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First records of two *Padina* species (Dictyotales, Phaeophyceae) from the Syrian coast (eastern Mediterranean)

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Abstract

Padina ditristromatica and *Padina boryana* (Dictyotales, Phaeophyceae) are recorded for the first time from the Syrian coast (eastern Mediterranean). *Padina ditristromatica* has been previously reported in the west and the north east of the Mediterranean (Ni-Ni-Win et al. 2011) and *Padina boryana* from the southern Mediterranean (Geraldino et al. 2005). The morphological and anatomical characteristics have been used to confirm the new *Padina* spp.

Keywords: Dictyotales, Mediterranean Sea, *Padina*, *Padina boryana*, *Padina ditristromatica*, Phaeophyceae

Introduction

Marine macrophytes have been thoroughly studied in the western Mediterranean, but there are fewer studies for the eastern Mediterranean (Giaccone 1968; Mayhoob 1976; UNEP/IUCN/GIS 1990) especially of the Phaeophycean algae (Mayhoob 1989, 2004; Mayhoob and Billard 1991; Mayhoob and Hatoum 2005).

Specimens of the genus *Padina* Adanson were collected from Syria during a survey of Phaeophyceae.

This genus includes about 27 species (Papenfuss 1977) in tropical and sub-tropical waters. In the Mediterranean Sea only 5 species have been reported: *Padina pavonica* (L) Thivy, *P. boryana* Thivy (Ribera et al. 1992), *P. antillarum* (Kützing) Piccone (*P. tetrastromatica* Hauck (Mayhoob 2004)), *P. ditristromatica* Ni-Ni-Win & H. and *P. pavonicoides* Ni-Ni-Win & H. Kawai (Ni-Ni-Win et al. 2011; Cormaci et al. 2012). Two of these are found on the Syrian coast: *P. pavonica* and *P. tetrastromatica* (Mayhoob 2004).

This paper describes the recording of 2 species of the brown alga genus *Padina* (Dictyotales, Phaeophyceae) for the first time on the Syrian coast.

Materials and methods

Samples were collected from 2 sites: Al-madinah Al-riadiah (35° 17′ 38.07″ N, 35° 55′ 23.71″ E) and the coast of Tal Socass (35° 17′ 54.86″ N, 35° 55′ 17.67″ E) in spring-summer 2014 from the lower intertidal zone at a depth of 2 m. The samples were washed thoroughly and preserved in a 4 % formalin-seawater solution for further investigation. Some of these samples were preserved in the form of herbarium sheets and given series numbers with the date of collection. They were kept in the herbarium of the High Institute of Marine Researches (Latakia, Syria).

Transverse sections were made by freehand cutting with the help of shaving blades.

Results

Specimens examined

Twenty preserved specimens of *Padina boryana* and 50 specimens of *Padina ditristromatica* were studied morphologically and anatomically.

Padina boryana Thivy

Morphology The thalli are yellowish brown in colour, and are moderately calcified on the lower surface (opposite the inrolled margin), especially at the stipe and lightly calcified on the upper surface (facing the inrolled margin). They are composed of

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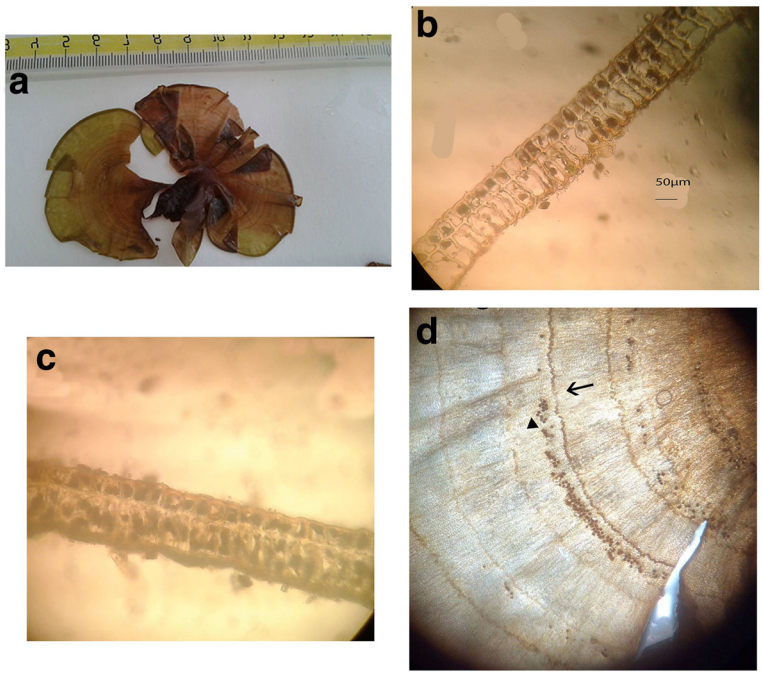

