

## New records of benthic marine algae from Morocco

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*Nuevas citas de algas marinas bentónicas de Marruecos*

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**Palabras clave:** Algae, Océano Atlántico, *Champia compressa*, *Diplothamnion jolyi*, *Radicilingua thysanorhizans*.

Morocco has always been an interesting field of marine research due to its vast coastline, 3500 km in length, and a particular geographical position between the Mediterranean Sea and Atlantic Ocean. The study of algal biodiversity in Moroccan coast started in 1892 by Bornet; followed by a number of surveys (e. g. Debray, 1897; Hariot, 1909; Sauvageau, 1913). In the first half of the 20th century, the Moroccan coast has attracted much interest of several authors such as Werner (1956) who presented some reflections about structure and zonation of algal communities in the Moroccan coast; Gattefosse et al. (1935), Dangeard (1949), Feldmann (1955), Gayral (1958), Cavassillas (1963), Riadi (1989) who studied the benthic phycoflora of the Atlantic coast, Lozano Cabo (1953), Kazzaz (1989), Gonzalez & Conde (1991, 1994, 1995), whose studies focused especially on the Mediterranean coast.

Despite this apparent surge in phycological effort, considering the vastness of the geographic area in question and the diversity of biotopes available, most localities still remain largely unexplored, especially for deeper water flora. In general, the Moroccan coast remains poorly studied, if compared to other biogeographic regions. In recent years, there has been an increasing interest in its algal biodiversity (Riadi *et al.*, 2013; Moussa *et al.*, 2015; Salhi *et al.*, 2016; Hassoun *et al.*, 2014, 2015, 2016a-b, 2018).

All specimens examined in this study were collected from different localities in northwest of Atlantic Morocco coast: Hyayda (35°05'15.7"N, 6°12'51.4"W), Larache (35°19'14.58"N,

