



New scenario for speciation in the benthic dinoflagellate genus *Coolia* (Dinophyceae)



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ABSTRACT

In this study, inter- and intraspecific genetic diversity within the marine harmful dinoflagellate genus *Coolia* Meunier was evaluated using isolates obtained from the tropics to subtropics in both Pacific and Atlantic Ocean basins. The aim was to assess the phylogeographic history of the genus and to clarify the validity of established species including *Coolia malayensis*. Phylogenetic analysis of the D1–D2 LSU rDNA sequences identified six major lineages (L1–L6) corresponding to the morphospecies *Coolia malayensis* (L1), *C. monotis* (L2), *C. santacroce* (L3), *C. palmyrensis* (L4), *C. tropicalis* (L5), and *C. canariensis* (L6). A median joining network (MJN) of *C. malayensis* ITS2 rDNA sequences revealed a total of 16 haplotypes; however, no spatial genetic differentiation among populations was observed. These MJN results in conjunction with CBC analysis, rDNA phylogenies and geographical distribution analyses confirm *C. malayensis* as a distinct species which is globally distributed in the tropical to warm-temperate regions. A molecular clock analysis using ITS2 rDNA revealed the evolutionary history of *Coolia* dated back to the Mesozoic, and supports the hypothesis that historical vicariant events in the early Cenozoic drove the allopatric differentiation of *C. malayensis* and *C. monotis*.

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1. Introduction

Marine benthic and epiphytic dinoflagellates are a group of protists associated with benthic substrates as their common habitat in marine ecosystems. This group has received significant scientific attention recently because the frequency of benthic harmful algal blooms (BHABs) events, which threaten human health and cause significant economic losses, have been increasing

(e.g. Perini et al., 2011). Human illnesses caused by BHABs include ciguatera fish poisoning (CFP) (e.g. Yasumoto et al., 1977; Hallegraeff, 1993; Poon-King et al., 2004), clupeotoxism (reviewed in Aligizaki et al., 2011), syndromes in the respiratory system (e.g. Durando et al., 2007; Barroso Garcia et al., 2008), and dermatologic syndromes (Tubaro et al., 2011).

Six genera are associated with BHABs, namely *Gambierdiscus* Adachi & Fukuyo, *Ostreopsis* Schmidt, *Fukuyoa* Gómez, Qiu, Lopes & Lin, *Prorocentrum* Ehrenberg, *Amphidinium* Claparède & Lachmann, and *Coolia* Meunier. The genus *Coolia* (Meunier, 1919) has been well studied with regard to taxonomy, distribution and toxicology. Even though no species of *Coolia* has been associated with any HAB

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