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Three dimensional morphological studies of Larger Benthic Foraminifera at the population level using micro computed tomography

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Symbiont-bearing larger benthic Foraminifera (LBF) are long-living marine (at least 1 year), single-celled organisms with complex calcium carbonate shells. Their morphology has been intensively studied since the middle of the nineteenth century. This led to a broad spectrum of taxonomic results, important from biostratigraphy to ecology in shallow water tropical to warm temperate marine palaeo-environments. However, it was necessary for the traditional investigation methods to cut or destruct specimens for analysing the taxonomically important inner structures.
X-ray micro-computed tomography (microCT) is one of the newest techniques used in morphological studies. The greatest advantage is the non-destructive acquisition of inner structures. Furthermore, the running improve of microCT scanners' hard- and software provides high resolution and short time scans well-suited for LBF. Three-dimensional imaging techniques allow to select and extract each chamber and to measure easily its volume, surface and several form parameters used for morphometric analyses. Thus, 3-dimensional visualisation of LBF-tests is a very big step forward from traditional morphology based on 2-dimensional data.
The quantification of chamber form is a great opportunity to tackle LBF structures, architectures and the bauplan geometry. The micrometric digital resolution is the only way to solve many controversies in phylogeny and evolutionary trends of LBF. For the present study we used micro-computed tomography to easily investigate the chamber number of every specimen from statistically representative part of populations to estimate population dynamics. Samples of living individuals are collected at monthly intervals from fixed locations. Specific preparation allows to scan up to 35 specimens per scan within 2 hours and to obtain the complete digital dataset for each specimen of the population. MicroCT enables thus a fast and precise count of all chambers built by the foraminifer from its birth until the time of collection and to extract selected chambers for further studies. The variation in chamber number during the sampling period (in this study limited at 15 months) will allow the estimation of the mean chamber building rate for each investigated species. However, a number of morphological aberrations within the population can be observed: often multiple proloculi are present; their orientation to the equatorial plane (or planes) respectively the spatial position of the foramina between proloculus (or proloculi) to the reniform deuterolocuili, the geometry of septa and septula and their variation trough ontogeny and several other ontogenetic variation need further attention. Many new insights into the biology of living and fossil LBF will be obtained when the three dimensional morphology of the complete foraminiferal shell is raised to the population level.