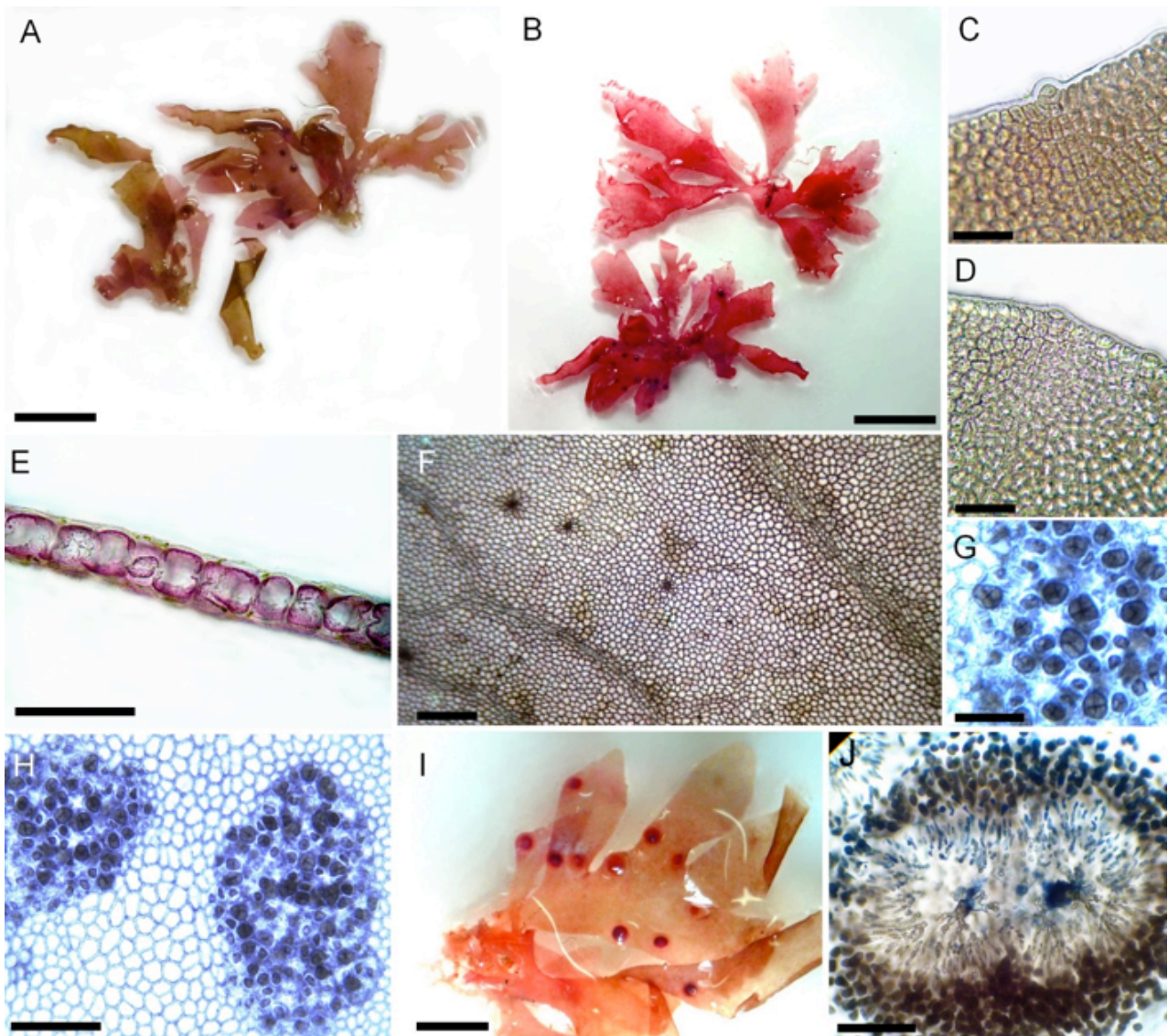
6°17'01.81"W) and Asilah (35°45'64.62"N, 6°04'91.00"W). The study was carried out in the period 2013–2015, in the upper subtidal (0.5-1 m depth) and low intertidal of wave exposed rocky shores. Studies were carried out on samples preserved in 5% formalin-seawater solution; sections were made by hand with a razor blade. When necessary, permanent material was stained with 1% aqueous aniline blue and preserved in karo®. Selected specimens were deposited in the Phycological Herbarium of the Phycology and Mycology laboratory, Faculty of Sciences, Abdelmalek Essaâdi University, Tetouan, Morocco [= HTET]. Photomicrographs were taken with an Olympus camera XC50 (Tokyo, Japan) coupled to Olympus Bx43 microscope. For nomenclatural purposes the following taxonomic databases were used: Index Nominum Algarum (Silva, 2018) and AlgaeBase (Guiry & Guiry, 2018).

The aim of this paper is to report three macroalgal species recorded for the first time from Morocco or from the eastern coast of the Atlantic Ocean.

### *Radicilingua thysanorhizans* (Holmes)

Papenfuss (Figure 1)

Tetrasporophytic and vegetative specimens of *Radicilingua thysanorhizans* were collected from the low to mid-intertidal zone in Hyayda in March and August 2014, female gametophytes in July 2015 from Larache. The specimens were epiphytic on *Cladostephus spongiosum* (Hudson) C. Agardh and associated with other epiphytes, such as *Centroceras clavulatum* (C. Agardh) Montagne,



**Figure 1.** *Radicilingua thysanorhizans*, A-B: habit; C-D: apex showing the growth of thallus by transverse division of a prominent apical cell surrounded by semi-circular arrays of cells, E: transverse section of the monostromatic blade, F: microscopic veins, G: tetrasporangia divided tetrahedrally, H: tetrasporangial sori, I: female blade with cystocarps, J: section through mature cystocarp with carposporangia. Scale bars: A, B= 2 cm, C, D= 20  $\mu\text{m}$ , E, G= 100  $\mu\text{m}$ , F, J= 200  $\mu\text{m}$ , H= 150  $\mu\text{m}$ , I= 2 mm.