Fig. 1 *Padina boryana* Thivy: (**a**) Morphology of *Padina boryana* Thivy Sporophyte, (**b**) Transverse section of middle portion, showing 2 layers of cells, (**c**) Transverse section of basal portion, showing 2 layers of cells, (**d**) Surface view of the upper surface of the thallus, showing relationship of the hair lines (arrow) and the sporangial sori on the upper surface (triangle)

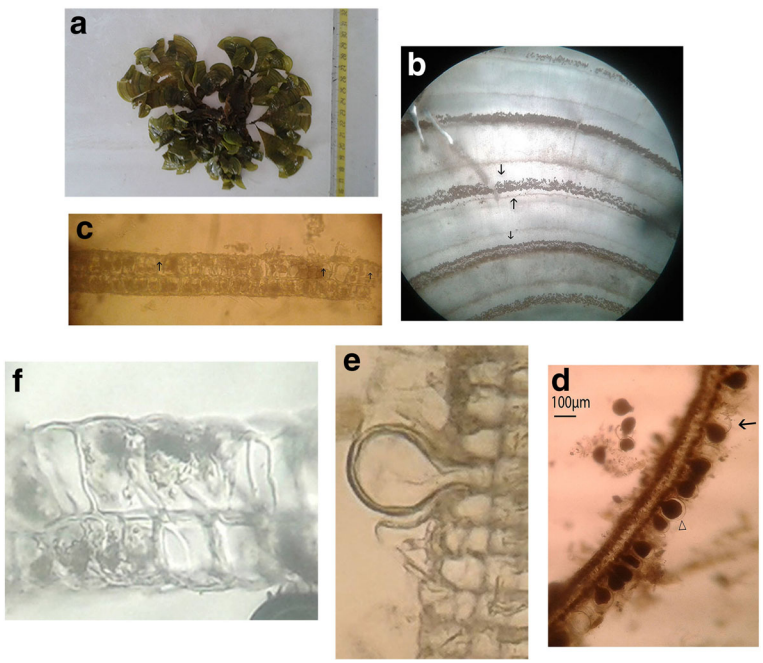

Fig. 2 *Padina ditristromatica* Ni-Ni-Win & H. Kawai. (**a**) Morphology of *Padina ditristromatica* Ni-Ni-Win & H. Kawai female gametophyte, (**b**) Surface view of the lower surface of the thallus, showing relationship of the alternating hair lines and the reproductive sori on lower surface (arrow), (**c**) Transverse section of middle portion, showing mixture of 2 to 3 layers (arrows), (**d**) Mature obovate oogonium (triangle) with empty oogonia (arrow), (**e**) Mature oogonium, showing spherical shape, (**f**) Transverse section of marginal portion showing two cell layers

Table 1 Comparing of the characteristics of five species of the Mediterranean *Padina*

	Height (cm)	Color	Surface	Hair lines		Sporangial sori		Holdfast		Cell layers	Indusium	References
				Position	Arrangemant	Position	Arrangemant	Length (mm)	Breadth (mm)			
P. tetrastromatica	8-16	Greenish brown	Lightly calcified	On both surfaces	Alternate	On both surfaces	Successive	7	4	4	Absent	(Gaillard 1967)
P. pavonica	6	Yellowish brown	Heavily calcified	On both surfaces	Alternate	On both surfaces	Alternate	7-20	5-15	3-4	Present	(Taylor, 1960)
P. pavonicoides	-	-	-	On both surfaces	Alternate	Lower surface	Successive	-	-	2-3	Present	(Ni-Ni-Win et al. 2011
P. boryana	7	Yellowish brown	Moderately calcified on the lower surface and lightly calcified on the upper surface	upper surface	successive	Upper surface	Successive	7	4	2	Absent	(this study)
P. ditristromatica	5-10	Yellowish or greenish	Heavily calcified	On both surfaces	Alternate	Lower surface	Successive	7-10	5-7	2-3	Present	(this study)

fan-shaped blades with rhizoids forming the holdfast (Fig. 1a). The erect thalli are up to 7 cm in height. The sporangial rows alternate with hair rows at different intervals only on the upper surface of the thallus.

