc Nat. 2010;51:135–212.
- Conde F, Flores-Moya A, Soto J, Altamirano M, Sánchez A. Check-list of Andalusia (S. Spain) seaweeds. III. Rhodophyceae. Acta Bot Malacit. 1996;21:7–33.
- Dangeard P. Les algues marines de la côte occidentale du Maroc. Le Botaniste. 1949;34:89–189.
- Dawson EY. A review of the genus *Rhododymenia*, with descriptions of new species. Allan Hancock Pacif Expeditions. 1941;3:123–80.
- Debray F. Catalogue des Algues du Maroc, d'Algérie et de Tunisie. Alger: A. Jourdan; 1897.
- Dizerbo AH, Herpe E. Liste et répartition des algues marines des côtes françaises de la Manche et de l'Atlantique, Iles Normandes incluses. Landernau: Éditions Anaximandre; 2007.
- Duby JÉ. Aug. Pyrami de Candolle Botanicon gallicum sen synopsis plantarum in flora gallica descriptarum. Editio secunda, Ex herbariis et schedis Candollianis propriisque digestum a J. É. Duby V.D.M. Pars secunda plantas cellulares continens. Paris: Ve Desray; 1830.
- Engler A. Syllabus der Vorlesungen über specielle und medicinisch-pharmaceutische Botanik. Eine Uebersicht über das gesammte Pflanzensystem mit Berücksichtigung der Medicinal- und Nutzpflanzen, Grosse Ausgabe. Berlin: Gebrüder Borntraeger; 1892.
- Gattefossé J, Werner RG. Catalogus algarum maroccanorum adhuc cognitorum. Bull Soc Sci Nat Maroc. 1935;15:72–107.
- Giaccone G. Raccolte di fitobenthos sulla banchina continentale Italiana. G Bot Ital 1970. 1969;103:485–514.
- Greville RK. Algae Britannicae, or descriptions of the marine and other inarticulated plants of the British Islands, belonging to the order Algae; with plates illustrative of the genera. London: MacLachlan & Stewart, Baldwin & Cradock; 1830.
- Guiry MD. Studies on marine algae of the British Isles. 10. The genus *Rhododymenia*. Br Phycol J. 1977;12:385–425.
- Guiry MD, Hollenberg GJ. *Schottera* gen. nov. and *Schottera nicaeensis* (Lamour. ex Duby) comb. nov. (= *Petroglossum nicaeense* (Lamour. ex Duby) Schotter) in the British Isles. Br Phycol J. 1975;10:149–64.
- Guiry MD, Guiry GM. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. <http://www.algaebase.org>. Accessed 16 Sep 2015.
- Harvey WH. Nereis australis, or algae of the southern ocean: being figures and descriptions of marine plants, collected on the shores of the Cape of Good Hope, the extra-tropical Australian colonies, Tasmania, New Zealand, and the Antarctic regions; deposited in the Herbarium of the Dublin University. London: Reeve Brothers; 1849.
- Hardy FG, Guiry MD. A check-list and atlas of the seaweeds of Britain and Ireland. London: British Phycological Society; 2003.

- Haroun RJ, Gil-Rodríguez MC, Díaz de Castro J, Prud'homme van Reine WF. A checklist of the marine plants from the Canary Islands (central eastern Atlantic Ocean). *Bot Mar.* 2002;45:139–69.
- Hassoun M, Salhi G, Bouksir H, Moussa H, Riadi H, Kazzaz M. *Codium tomentosum* var. *mucronatum* et son épiphyte *Aglaothamnion pseudobyssoïdes*, deux nouvelles espèces d'algues benthiques pour la phycoflore du Maroc. *Acta Bot Malacit.* 2014;39:37–44.
- Hassoun M, Salhi G, Kazzaz M, Riadi H, Moussa H. New records of *Polysiphonia* sensu lato from the Atlantic Ocean in Morocco. *Mar Biodivers.* 2015a;46:434–9.
- Hassoun H, Moussa H, Kazzaz M, Riadi H, Salhi G. First record of *Polyneura bonnemaisonii* (Delesseriaceae, Rhodophyta) from the Atlantic Ocean of Africa. *Mar Biodivers Rec.* 2015b;8:1–4.
- Hassoun H, Salhi G, Moussa H, Riadi H, Kazzaz M, Hanaa Z. *Ceramium comutum* and *Ceramium pallidum* (Rhodophyta: Ceramiales) two new records for Morocco: morphology and reproductive structures. *Bot Lett.* 2016;163(1):25–31.
- Hiscock S, Maggs CA. Notes on the distribution and ecology of some new and interesting seaweeds from south-west Britain. *Br Phycol J.* 1984;19:73–87.