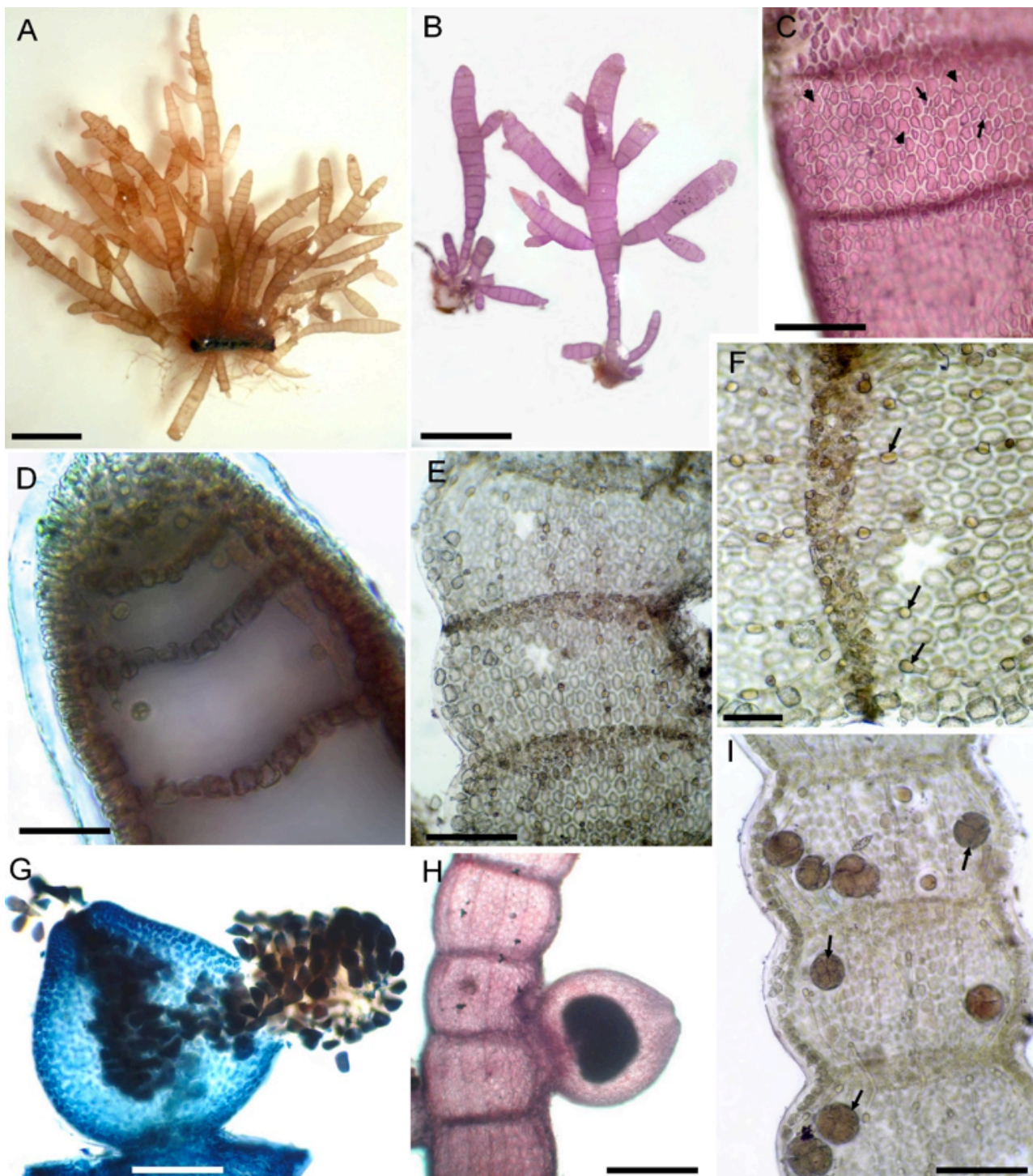
and *Ceramium* spp. (HTET 884 and 891).

