



# Intraspecific genetic diversity with unrestricted gene flow in the domoic acid-producing diatom *Nitzschia navis-varingica* (Bacillariophyceae) from the Western Pacific

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## ABSTRACT

The benthic pennate diatom *Nitzschia navis-varingica*, known for producing domoic acid (DA) and its isomers, is widely distributed in the Western Pacific (WP) region. To investigate the genetic differentiation and gene flow patterns among the populations in the WP, the genetic diversity of 354 strains of *N. navis-varingica* was analysed using two nuclear-encoded rDNA loci: the large subunit rDNA (LSU rDNA) and the internal transcribed spacer 2 (ITS2). Frustule morphology of each strain was examined by TEM. The LSU rDNA phylogeny revealed a monophyletic lineage encompassing all strains, with sequence divergences of <0.9%. Phylogenetic and population genetic analyses of ITS2 identified eight distinct clades (designated as Groups A to H) with moderate to high genetic heterogeneity (0.5–19.7%). The low genetic differentiations between the geographically separated populations (pairwise  $F_{ST}$  of <0.03) suggested high gene flow and lack of spatial genetic structuring. Molecular clock analysis of the ITS2 phylogeny traced the evolutionary history of *N. navis-varingica* to the Eocene Epoch, and the split between clades likely occurred from the mid-Miocene to Pleistocene Epochs (10.8–1.2 Ma). The population dispersal in the WP were likely influenced by historical events like the Quaternary glacial cycles during the period, contributing to its homogenous distributions in the region.

## 1. Introduction

The pennate benthic diatom *Nitzschia navis-varingica* Lundholm et Moestrup is known to produce domoic acid (DA) and its isomers (Kotaki et al., 2000, 2004, 2005, 2006, 2008; Bajarias et al., 2006; Romero et al., 2008, 2011, 2012; Thoha et al., 2012; Tan et al., 2016; Bates et al., 2018, 2019; Puilingi et al., 2022). The toxins are a group of neuro-excitatory amino acids that bind irreversibly to the glutamate receptor of

vertebrate nervous systems and cause amnesic shellfish poisoning (ASP) through the food chain. Interestingly, there have been no human poisoning cases reported to be directly associated with the species, however, such cases could be underdiagnosed or unreported. The species was first discovered in Do Son, Vietnam (Kotaki et al., 2000; Lundholm and Moestrup, 2000), and later found to be widespread in the Western Pacific (WP): Japan (Kotaki et al., 2004, 2008), Philippines (Bajarias et al., 2006; Kotaki et al., 2004, 2005, 2006; 2008; Romero

**Abbreviations:** ASP, Amnesic shellfish poisoning; AIC, Akaike information criterion; CBCs, compensatory base changes; DA, domoic acid; ITS2, second internal transcribed spacer; MP, maximum parsimony; ML, maximum likelihood; MJN, median-joining network; SEM, scanning electron microscopy; TEM, transmission electron microscopy; WP, Western Pacific.

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