



Taxonomy and toxicity of *Prorocentrum* from Perhentian Islands (Malaysia), with a description of a non-toxicogenic species *Prorocentrum malayense* sp. nov. (Dinophyceae)

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ABSTRACT

Thirteen isolates of *Prorocentrum* species were established from the coral reefs of Perhentian Islands Marine Park, Malaysia and underwent morphological observations and molecular characterization. Six species were found: *P. caipirignum*, *P. concavum*, *P. cf. emarginatum*, *P. lima*, *P. mexicanum* and a new morphotype, herein designated as *P. malayense* sp. nov. *Prorocentrum malayense*, a species closely related to *P. leve*, *P. cf. foraminosum*, *P. sp. aff. foraminosum*, and *P. concavum* (Clade A *sensu* Chomérat et al. 2018), is distinguished from its congeners as having larger thecal pore size and a more deeply excavated V-shaped periflagellar area. Platelet arrangement in the periflagellar area of *P. malayense* is unique, with the presence of platelet 1a and 1b, platelet 2 being the most anterior platelet, and a broad calabash-shaped platelet 3. The species exhibits consistent genetic sequence divergences for the nuclear-encoded large subunit ribosomal RNA gene (LSU rDNA) and the second internal transcribed spacer (ITS2). The phylogenetic inferences further confirmed that it represents an independent lineage, closely related to species in Clade A *sensu* Chomérat et al. Pairwise comparison of ITS2 transcripts with its closest relatives revealed the presence of compensatory base changes (CBCs). Toxicity analysis showed detectable levels of okadaic acid in *P. lima* (1.0–1.6 pg cell⁻¹) and *P. caipirignum* (3.1 pg cell⁻¹); this is the first report of toxicogenic *P. caipirignum* in the Southeast Asian region. Other *Prorocentrum* species tested, including the new species, however, were below the detection limit.

1. Introduction

The genus *Prorocentrum* Ehrenberg is a group of dinoflagellates that can be found in planktonic and benthic marine ecosystems (Faust, 1990; Chomérat et al., 2010; Hoppenrath et al., 2013), with 75 valid species hitherto (Guiry and Guiry, 2018), bisected into planktonic and benthic/epiphytic. At least ten species (*P. borbonicum* Ten-Hage, Turquet, Quod, Puiseux-Dao & Couté, *P. caipirignum* Fraga, Menezes & Nascimento, *P. concavum* Fukuyo, *P. emarginatum* Fukuyo, *P. faustiae* Morton, *P. hoffmannianum* Faust, *P. lima* (Ehrenberg) Stein, *P. mexicanum* Osorio-Tafall, *P. texanum* Henrichs, Steidinger, Scott & Campbell, and *P. leve* Faust) have been confirmed to produce a suite of diarrhetic toxins, okadaic acid (OA) and the methyl derivatives

dinophysistoxins (DTXs) (reviewed in Hoppenrath et al., 2013), of which nine are benthic (Murakami et al., 1982; Holmes et al., 2001; Hoppenrath et al., 2013, 2014; Nascimento et al., 2016; Luo et al., 2017). The toxins that accumulated in molluscan shellfish are responsible for diarrhetic shellfish poisoning (DSP) in humans. Some species of *Prorocentrum* also produce various bioactive compounds (Faust and Gullede, 2002; reviewed in Hoppenrath et al., 2013). While DSP toxins-producing *Prorocentrum* species have been recorded, reports of DSP incidents related to benthic *Prorocentrum* species were scarce, to our knowledge, only one DSP event from Patagonian Gulfs, Argentina has been reported to attribute to *P. lima* (Gayoso et al., 2002). Documentation on the occurrence and outbreaks of this particular poisoning have been proven difficult owing to its relatively generic

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