

Structural difference between phaeodarians and radiolarians (unicellular zooplankton)

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Radiolaria, Foraminifera and Phaeodaria are classified to the supergroup Rhizaria. Most of radiolarians and phaeodarians commonly possess skeletons made of amorphous silica ($\text{SiO}_2 \cdot n\text{H}_2\text{O}$), and the overall appearance of some phaeodarians is similar to that of radiolarians. Previous studies, however, revealed the structural difference among the two groups: Phaeodaria generally have spaces inside of the skeleton, and its fine structure is porous. Whereas, Spumellaria (Radiolaria) have solid skeleton, and there are no spaces within the skeleton (Takahashi & Hurd 2008, Nakamura et al. 2018). This study further examines the structural distinction among these two rhizarians groups from the viewpoint of ultrafine and overall structures.

Zooplankton were sampled in from 2011 to 2018 at ca. 20 stations in the North Pacific and the Mediterranean Sea. Phaeodarians and radiolarians were picked up from the samples and identified by observing their morphology. Individual specimens were then analyzed by the following three methods: (1) Thin cross-sections of ca. 70–200 nm were prepared, and the ultrafine structures were observed with a Transmission Electron Microscope (TEM). (2) The framework of the whole skeleton was visualized with a Micro-Xray Computed Tomography (MXCT). (3) Living radiolarians and phaeodarians were cultured with HCK-123, a fluorescent reagent specifically reacting to silica-precipitating parts, and the skeleton formation process was observed.

(1) Detailed observation of thin cross-sections revealed that the skeletons of radiolarians (including the orders Nassellaria and Collodaria) had no space within the skeleton, while the skeletons of all the analyzed phaeodarians were porous. (2) This result was confirmed by the MXCT analysis. Radiolarian skeleton did not contain any spaces, while numerous spaces were observed inside of the phaeodarian skeleton. (3) The culture experiment clarified that radiolarians form their skeleton from the central part of the cell. However, phaeodarians first create new skeletons (daughter cells) with almost the same size as that of the mother cell. The new skeleton then becomes thicker by adding silica from the inside. One mother cell produced four daughter cells within 12 hours at the fastest, suggesting that phaeodarians can create new skeletons faster than radiolarians. Considering also the occasional high biomass of phaeodarians, this group would be able to rapidly increase their number when the environment becomes preferable.

Keywords: Cercozoa, protist, biomineralization, silica, plankton