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Molecular diversity of the *Caulerpa racemosa–Caulerpa peltata* complex (Caulerpaceae, Bryopsidales) in New Caledonia, with new Australasian records for *C. racemosa* var. *cylindracea*

Thomas Sauvage[1,2]*, Claude Payri[3], Stefano G.A. Draisma[4], Willem F. Prud'homme van Reine[5], Heroen Verbruggen[6,7], Gareth S. Belton[8], C. Frederico D. Gurgel[8,9,10], Daniela Gabriel[1,11], Alison R. Sherwood[2] and Suzanne Fredericq[1]

[1]*Department of Biology, University of Louisiana at Lafayette, Lafayette, LA 70504-2451, USA*
[2]*Department of Botany, University of Hawaii at Manoa, 3190 Maile Way, Honolulu, HI 96822, USA*
[3]*Institut de Recherche pour le Développement, BPA5, 98848 Nouméa, New Caledonia*
[4]*Institute of Ocean & Earth Sciences, University of Malaya, Kuala Lumpur 50603, Malaysia*
[5]*Netherlands Centre for Biodiversity Naturalis (section NHN), Leiden University, P.O. Box 9514, 2300 RA, Leiden, The Netherlands*
[6]*Phycology Research Group, Ghent University, Krijgslaan 281 (S8), 9000 Ghent, Belgium*
[7]*School of Botany, University of Melbourne, Victoria 3071, Australia*
[8]*School of Earth & Environmental Sciences, University of Adelaide, North Terrace. Adelaide, SA 5005, Australia*
[9]*South Australian State Herbarium, Science Resource Centre, Department of Environment and Natural Resources, GPO Box 1047, Adelaide, SA 5001, Australia*
[10]*South Australian Research & Development Institute, Aquatic Sciences, P.O. Box 120 Henley Beach, SA 5022, Australia*
[11]*Research Center in Biodiversity and Genetics Resources (CIBIO), University of the Azores, 9501-801 Ponta Delgada, Portugal*

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Molecular characterization (plastid-encoded *tuf*A gene) of New Caledonian members of the *Caulerpa racemosa–Caulerpa peltata* complex identified five lineages, each possibly harboring multiple species-level entities. On a global scale, the complex encompassed six lineages, two of which were pantropical and the remainder seemingly were restricted to the Indo-Pacific basin. *Caulerpa racemosa* var. *cylindracea*, a fast-spreading introduced taxon in the Mediterranean Sea and the Canary Islands, was previously thought to be restricted to southwestern Australia; it was newly reported here for New Caledonia and several northern Australian locations, including the Great Barrier Reef.

Key Words: Alien, Biodiversity, Biogeography, *Caulerpa*, *C. peltata*, *C. racemosa*, *C. racemosa* var. *cylindracea*, *C. taxifolia*, Invasive, New Caledonia, Seaweed, *tuf*A

INTRODUCTION

The genus *Caulerpa* J.V. Lamouroux is well known for its morphological plasticity (e.g. Weber-van Bosse 1898; Børgesen 1907; Eubank 1946); intermediate morphologies are known to occur under changing abiotic conditions (e.g. flow, light intensity), after field transplant experiments (Tandy 1933, 1934; Senerpont Domis *et al*. 2003) and during laboratory culture studies (Peterson 1972; Calvert 1976; Enomoto & Ohba 1987; Ohba & Enomoto 1987; Ohba *et al*. 1992; Carruthers *et al*. 1993).

The *Caulerpa racemosa–C. peltata* complex has a predominantly tropical distribution (see Verlaque *et al*. 2000, fig. 17), and it comprises morphologically convergent entities which develop racemes of vesicles and/or shields. Morphological variations are taxonomically classified under numerous varieties or formae, mostly within *C. racemosa* (Forsskål) J. Agardh, but some subspecific ranks are also accepted within *C. peltata* J.V. Lamouroux (Guiry & Guiry 2012). *Caulerpa peltata* is also accepted by some as a variety of *C. racemosa* (e.g. Abbott & Huisman 2004; Kraft 2007). Overall, the morphological instability and the inconsistent use of varieties and formae have resulted in a nomenclatural tangle. We have undertaken a new investigation of the molecular diversity of the complex, which previous studies had initiated (Famà *et al*. 2000, 2002; Verlaque *et al*. 2000, 2003, 2004; Durand *et al*. 2002; Senerpont Domis *et al*. 2003; Stam *et al*. 2006; Yeh & Chen 2004).

Previous phylogenies based on the chloroplast gene *tuf*A (elongation factor *Tu*) have shown that the *C. racemosa–peltata* complex is polyphyletic; there are multiple entities found within three main lineages of a large, rapidly diversifying and unresolved clade termed 'modern and fast evolving' by Famà *et al*. (2002). Additional taxa of *Caulerpa* that exhibit raceme morphologies belong to a separate clade, which is termed 'ancient and species poor' (Famà *et al*. 2002). However, these latter species can be readily separated from the *C. racemosa–peltata* complex by having an embedded pyrenoid and by having vesicles sharply delimited from the stipe by a constriction (e.g. *C. lentillifera* J. Agardh, *C. okamurae* Weber-van Bosse and *C. opposita* Coppejans & Meinesz).

* Corresponding author (tomsauv@gmail.com).