

Fig. 5. Comparison of real species and results of our model. Upper parts (a, c, and e) are simulated forms by our model. Lower parts are Scanning Electron Microscopes (SEM) images of real species. b) *Globigerinita glutinata*, d) *Neogloboquadrina incompta*, and f) *Gallitellia vivans*.

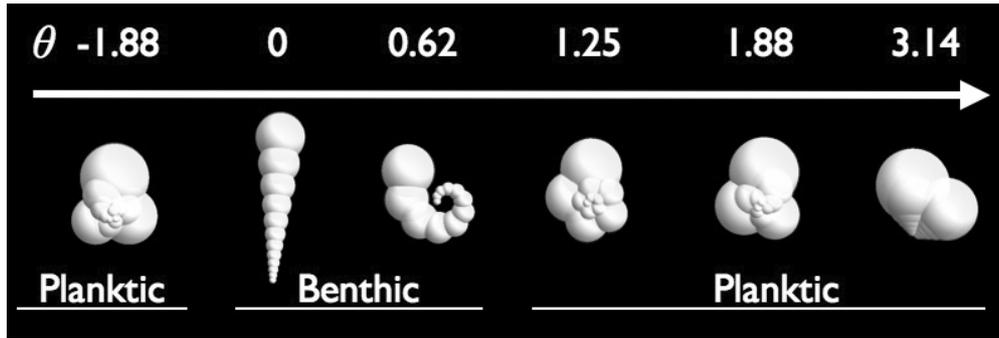


Fig. 6. Initial angle dependence of foraminiferal models. Other parameters are fixed.

consider the case of $\theta = 0$ at which the chambers are connected on a straight line. Results of this linear connection condition can be applied to the cases of other θ values as far as the chambers overlap only with neighboring ones. This type of sequential form corresponds to an uniserial form of benthic foraminifers.

The objective function can be expressed as,

$$p(d|r, n) = \frac{\frac{4}{3}\pi r_1^3 - v(l'_1, r_1) + \sum_{i=2}^n \left(\frac{4}{3}\pi r_i^3 - v(l_i, r_i) - v(l'_i, r_i) \right)}{4\pi r_1^2 - s(l'_1, r_1) + \sum_{i=2}^n (4\pi r_i^2 - s(l_i, r_i) - s(l'_i, r_i))}, \quad (3)$$

where l_n and l'_n are

$$l_n = r_n \cos \alpha_n = \frac{r_n^2 + d_n^2 - r_{n+1}^2}{2d_n},$$

$$l'_n = r_n \cos \alpha'_{n-1} = \frac{r_n^2 + d_{n-1}^2 - r_{n-1}^2}{2d_{n-1}}. \quad (4)$$

Figure 4 shows the definitions of these variables. The functions $v(x, r)$ and $s(x, r)$ correspond to volume and surface area of spherical cap of a sphere whose radius and radius of cross section are x and r , respectively. These functions are written as,

$$v(x, r) = \pi \left(\frac{2}{3}r^3 - r^2x + \frac{1}{3}x^3 \right), \quad (5)$$

and,

$$s(x, r) = 2\pi x(r - x). \quad (6)$$

The optimized value of d with fixed r and n can be found numerically using the steepest descent method (e.g. Press *et al.*, 2002).

3. Results

Using some parameter set, the model realized the chamber forms that are nearly identical to the real foraminifera. Figure 5 shows the comparison of model results and the SEM images of real foraminifera. The form of Fig. 5a was obtained by the parameter set of $r = 1.3$, $d = 1.4$, $\theta = -1.26$, and $h = 0.3$ at $n = 12$, which was identical to