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

NI-NI-WIN¹, TAKEAKI HANYUDA², STEFANO G. A. DRAISMA³, GIOVANNI FURNARI⁴,
ALEXANDRE MEINESZ⁵ AND HIROSHI KAWAI²

¹Graduate School of Science and Technology, Kobe University, Rokkodai, Kobe 657-8501, Japan

²Kobe University Research Center for Inland Seas, Rokkodai, Kobe 657-8501, Japan

³Institute of Ocean & Earth Sciences, University of Malaya, 50603 Kuala Lumpur, Malaysia

⁴Dipartimento di Botanica dell'Università di Catania, via A. Longo 19-95125 Catania, Italy

⁵Faculté des Sciences, Parc Valrose, Université de Nice, Sophia Antipolis 06108, Nice Cedex 2, France

(Received 20 March 2011; revised 17 June 2011; accepted 29 June 2011)

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 *rbcS* 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 *rbcS* 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 *rbcS* 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.

Correspondence to: Ni-Ni-Win. e-mail: nini.niniwin@gmail.com