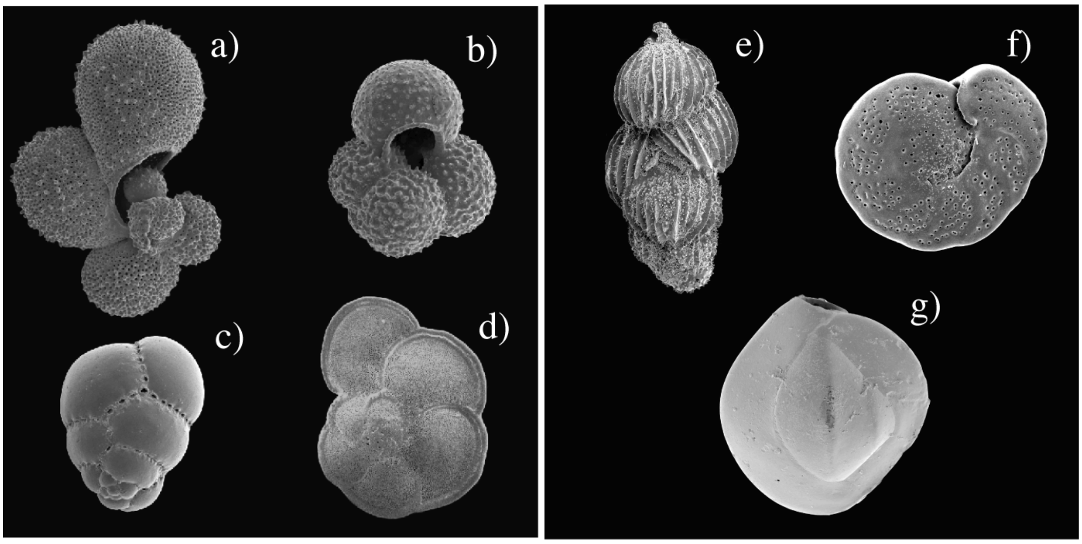

Fig. 1. Representative morphologic variations of planktic and benthic foraminifera. Samples from a to b correspond to planktic foraminifera and others correspond to benthic one. a) *Globigerinella*, b) *Globigerina*, c) *Candeina*, d) *Globorotalia*, e) *Uvigerina*, f) *Cibicidoides*, and g) *Quinqueloculina*.

scribe quantitatively their morphologies quantitatively using mathematical expression. If their morphological features are described mathematically, we can test their mechanical properties with their boundary conditions using numerical analysis. Furthermore it might be understood their morphological meanings in terms of mechanical functions through evolutionary processes over the earth history. In this study, we investigate a simple mathematical model for chamber arrangement of planktic foraminifera in order to consider the parametric description of their forms systematically.

Here, we construct a discrete growth model for foraminifera and examine the reproducibility of their forms. The arrangement of foraminifera chamber can also be related to shells of snails and ammonoids. Thompson (1942) insisted that the chamber arrangement of foraminifera was qualitatively approximated to logarithmic spirals. Okamoto (1988) proposed a differential geometrical model of ammonoids called growing tube model. His model described many types of ammonoids and reproduced the formation of an irregularly arranged coiling of *Eubostrychoceras japonicum*. Both of Thompson's and Okamoto's models are based on continuous function. Their methods are not directly applicable to chamber formation of foraminifera since foraminifers have discrete chambers. We also discuss the optimization of simple chamber arrangement which for maximizing the ratio of volume to surface area as an application of the mathematical model of the chamber arrangement.

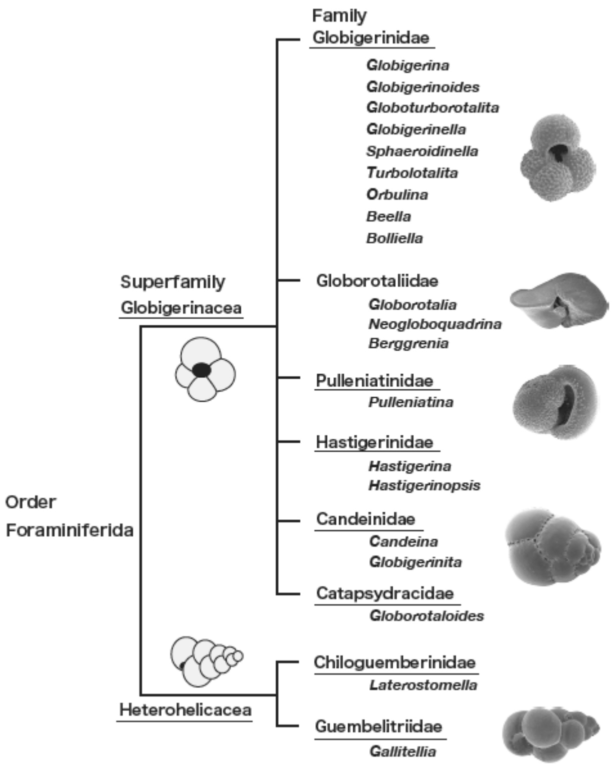

Fig. 2. Classification of modern planktic foraminifera. Right side photographs correspond to typical morphospecies of each family.

2. Model

2.1 Chamber arrangement

We choose a sphere as a representative shape of a chamber for simplicity and applicability to analyses such as optimization problem described below. Construction of sphere arrangement is successive addition of given radii of spheres. So there is an initial sphere at the beginning of construction. The radius of the initial sphere is set to be unity and the radii of other spheres are given by the relative lengths to the initial one. We allocate the initial sphere at the origin of coordinate. The locations of the other spheres are determined by relative vectors with the center of the initial sphere. Locations of the other spheres are determined by relative vectors with their beginning points at the center of the initial sphere. Because we focused on chamber arrangement, not formation process, the radii are kept constant once