Some problems on a Mathematical Model of Skeleton of Spherical Radiolaria

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http://plankton.random-walk.org/

We have tried to exploit design principles of skeleton-bearing protistan plankton. We expect that such skeletons themselves have roles of proxy, which indicates some condition of oceans. We have discussed a basic mathematical model of skeletogenesis of foraminifera and radiolarians. In this study, we report some results and related problems derived from our studies.

Our discussion about the rule of skeleton formation of spherical radiolarians is summarized as follows. Our works revealed that the frame or assemblage of edges of the polyhedrons obtained by the spherical Voronoi division of the points allocated on spherical surface (we call such points generators in the following) are quite good approximations of skeletons of spherical radiolaria (The generators correspond to pores of radioralia). According to this fact, we can say that variation of skeletons of spherical radiolaria is dependent on variation of generators.

We considered two generators: random and ordered allocations. The former corresponds to assemblage of random points uniformly distributed on spherical surface and the latter does regular configuration of given number of points as follows. There are only five arrangements, which have completely equivalent point set on spherical surface: vertex allocation of five Platonic regular polyhedrons. For this reason, in order to realize the configurations for arbitrary number of generators, we obtain the equilibrium allocation of evenly charged particles from initial random points using the Markov Chain Monte Carlo method. The skeletons produced by such generators have similar structures with the skeletons of spherical radiolaria. Under the condition of same number of generators, we compared the total edge lengths of random and charged particle models and found that the length of charged particle model was about 6 percent smaller than that of the random model. It is one of important problems for revolution of spherical radiolarians that both types of skeletons are observed in spite of the difference of material costs.

Appling this charged particle model to Pantanellium (Mesozoic radiolarian), we discussed its skeleton shape. The genus Pantanellium has a cortical shell with pore frames and two polar spines. As an initial condition, we allocated both of 24 random points commonly observed number of pore frames and 2 hard spherical caps of given radius at the poles on which any points cannot be allocated. Under the conditions of variaous values of radius of the spherical caps, we examine the shapes of polyhedrons. As a result, we cannot obtain any frames similar to the skeleton of Pantanellium. This fact indicates that the skeleton formation of Pantanellium is not isotropic but anisotropic for some reasons. It is also an important problem from a biological viewpoint whether such an anisotropy is caused by the existence of polar spine or not.