Padina ditristromatica sp. nov. and Padina pavonicoides sp. nov. (Dictyotales, Phaeophyceae), two new species from the Mediterranean Sea based on morphological and molecular markers

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A study of the genus Padina in the Mediterranean Sea, based on detailed morphological and molecular analyses using chloroplast rbcL and mitochondrial cox3 gene sequences, as well as RuBisCO spacer and partial rbs sequences, revealed the presence of two new species, P. ditristromatica Ni-Ni-Win & H. Kawai and P. pavonicoides Ni-Ni-Win & H. Kawai. They are two to three-layered and three-layered species, respectively. Padina ditristromatica is characterized by a thallus composed of two cell layers from the marginal portion to the inrolled margin and a mixture of two and three layers in the other portions; heavy calcification on both surfaces of the thallus except for the hair lines; alternating hair lines that are spaced at unequal distances between the upper and lower surfaces; and broad indusiate oogonial and tetrasporangial sori forming broken lines or patches arranged in a concentric row, which are distally close to the hair lines and half immersed in the epidermis layer only on the lower surface. Padina pavonicoides is characterized by a thallus composed of three cell layers from the base to the marginal portion and two layers at the inrolled margin; alternating hair lines that are spaced at equal distances between the upper and lower surfaces; and indusiate oogonial and tetrasporangial sori forming patches located distal to the hair lines only on the lower surface. All molecular phylogenetic analyses indicated that the new species are closely related to P. pavonica, a common species in the Mediterranean Sea. However, the cox3 region could not be amplified for P. ditristromatica. Therefore, the RuBisCO spacer and partial rbs were analysed for the Mediterranean specimens in order to confirm their identity as well as their closest relationships. The combined rbcL, RuBisCO spacer and partial rbs data also support their genetic separation and show that P. pavonica is more closely related to P. pavonicoides than P. ditristromatica, as in other molecular analyses.

Key words: cox3, Dictyotales, Mediterranean Sea, molecular analyses, Padina ditristromatica, Padina pavonicoides, Phaeophyceae, rbcL, taxonomy

Introduction

The genus Padina Adanson is widely distributed in warm temperate to tropical coastal regions, where it is found from the lower intertidal to deep subtidal zones. The plants are usually fan-shaped with an inrolled margin of meristematic cells by which growth is initiated. However, some species show a ‘Vaughaniella’ stage (creeping rhizomes) with a single apical cell from which the erect thalli develop (Børgesen, 1951; Cribb, 1951; Umezaki & Yoneda, 1962; De Clerck & Coppejans, 1997). The thallus is calcified to a greater or lesser extent on both surfaces or only on the upper (superior) surface (facing the inrolled margin). The life cycle is isomorphic–diplohaplontic with an alternation of haploid gametophytes and diploid sporophytes. According to AlgaeBase (Guiry & Guiry, 2011: http://www.algaebase.org), 37 species are currently recognized worldwide. Recently, Ni-Ni-Win et al. (2008, 2010, 2011) have reported eight new species of Padina from the North-West Pacific and the Indo-Pacific transition zone and four new records for Japan (mainly from the southern offshore islands), indicating a relatively high species diversity in Japan, with 18 species in total.

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