Thallus membranous, translucent and delicate, pale rose or/to light red, very thin, up to 6 cm long (Figs. 1A-B). The most divided blades consisting of irregularly dichotomously to sub-dichotomously branched segments, 3–6 mm wide with widely divergent branches. Blade margins entire, undulating and with rounded or pointed apices, forming marginal projections that serve to attach the blades to the substratum.

Apex showing the growth of thallus by transverse division of several apical cells, 7–8  $\mu\text{m}$

in diameter (Figs. 1C-D). The blade is thin and mostly monostromatic at the upper part, about 50  $\mu\text{m}$  thick (Fig. 1E), and increasing in thickness near the base to 70  $\mu\text{m}$ , with the blades becoming polystromatics. The blade comprises cells that are elongate to polygonal, pigmented, 35–90  $\mu\text{m}$  long and 30–60  $\mu\text{m}$  wide. Midribs and macroscopic veins absent; a network of microscopic veins with a trellis-like pattern of transverse generally parallel, longitudinal are present (Figs. 1F-G).

Tetrasporangial sori are grouped into rounded or triangular near apices, singly paired on both side



**Figure 2.** *Champia compressa*, A-B: habit, C: apex in surface view showing large (arrowheads) and small (arrows) cells, D: longitudinal section showing single-layered diaphragms with 8 to 10 cells across from dorsal to ventral surfaces, E-F: longitudinal section of thallus showing longitudinal elongate medullary filaments with gland cells (arrows), G: Mature cystocarp with detail of gonimocarp containing numerous angular carposporangia, H: inmature cystocarp, I: longitudinal section showing tetrasporangia (arrows). Scale bars: A, B= 4 mm, C, D, E, F= 150  $\mu$ m, G= 200  $\mu$ m, H= 300  $\mu$ m, I= 100  $\mu$ m.

of apex of blade, up to 3 mm wide. Tetrasporangia tetrahedrally divided, spherical, 25–40  $\mu\text{m}$  in diameter (Fig. 1H). Cystocarps formed on both side of blade, scattered, spherical to hemispherical, up to 500  $\mu\text{m}$  in diameter when mature and with slightly protruding ostiole (Figs. 1I–J).

This species, originally described as *Nitophyllum thysanorhizans* Holmes 1873, based on specimens from Torpoint, Cornwall, England, is also known from Britain (Newton, 1931) as *Rhizoglossum thysanorhizans* (Holmes) Kylin 1924. *R. thysanorhizans* widely distributed in the Mediterranean Sea, all previous records outside the Mediterranean coast are limited to northern Atlantic Ocean of Europe and its distribution into the Atlantic Ocean regions of Africa has been enlarged in this study.

### ***Champia compressa* Harvey (Figure 2)**

Tetrasporangial, female gametophytes, and vegetative specimens were collected from Hyayda in December 2013 and August 2014. From Larache in August 2014. From Asilah in February 2015. Species commonly inhabits upper sublittoral zone of rocky exposed shores, as epiphytes on *Halurus equisetifolius* (Lightfoot) Kützinger, associated with other epiphytes, such as *Ceramium*, *Chaetomorpha*. (HTET 744, 751, 752 and 886).

Algae are to 2 cm in height pale red, with 1–4 axes arising from a common holdfast; with oppositely branched, sometimes alternately; axes clearly segmented, are terete at the base, up to 500  $\mu\text{m}$  in diameter, increasing in diameter distally to 1–1.3 mm at the middle before decreasing in breadth at the apices (Figs. 2A–B).

Lateral branches are tapered at bases and apices, broader in median parts. Axes and branches are hollow, segmented, with diaphragms 8–10 cells across between the dorsal and ventral surfaces (Figs. 2C–D). The medulla consisting of longitudinal filaments of 8–18  $\mu\text{m}$  in diameter and 70–200  $\mu\text{m}$  long, with small spherical gland cells, up to 14  $\mu\text{m}$  in diameter (Figs. 2E–F).

