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be as low as 65% in the >150 μm size fraction or 55% in the >125 μm size fraction has implications for the training and testing of automated identification systems.

Morphological variation in late Pleistocene-Holocene globorotalid foraminifera

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Morphological variation through time is often cited as an indication of evolutionary change within a species. *Globorotalia menardii* and *Globrotalia tumida* are two morphologically similar extant species' of Globorotalid foraminifera. Their biogeographical distribution is tropical to subtropical, they share a distinctive lenticular keeled morphology, however, *G.tumida* shows greater lateral inflation of the test with a heavier surface encrusting of calcite. *G. menardii* has a range of morphotypes that show great variation in the spiral height, ranging from delicately walled finer keeled forms with a compresed test (*G. menardii cultrata*), to the more robust heavily keeled forms (*G.menardii menardii*). An extremly high spired form is also known (*G. menardii gibberula*).

Studies of the biogeographical distribution of menardii morphotypes, show that the Caribbean Sea / Gulf of Mexico are dominated by the relatively compressed *G. menardii cultrata* morphology. The Atlantic Ocean shows increased variation, with the warmer waters showing greatest numbers of the cultrata morphotype, but with the introduction of the more inflated *G. menardii menardii* morphology in cooler waters. The highest spired forms are of *G. menardii gibberula* morphotype which is found towards the most southerly extent of the menardii global range. The Indian Ocean shows the greatest variation in the mix of morphologies present in each sample, this is probably a reflection of the greater oceanographic variation caused by the dominace of the monsoonal circulatory system. However regions that show the highest seasonal SST show the greatest numbers of the cultrata morphotype. The highly inflated *G. menardii gibberula* morphotype is restricted to the southern part of the Indian Ocean. The Western Pacific Ocean shows a similar range of morphologies to those seen in the central Indian Ocean, with the warmest waters being dominated by the cultratid morphotype. The Eastern Pacific samples show both cultrata and menardii morphotypes, but both morphologies

show a restricted size range. *G.tumida* shows a constrainted test morphology, with all samples showing a similar range of morphological variation. The lack of regional variation as seen in the *G. menardii* plexus suggests that *G.tumida* could represent either a single global population or cryptic species. *Globorotalia ungulata* identified during this project, shows, apart from the secondary encrusting, great morphological similarity to G. tumida which suggests that they are members of the same species. The differences in the secondary encrusting are considered to be ecophenotypic, with *G. ungulata* representing a shallow warm water dwelling juvenile form, and *G. tumida* the deeper dwelling adult form this hypothesis is also supported by results form stable isotope analysis carried out on specimens form the Caribbean.

Gametogenic calcification cannot account for the observerd variation in the morphology of the *G. menardii* plexus. The ratio of the “x and “y variates is not significantly changed with the over plating of a calcitic curst. Adaption to different depth environments could result in a change of morphology and it is hypothesised that the increase in spire hight is an adaption to buoyancy problems in differing water masses. In 1973 George Scott hypostulated that *G. menardii* would show the most compressed (flattest) tests in the warmer waters, this hypothesis was discarded at the time due to lack of supporting evidence, however the evidence presented here appears to support this. The dominace of the cultratid morphology in the Caribbean is seen as a result of the exsistance of the deep warm waters in the region, while *G. menardii gibberula* is thought to represent an extreme form of the *G. menardii menardii* morphotype showing adaption to the deepest depths.

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