Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

BPT23-11 Room:301B Time:May 23 15:00-15:15

3-D Geometric Morphometric Analysis of Planktonic Foraminifera Chamber Form with a Fixed Number Anchorpoints Method

ITO, Hikaru[1*], SASAKI, Osamu[2], NAGAHAMA, Hiroyuki[1]

[1]Department of EARTH SCIENCE, Tohoku University, [2]The Tohoku University Museum

This study presents a new Three Dimensional (3-D) morphometric analysis method of planktonic foraminifera focusing on chamber forms. Most of existing morphometric analysis methods of planktonic foraminifera (e.g. Lohmann, 1983; Malmgren *et al.*, 1984; Hull and Norris, 2009; Scott *et al.*, 2007) were based on Two Dimensional (2-D) specific sideviewing pictures of shells had lost accurate 3-D form data, and were not dealt with chamber forms that often indicates specific growth on foraminifera's ontogeny and is one of elements to compose whole shell shape. Therefore morphometric 3-D chamber analysis was required to be developed as evaluating similality and morphometric characteristic of chamber quantitatively.

Accordingly, it was useful for chamber form analysis to introduce X-ray Computed Tomography (X-ray CT) and generally 3-D morphometric methods (e.g. Brechbuhler *et al.*, 1995; Macleod, 1999; Wiley *et al.*, 2005; Mitterocker *et al.*, 2005; Shen and Makedon, 2006; Macleod, 2008; Polly, 2008; Polly and Macleod, 2008) that make rapid progress in recent years. But although 3-D chamber analysis needs a function of scanning inner structures as 3-D shape of chamber is appropriate to be represented by inner walls of shell keeping inception forms, we had been impossible to observe inner structures of microfossils until recently resolution enhancement of X-ray CT. In addition, above mentioned methods were not designed to evaluate 3-D foraminifera specimens that are microscale and have a margin and an aperture.

This new developed method allowed us to segment chambers from 3-D shell model in the form of Patch Object which surface is represented by an aggregate of microtriangle (patch), and to analyze 3-D marginate forms of microscale specimens quantitatively. the chamber segmentation procedure is composed of five phases as called ”Selecting with normalvector”, ”Selecting with total brightness of a route”, ”Selecting with Potential Field”, ”Selecting with adjoining chamber”, and ”Selecting with connecting Patch”. The analysis procedure is designed expressing chamber form with Anchorpoints of a fixed number and measuring quantitative morphometric values, composed of four phases as called ”Scaling with Centroid Size”, ”Procrustes (GLS; General Least-Squares) Superimposition”, ”Setting of Anchorpoints”, and ”Relative Warp Analysis” respectively. ”Scaling with Centroid Size” is the process that coordinates of 3-D chamber model data are divided by Centroid Size is the unique independent size variable of shape (Bookstain, 1991). ”Procrustes (GLS; General Least-Squares) Superimposition” is the process that coordinates of 3-D model data are rotated for most optimal positions of analysis around the centroid with Procrustes Rotation (Rohlf, 1990, Rohlf and Slice, 1990). ”Setting of Anchorpoints” is the process that Anchorpoints of a fixed number (1000) is placed equally on 3-D chamber model data scaled and rotated. ”Relative Warp Analysis” is the process that Anchorpoints representing 3-D chamber shape is analyzed into principal components of coefficients of Anchotpoints' warps (Bookstain, 1991; Rohlf, 1993, 1996).

The result that some Neogloboquadrina specimens were applied with this approach indicated recognizable closeness between discrete chambers of an identical specimen and nearness between homologous regions of respective specimens of identical species on principal component space, and enabled us to grasp degree of similarity in the form of a distance among voluntary chambers on principal components space. Therefore, this method is available to trace the spatial and temporal transition of 3-D chamber forms visually. In particular, this method is expected to estimate a growth stage of any specimen and to discover ontogeny patterns. This analysis was applied to planktonic foraminifera Neogloboquadrina, that have less-characteristic chamber, and enables us to evaluate quantitative differences among arbitrary chamber forms of various species.

Keywords: planktonic foraminifera, morphometric analysis, quantitative analysis, 3-D specimen, X-ray CT

BPT23-11 Room:301B Time:May 23 15:00-15:15