Independent evolution between cell shape and shell materials in foraminifers

*Yurika Ujiie[1], Yoshiyuki Ishitani[2]

1. CMCR, Kochi University, 2. CCS, University of Tsukuba

Foraminifers, a representative group of Rhizaria, form hard shells by using variable materials and minerals: e.g., sedimentary grains and two different calcite minerals (porcelaneous and hyaline). These different materials of the shells are basic but identical for foraminiferal classification, together with the shell morphology. Indeed, foraminifers have been successfully classified at the order and lower ranking lineages based on the shell characters. However, the evolutionary scenario of these variable lineages is incongruent between morphological and molecular phylogenies. An omnibus scenario based on the molecular phylogeny of the small subunit ribosomal DNA (SSU rDNA) sequences suggested the lineages of the grain-agglutinated shells are polyphyletic (Pawlowski et al., 2013). Although the previous study had broad taxonomic sampling among foraminifers, they have weak supports for the important nodes between the lineages with agglutinated- and calcareous-walls. Moreover, previous gene marker (SSU rDNA) is uncertain for the contribution to selection of shell materials in foraminifers. On the other hand, foraminifers form new shell on an extracellular region of cell surface in the growth of chambers. It means the shell shape is corresponded to the outline of the cell. The genes, which are related to the cytoskeleton, could provide new insights into the evolution of various foraminiferal lineages. This study focused on one protein-coding gene, β-tubulin, to reveal the evolutionary scenario of cell shape in foraminifers. The β-tubulin generally polymerize into microtubules, as one of major cytoskeleton filament system. The microtubules are growing/shrinking and work towards to maintain cell shape and its change, cell division, intercellular material transport, etc. In particular, foraminiferal β-tubulin has uniquely evolved with radiolarians within eukaryotes (Ishitani et al., 2011). We obtained β-tubulin sequences from taxa, which have agglutinated, porcelaneous, and hyaline shells. Our phylogeny clearly separate two major groups according to cell shape regardless of the shell materials. The clades are associated with the tubular or globular shapes of the cell, indicating tubular or fan-shaped extension of cytoskeleton in the growth of cell. This suggests that cell-shape and forming shells have been differently evolved in foraminifers.

References:
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