Abstract

Polychaetes (Annelida) are almost exclusively marine invertebrates. As an immense majority of them are represented by soft-bodied organisms, their fossil record is scarce and most often restricted to the Lagerstätte (conservation) deposits. In the fossil record, polychaete fossils are dominated by hard parts of the exoskeleton represented by biomineralized dwelling tubes and less often by jaw elements (scolecodonts), as well as opercula. Among the all polychaete groups only the sessile Serpulidae, Sabellidae, and Cirratulidae are known to produce hard tubes made of calcium carbonate, of which only the family Serpulidae encompasses common calcareous tube builders. Previous research on the Jurassic sessile polychaetes is rather poor in comparison to other invertebrate groups, comprising only a few published articles, and only one concerning the Juassic serpulids from the area of Poland. This scientific project aimed to fill up these deficiencies.

Fossil tubes of Jurassic serpulids and sabellids derived from the upper Bajocian-lower Kimmeridgian deposits of the Polish Basin were subjected to taxonomic, paleoecological, and ultrastructural research. Based on the diverse assemblages of serpulids and sabellids, 24 taxa were reported including two new species – *Filogranula spongiophila* and *Cementula radwanskae*. 23 taxa represent two of three main serpulid clades and one species (*Glomerula gordialis*) belongs to the family Sabellidae.

Based on the identified taxonomic composition of the communities, distinct groups corresponding to certain paleoenvironments have been recognized. The abundance, diversity, and colonization patterns of the assemblages are strictly dependent on the nature of the colonized substrate and other paleoecological variables (e.g., nutrient availability, environmental energy), whereas the stratigraphic interval plays a secondary role. Other paleoenvironmental factors, such as nutrient availability and environmental hydrodynamics, also play a significant role. In addition, many tube-dwelling polychaetes show a characteristic distribution pattern reflecting their paleoecological adaptations, such as a cryptic lifestyle or spatial competition.

The analysis of paleontological material from an ecological and paleoenvironmental perspective also concerned symbiotic relationships between serpulids and hydroids, which were preserved in the process of bioclaustration. Although this kind of interaction has a very long evolutionary history (Pliensbachian-Recent), the fossil record of this phenomenon is highly dispersed both in time and space. In the Jurassic sea of the Polish Basin, serpulids very rarely hosted symbiotic hydroids referred to as the species *Protulophila gestroi*. In the herein research,

hydroids were highly selective in the choice of their host colonizing only one serpulid genus, *Propomatoceros*. Moreover, the vast majority of the infestation cases (17 out of 20) was recorded from a single site and a single stratigraphic zone. In order to visualize the internal morphology of the symbiotic hydroids, micro-computed tomography (micro-CT) has been applied for the first time.

The microstructural analysis of serpulid tubes encompassing 12 taxa revealed a relatively low microstructural diversity comprising three types – irregularly oriented prismatic structure (IOP), spherulitic prismatic structure (SPHP) and simple prismatic structure (SP). Six of the taxa have skeletal walls composed of a single layer and six taxa have two-layered tubes. Microstructure types correspond to the specific clades and provide important phylogenetic signals; however, they are neither genus nor species-dependent. Therefore, contrary to some geologically younger serpulids, they are not suitable for ultrastructure-based recognition. Anyhow, the development of ultrastructural diversity in serpulids and the emergence of multi-layered tubes was presumably connected with the evolutionary importance of the tubes for the taxon, which could be enhanced by increased predation levels during the Marine Mesozoic Revolution.

The biomineralization system of serpulids differs from that of sabellids and remains more complex. Jurassic calcareous sabellids built a single-layered tube, the secretion of which proceeds along the long and oriented parallelly to the tube wall growth lines, where the subsequent growth increments are added to the interior of the tube - therefore *Glomerula* is unable to modify its external morphology. It also results in a very uniform set of tube characters and makes the tube fragile and susceptible to mechanical damage. On the other hand, sabellids bear a relatively low energy expenditure during tube secretion, being able to perform an opportunistic, “fugitive” strategy. Serpulids instead, add their subsequent growth increments to the rim of the aperture and are able to actively modify their external morphology. As a result, serpulids are capable of mechanically strengthening the tube being more resistant to any damage.

Throughout evolutionary history, the skeleton mineralogy of numerous groups of organisms has changed in response to oscillations in the chemical composition of seawater. Sabellids first formed a mineralized skeleton in the Middle Permian, a period when aragonite seas dominated. The skeleton of contemporary calcareous sabellids, represented by one endemic species - *Glomerula piloseta*, is aragonitic. Based on the Raman spectroscopy the mineralogy of the tube of the sabellid *Glomerula gordialis* has been identified for the first time as low-Mg calcite, which corresponds to the Middle Jurassic-Eocene calcite seas. The ambient seawater chemistry had a significant impact on the sabellid skeleton mineralogy. The origin and subsequent long-term fluctuations in the mineral composition of the sabellid skeleton were presumably dependent to a large extent on the changes of the ionic ratio of seawater over geological periods.