

A DINOFLAGELLATE CYST ACME IN THE LATE CRETACEOUS OF ANTARTICA: A CONSEQUENCE OF PALAEOCLIMATE OR NUTRITION?

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Some Late Cretaceous Antarctic sections have yielded the small chorate dinoflagellate cyst *Impletosphaeridium clavus* in extremely high proportions. The Upper Campanian–Lower Maastrichtian Snow Hill Island Formation of Ekelöf Point, James Ross Island, includes an abundance peak of *Impletosphaeridium clavus* representing 73.5% of the marine palynomorphs. In younger strata, specifically 250 m below the Cretaceous/Paleogene (K/Pg) boundary in the López de Bertodano Formation of Seymour Island, *Impletosphaeridium clavus* comprises 99% of the marine assemblage. It has been suggested that the acmes of *Impletosphaeridium clavus* are associated with the presence of Antarctic winter sea-ice during the Maastrichtian. In this hypothesis, the sea-ice influenced blooms of the parent dinoflagellate and hence the *Impletosphaeridium clavus* acmes. An alternative hypothesis invokes nutrient availability and the physico-chemical properties of marine waters. The latter theory appears consistent with the *Impletosphaeridium clavus* acme at Ekelöf Point which does not seem to be associated with ice-sea cover. However, the Maastrichtian acmes appear to probably have been sea-ice driven. During most of the Late Cretaceous–Eocene greenhouse interval, ice sheets were ephemeral, situated well inland and did not reach the coast (thereby keeping it relatively warm). *Impletosphaeridium clavus* is in the Order Gonyaulacales due largely to its apical archaeopyle (type 4A). Another hypothesis is that *Impletosphaeridium clavus* is related to the heterotrophic round brown spiny cysts (RBSCs). Autotrophic dinoflagellates produce both all gonyaulacalean cysts. By contrast, heterotrophic dinoflagellates produce peridiniacean and gymnodiniacean cysts. The cyst walls produced by autotrophic dinoflagellates are composed by cellulose-like glucan, while heterotrophic forms produced a nitrogen-rich glycan. This implies that nutritional strategy, not phylogeny, is the primary factor determining wall cyst composition. Wall composition differences between autotrophic and heterotrophic dinoflagellates and dinoflagellate cysts can be determined by fluorescence; autotrophic forms and their cysts exhibit autofluorescence and the heterotrophic ones do not. It is possible that the dinoflagellates which produced *Impletosphaeridium clavus* may have been heterotrophs, which are consistent with environments with high nutrient availability and ones cold enough to produce sea-ice. The nutrients could have been provided by melting of ice sheets during the Late Campanian–Early Maastrichtian generating acmes of *Impletosphaeridium clavus*. Close to the K/Pg boundary, short-term regressions and/or ocean cooling have been recognised globally. The regression could have produced ephemeral sea-ice and erosion of land sediments proving marine nutrients to the sea and hence causing successive *Impletosphaeridium clavus* acmes.