Cystocarps are ovoid, sessile, 400–500  $\mu\text{m}$  in diameter and 500–600  $\mu\text{m}$  in height, with a conspicuous beak-like ostiole, carposporangia ovoid to polygonal (Figs. 2G–H). Tetrasporangia are formed in sori; mature tetrasporangia are spherical in shape, tetrahedrally divided and are 40–55  $\mu\text{m}$  in diameter (Fig. 2I).

This is the first record of *Champia compressa* from the eastern coast of the Atlantic Ocean. *Champia parvula* is the most common species of the genus, is widely reported throughout the world and throughout the Moroccan shores, both, Mediterranean and Atlantic coast. Some authors

believe that many records need verification (Irvine & Guiry, 1983; Lozada-Troche & Ballantine, 2010). We believe that this view applies to many previous records of *C. parvula* from Morocco. Its diaphragms have also 8–10 cells across axes segmented, beaded (below, with cystocarps), segments about as broad as long, filled with a watery mucilag. But, it is clearly distinguished from *C. compressa* by its cylindrical axes and branching pattern (Ballantine & Lozada Troche, 2008; N'Yeurt & Payri, 2010; Moussa *et al.*, 2015).

### ***Diplothamnion jolyi* C. van den Hoek (Figure 3)**

This species, which was described from Klein Piscadera, Curacao, Netherlands Antilles (Van den Hoek, 1978), widely reported in the western coast of the Atlantic ocean and Pacific Islands (Guiry & Guiry, 2018), so that their presence in Morocco merely extends their range.

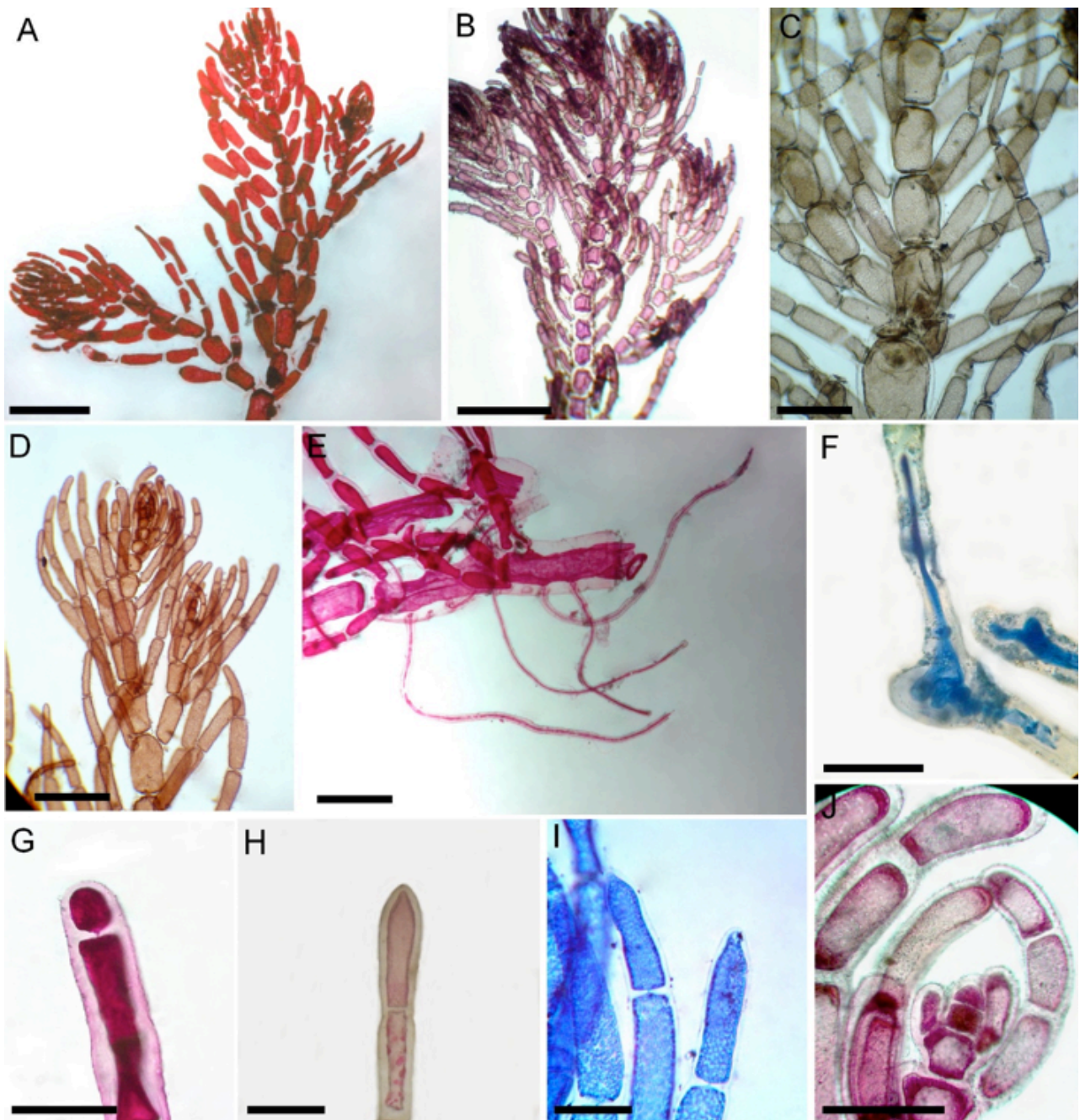
Specimens were collected from Hyayda on December 2013 and August 2014. From Larache in August 2014 and in November 2015. From Asilah in February 2015. This species commonly found in the upper sub-littoral, as epilithic and epiphyte on larger algae such as *Corallina officinalis* Linnaeus and *Cystoseira tamariscifolia* (Hudson) Papenfuss. (HTET 693–696).

