Morphospecies, cryptic species or biological species…? Searching for the evolutionary significance of diversity in foraminifera

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Many groups of foraminifera are characterized by the formation of elaborate shells. These shells provide detailed morphological features that can be used for species classification. Since the majority of works on foraminifera focuses on their fossil record and their application as proxies in micropaleontological studies, a comprehensive morphotaxonomy has been established, describing tens of thousands of extant and extinct morphospecies. On the other hand, genetic analyses of the group revealed an even higher diversity on the molecular level, hidden within the traditional morphospecies. These cryptic species are usually marked by large genetic distances, differentiated biogeographic distribution patterns and ecological adaptations, implying that cryptic species rather than morphospecies represent the level of biological species.
Biological species are defined as reproductively isolated groups of organisms and their identification forms the basis for all studies on the biodiversity, biogeography and ecology of any group of organisms. Yet so far in foraminifera the evolutionary significance of both the morphological as well as genetic diversity and their relation to reproductive isolation remain uncertain, even though this knowledge is indispensable to improve the application of foraminifera as paleoceanographic proxies. E.g. the amount of genetic variation that represents species level divergence instead of intra-population variability is not yet known. In addition, it cannot be objectively stated which morphological features represent species-level differences and which are the result of environmental adaptations. Thus, in order to achieve an objective identification of the level of biological species in foraminifera, culturing experiments are needed to observe reproductive isolation.
We apply a single cell approach to survey the extent of cryptic diversity within foraminifera morphospecies and to examine their distribution and ecological adaptations. In addition, we conduct morphometric analysis in order to establish a connection between morphological and genetic diversity. Furthermore, we carry out mating experiments in order to determine the degree of genetic divergence that corresponds to reproductive isolation and thus represents the level of biological species in foraminifera. In addition, we will try to investigate the existence of different mating types, in order to elucidate the influence of the mating system on the evolution and diversification of the group.

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