Anatomy A transverse section of the thallus shows 2 layers of cells (Fig. 1b). The outer cells are small and nearly square, measuring 36 μm in length. The inner cells are large and rectangular in shape, measuring 58 μm in length. The sporangial sori and hair lines are close to each other (Fig. 1d). The sporangial sori are not covered with an indusium.

Padina ditristromatica Ni-Ni-Win & H. Kawai

Morphology The thalli are composed of fan-shaped lobes with inrolled margins. These lobes are attached to each other at the base by a short stem (Fig. 2a).
The thallus is yellowish or greenish-brown between 5 and 10 cm high and moderately calcified on both surfaces.

On the lower surface of the thallus a number of semi-circular lines of 2 different types can be seen: reproductive sori (the larger and darker lines) and hair lines. The reproductive sori were found only on the lower surface and formed a single line of separated dark spots (Fig. 2b). And they are successive at equal distance.

The reproductive sori and the hair lines are close to each other or may be merged into single lines (Fig. 2b).

Hair lines were found on the lower and upper surface of the thallus alternating between the 2 surfaces (Fig. 2b). The long fibrous hairs are only on the lower surface of stem of the thallus. The 'Vaughaniella' stage was not found in this species.

Anatomy Figure 2f shows the 2 cell layers at 68–72 mm from the margin of the thallus. In other parts of the thallus, we found layers of 2 and 3 cells at 80–120 mm in the transverse section (Fig. 2c).

The oogonial sori are located near to the hair lines (Fig. 2b) and formed spots in narrow lines only on the lower surface (Fig. 2a). Each 1 of them is surrounded by an indusium (Fig. 2d). The mature oogonium has a spherical shape and is 100 μm in diameter (Fig. 2e).

Discussion

According to the morphological and anatomical observations of these specimens and previous research (Gaillard 1967; Geraldino et al. 2005; Coppejans et al. 2009; Ni-Ni-Win et al. 2011; Abbas and Shameel 2013) the species are identified as *P. boryana* Thivy and *P. ditristromatica* Ni-Ni-Win & H. Kawai.

They are clearly distinguished from each other in terms of morphological and anatomical characteristics, mainly in the numbers of cell layers in the thallus, the degree of calcification on the thallus surface, and the structure of the reproductive sori.

P. pavonica is mostly 3 layers thick and occasionally 4 layers at the base of the thallus (Taylor 1960; Ni-Ni-Win et al. 2011), but there is a mixture of 2 and three layers in *P. ditristromatica* (Ni-Ni-Win et al. 2011; this study).

Padina ditristromatica is similar to *P. tetrastromatica* Hauck in respect of the dioecious gametophyte and the presence of an indusium (Gaillard 1967; Ni-Ni-Win et al. 2011; this study) (Table 1), but they differ in the numbers of cell layers in the thallus (Table 1) where *P. tetrastromatica* is mostly 4 layers thick (Gaillard 1967).

In addition, *P. ditristromatica* is different from *P. pavonica* and *P. tetrastromatica* in terms of the structure and arrangement of sporangial sori which in this species are located distally and adjacent to the hair lines only on the lower surface (Ni-Ni-Win et al. 2011). Mean while in *P. pavonica* and *P. tetrastromatica* they are located in concentric rows girdling the hair lines on both surfaces (Taylor 1960; Gaillard 1967; Ni-Ni-Win et al. 2011).

Padina pavonicoides is different from *P. ditristromatica* in that its thallus is composed of 3 cell layers from the base to the marginal portion and 2 layers at the inrolled margin and by the alternating hair lines that are spaced at equal distances between the upper and lower surfaces (Ni-Ni-Win et al. 2011).

Padina boryana differs from *P. ditristromatica* in terms of the number of cell layers in that it is mostly 2-layers thick throughout the thallus and it also lacks an indusium (Farrant and King 1989; Geraldino et al. 2005; this study) (Table 1).

Marine vegetation in the eastern Mediterranean, including the coast of Syria, belongs to the Atlantic-Mediterranean province (Giaccone 1968; Mayhoob, 1976). However, some circumtropical species are establishing permanent populations so that some tropical characteristics can be attributed to this region.

According to the world-wide distribution of these 2 species and the lack of information concerning the biodiversity of macroalgae in the eastern Mediterranean they might be endemic, relics of the Sea of Tethys, or alien species that have recently been introduced to the Mediterranean sea (Occhipinti-Ambrogi 2000; Boudouresque and Verlaque 2002; Streftaris et al. 2005, 2007; Galil and Zenetos 2008).

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