- Huvé P, Huvé H. Une nouvelle espèce de *Rhodymenia* des côtes orientales de Tunisie: *Rhodymenia leptofaucheoides* nov. sp. (Rhodophycées, Rhodyméniales, Rhodyméniacées). *Bull Soc Bot Fr.* 1971;16:51–60.
- Irvine LM. Seaweeds of the British Isles. Volume 1. Rhodophyta. Part 2A. Cryptonemiales (sensu stricto), Palmariales, Rhodymeniales. (Irvine, L.M. Eds). London: British Museum (Natural History); 1983.
- John DM, Prud'homme van Reine WF, Lawson GW, Kostermans TB, Price JH. A taxonomic and geographical catalogue of the seaweeds of the western coast of Africa and adjacent islands. *Nova Hedwigia Beih.* 2004;127:1–339.
- Kazzaz M, Riadi H. Inventaire préliminaire de la phycoflore benthique du littoral Marocain. II. Rhodophyceae. *Acta Bot Barc.* 2000;46:53–88.
- L'Hardy-Halos MT. A propos du *Rhodymenia coespitosella* sp. nov. (Rhodophycée, Rhodyméniale); comparaisons morphologiques, anatomiques et cytologiques. *Phycologia.* 1976;15:289–97.
- Montagne C. Cryptogamae brasilienses seu Plantae cellulares quas in itinere per Brasiliam à céleb. Auguste de Sainte-Hilaire collectas recensuit observationibusque nonnullis illustravit. *Ann Sci Nat.* 1839;12:42–55.
- Moussa H, Wynne MJ, Hassoun M, Salhi G, Zbakh H, Kazzaz M, Riadi H. On the occurrence of three red algal species new to the Mediterranean Sea in Al-Hoceima National Park (Morocco). *Bot Mar.* 2015;58(6):499–509.
- N'Yeurt A, Payri CE. Marine algal flora of French Polynesia III. Rhodophyta, with additions to the Phaeophyceae and Chlorophyta. *Cryptogam Algol.* 2010;31:3–205.
- Pérez-Cirera JL, Cremades J, Bárbara I. Precisiones sistemáticas y sinecológicas sobre algunas algas nuevas para Galicia o para las costas atlánticas de la Península Ibérica. *An del Jard Bot Madr.* 1989;46:35–45.
- Riadi H, Kazzaz M. Inventaire bibliographique des algues benthiques du littoral marocain. I. Chlorophyceae et Phaeophyceae. *Acta Bot Malacit.* 1998;23:23–41.
- Riadi H, Kazzaz M, Ater M. Contribution à la connaissance des algues marines benthiques du Détroit de Gibraltar et de la Méditerranée occidentale marocaine. I. Chlorophyceae et Phaeophyceae. *Acta Bot Malacit.* 2000;25:5–20.
- Riadi H, Salhi G, Saoud Y, Kadir M, Kazzaz M. Nuevas aportaciones a la flora algal de las costas marroquíes. *Acta Bot Malacit.* 2011;36:161–3.
- Riadi H, Salhi G, Bouksir H, Moussa H, Hassoun M. *Acrosymphyton purpuriferum* (J. Agardh) Sjöstedt et *Balliella cladoderma* (Zanardini) Athanasiadis, deux nouvelles espèces d'algues benthiques de la Méditerranée marocaine. *Bull Inst Sci Rabat Sect Sci Vie.* 2013;35:9–14.
- Rindi F, Sartoni G, Cinelli F. A floristic account of the benthic marine algae of Tuscany (Western Mediterranean Sea). *Nova Hedwigia Beih.* 2002;74:201–50.
- Rodríguez y Femenías JJ. Algas de las Baleares. *An Soc Esp Hist Nat.* 1889;18:199–274.
- Rodríguez-Prieto C, Ballesteros E, Boisset F, Afonso-Carrillo J. Guía de las macroalgas y fanerógamas marinas del Mediterráneo occidental. Barcelona: Ediciones Omega, S.A; 2013.
- Rull Lluch J. Marine benthic algae of Namibia. *Sci Mar.* 2002;Suppl 13:5–256.
- Silva P.C. Index Nominum Algarum, University Herbarium. Berkeley: University of California. <http://ucjeps.berkeley.edu/INA.html>. Accessed 15 Sep 2015.
- Silva PC, Basson PW, Moe RL. Catalogue of the benthic marine algae of the Indian Ocean. *Univ Calif Publ Bot.* 1996;79:1–1259.
- Stegenga H, Bolton JJ, Anderson RJ. Seaweeds of the South African west coast. Cape Town: Bolus Herbarium, University of Cape Town; 1997.
- Wynne MJ. Report on a collection of benthic marine algae from the Namibian coast (southwestern Africa). *Nova Hedwigia Beih.* 1986;43:311–55.

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