Thallus filamentous, delicate, pink to purplish-red, uncorticated, forming small tufts, up to 1 cm tall, without a distinct main axes (Figs. 3A–C). Consisting of extensive stoloniferous prostrate axis that give rise to numerous erect filaments.-

The erect portion bears from each segment (cell) two opposite whorl-branchlets decussately arranged (Fig. 3D). The stoloniferous prostrate axis are 35–70  $\mu\text{m}$  in diameter, attached to the substratum by unicellular rhizoids, 10–20  $\mu\text{m}$  in diameter and 200  $\mu\text{m}$  long and sometimes terminate in small digitate pads (Figs. 3E–F). The erect axis reaching 11 mm in height and 18–65  $\mu\text{m}$  in diameter.

The apical cells of the whorl-branchlets are occasionally thicker than the basal cells of branches and often with an irregular outline, rounded or pointed tip or or in diminutive end cells (Figs. 3G–J).

The genus *Diplothamnion* currently represented by 4 taxa with restricted geographical distribution (Guiry & Guiry, 2018). Originally described from the coast of southern Brazil (São Paulo), *Diplothamnion* is a relatively distinctive genus related in some characteristics to the *Spermothamnion* groupe, genus is mainly characterized by opposite decussate whorl branchlets and lack of a conspicuous fusion cell in the carposporophyte



**Figure 3.** *Diplothamnion jolyi*, A-B: habit, C-D: branching pattern showing whorled branching and opposite decussate arrangement of lateral branches, E: fragment of stoloniferous basal part with unicellular rhizoids, F: detail of unicellular digitate rhizoid, G: diminutive end cell, H-I: detail of apical cells showing apices end in apiculi, J: detail of apical cells. Scale bars: A, B = 200  $\mu\text{m}$ , C, F= 100  $\mu\text{m}$ , G, J= 50  $\mu\text{m}$ .

(Joly *et al.*, 1966; Huisman, 1991).

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