

# Morphological variation of two *Alexandrium* species responsible for paralytic shellfish poisoning in Southeast Asia

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## Abstract

We examined in clonal cultures the morphological variation of two toxic dinoflagellates, *Alexandrium tamiyavanichii* and *A. minutum*, responsible for paralytic shellfish poisoning events in Southeast Asia. The Malaysian strain of *A. tamiyavanichii* had either a straight or oblique posterior margin on the first apical plate, and a triangular, square to trapezoid-shaped precingular part of the anterior sulcal plate. Morphological variability was also detected in the shape of the first apical plate, its connection to the apical pore, and the position of the ventral pore. In *A. minutum*, the Malaysian strains showed variation in the sixth precingular plate and the anterior sulcal plate. The length:width ratio of the sixth precingular plate varied from one to two. An anterior sulcal plate with a long left extension also occurred in both of the Malaysian strains. Several characters that have been extensively used in the identification of *Alexandrium* species have been proven quite variable.

**Keywords:** *Alexandrium minutum*; *Alexandrium tamiyavanichii*; morphology; paralytic shellfish poisoning; toxicity.

## Introduction

The taxonomy of the genus *Alexandrium* Halim relies primarily on detailed descriptions of the thecal morphology of vegetative cells (Taylor 1984, Balech 1985, 1995). A consensus on the genus designation was reached in 1989 at the International Conference on Toxic Marine Phytoplankton held in Sweden (Balech 1990, Steidinger and Moestrup 1990). However, the species concept within the genus continues to be a subject of debate (Balech 1985, Taylor 1985, Steidinger 1990, Scholin 1998).

*Alexandrium tamiyavanichii* Balech and *A. minutum* Halim are the only two species of the genus *Alexandrium* reported so far to have caused paralytic shellfish poisoning (PSP) events in coastal regions of Southeast Asia

(e.g., Kodama et al. 1988, Usup et al. 2002a). In this region, *A. tamiyavanichii* was reported initially as *Protogonyaulax cohorticula* (Balech) Taylor (Kodama et al. 1988) and, subsequently, as *Alexandrium cohorticula* (Balech) Balech (Ogata et al. 1990). Balech re-examined specimens of *A. cohorticula* from the Gulf of Thailand and found some morphological differences that supported the designation of a distinct species, *A. tamiyavanichii* (Balech 1994, 1995). He also recorded the presence of this species in Manila Bay, Philippines, and the Andaman Sea of southwestern Thailand (Balech 1995). Morphological differences between *A. cohorticula* and *A. tamiyavanichii* were minor. The two species shared almost the same general thecal morphology, cell size and capability of forming chains of cells, whereas variations in the morphology of the anterior sulcal plate (s.a.), the posterior margin of the first apical plate (1') and the sulcal list projection have been used to distinguish the two species (Balech 1995).

*Alexandrium minutum* was recorded later in Southeast Asia and its importance was elevated by harmful outbreaks in Malaysia (Lim et al. 2004) and the Philippines (Bajarias et al. 2003). This species was described from Alexandria harbor, Egypt by Halim (1960), and a detailed description of the species was later provided by Balech (1989). *Alexandrium minutum* and its closely related taxa, *A. lusitanicum* Balech, *A. angustitabulatum* Taylor and *A. andersoni* Balech were distinguished by variation in several morphological characters (Balech 1995). *Alexandrium lusitanicum* was distinguished from *A. minutum* by the left margin extension of the anterior sulcal plate into the cingulum, while *A. angustitabulatum* was characterized by the lack of a ventral pore and *A. andersoni* by an irregular shape of the posterior sulcal plate (s.p.) (Balech 1995). A question remains as to whether or not these morphological characters warrant the separation of distinct species.

Some characters in *Alexandrium minutum* and its closely related species were proven to be unstable by Hansen et al. (2003). Recently, two new species, *A. camurascutulum* MacKenzie et Todd (MacKenzie and Todd 2002) and *A. tamutum* Montresor, Beran et John (Montresor et al. 2004), were described. These species also have a close relationship to *A. minutum*, but are distinguished by a different morphology of the sixth precingular plate (6''), which is wider in *A. camurascutulum* (MacKenzie and Todd 2002) and almost equal in width and length in *A. tamutum* (Montresor et al. 2004).

Our understanding of phenotypic variation within species of the genus *Alexandrium* is poor, and there are relatively few reports on intraspecific variability (Franco et al. 1995, Delgado et al. 1997, Hansen et al. 2003). It is difficult to assess phenotypic variability in field popula-