Pre-Publication Draft

Transient non-linear systems in the punctuated phyletic succession linking G. *pleisotumida* and G. *tumida*

Philip F. Henshaw

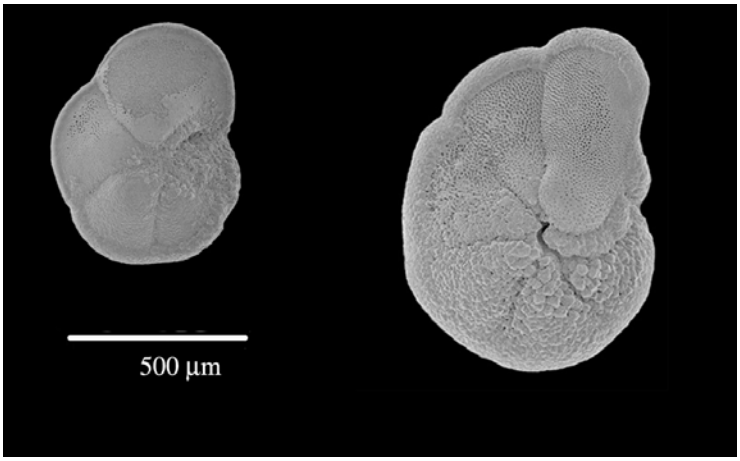
HDS research

680 Ft Washington Ave., New York NY 10040.

E-mail: id@synapse9.com

Abstract. - The evolutionary transition from planktonic foraminifera G. *pleisotumida* to G. *tumida* provides an unusually detailed picture of a single speciation event. The transition is marked by an overall tripling in size over 2 Myr and directly appears to follow trends that accelerate and decelerate. Using a new mathematical test of internal symmetry adapted from fractal theory the prior interpretation of the data as a random walk is disproved, legitimizing the use of shape analysis to reveal the behavior of the underlying process. The classic progression of growth stages bridging from one steady state to another that appears is a classic form of evolving complex system. It suggests various specific mechanisms, and would also appear to well satisfy the requirements for filling the typical gaps in the fossil record appearing at speciation for more complex organisms. The possibility of environmentally driven change and the plausibility and requirements for transient growth systems to be considered as one of the normal causal mechanisms of speciation are briefly discussed.

Keywords: planktonic foraminifera, G. *tumida.* pattern recognition, evolution, punctuated equilibrium, random walk, growth, complex systems, system identification



G. pleisotumida and G. tumida, electron micrographs taken by H.Hayashi (IGPS).

Introduction

The shapes of things generally reflect their underlying structures, with a few notable exceptions. What appear to be trends in the fossil record might or might not reflect the underlying causes of genetic variation and selective pressures. Trends in evolution might also be considered to reflect nothing more than accumulating random variation, since that is frequently considered as a default hypothesis for the mechanisms of genetic change and needs to be ruled out. Accumulations of random steps are called random walks, and often appear to have regular shapes or directions even though the underlying process has none. Whether random walks of biological characters actually occur is another question, but theoretically, characteristics of an organism that have no effect on survival could randomly wander, appearing to represent trends in evolution that actually aren't meaningful.

This study reexamines a classic example of evolutionary trends, the transition between the plankton species Globorotalia *pleisotumida* and Globorotalia *tumida* published by Bjorn Malmgren et all. (1983). His data shows an overall tripling in shell size, following a

sequence of more and then less rapid change connecting relative steady states. This was later reexamined by Bookstein (1987), and various others. As Bookstein saw it, the appearance of a succession of trends could not be read as reflecting the punctuated gradualism claimed by Malmgren et all. (1983) because he claimed it was probably produced by a random walk. This can now be ruled out with good confidence, using a more direct statistical test for the presence of random walk in the data, and confirming logic.

Materials and Methods

Preliminary Examination of the Data. - Globorotalia *tumida* is a predominantly warm water planktonic foraminifera first identified by Brady in 1877. The data published by Malmgren et al. (1983), (Figure 1), shows the average size of the shells (oriented silhouette area) from 95[1] sediment samples spanning the last 7 million years, including the transition from the G. *pleisotumida* to G. *tumida* beginning around 5.5 Ma. The samples of about 50 specimens each were gathered from a single 140 m Indian Ocean sediment core from site 214 of the Deep Sea Drilling Project. The site is near the equator, in the present location of the south equatorial current of the Indian Ocean. It provides a particularly high quality source for measures based on the fossil record, an all but perfectly continuous record of a single lineage over a long period from a single stable environment. The source is not prone to the worst normal defects of the fossil record, that fossilization is usually a rare and scattered occurrence, containing information strongly biased toward the present (Raup 1987). The dating of the layers of the core seems reasonably reliable as well, estimated by the magnetic guidepost method of Ness et al. (1980). The species appears to have been readily identifiable, abundant in every sample, to represent a single global species freely circulating in global ocean currents and to display only lineal morphological succession without lineal branching (Malmgren et al. 1983). The drilling site is believed to have been geologically stable over the period.

[1] To graphs show the first 86 of the 97 recorded data points to shorten the time axis and focus the graphics on the period of interest