New evidence of feedback animated process in genetic evolution, an analysis of transient flow in the phyletic succession linking G. *pleisotumida* and G. *tumida*

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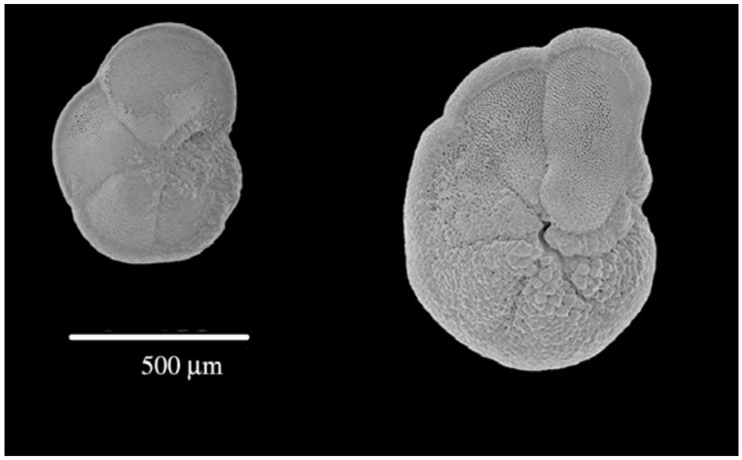
Abstract. - The evolutionary transition from planktonic foraminifera G. *pleisotumida* to G. *tumida* provides an unusually detailed picture of a single speciation event. The transition is marked by a complex change in shape and an overall tripling in size of the organism over 2 Myr and directly appears to follow trends that accelerate and decelerate. Mathematical tests for internal symmetry of variation, for flowing shape in the succession of slopes and the physical mechanisms involved rule out random walk as an explanation. Both light and strong smoothing display the clear dynamic shapes common in feedback animated systems exhibiting fluctuation on multiple scales, typical of natural systems. A way to explain the presence of classic growth and climax phases of developmental processes bridging steady states seems required, even if still speculative for lack of any identifiable mechanism. Some of the requirements for such mechanisms are discussed, along with how ordinary emergent feedback animated systems seem necessary to explain the typical gaps between stable states, the punctuated equilibria, in the general fossil record. Some of the other possible causes for rapidly fluctuating and transitional flowing shapes in the trends of changing biological forms are also briefly discussed.

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



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

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. Roopnarene (2003) reviews the literature on the subject finding that the study of rates of evolutionary change have generally not been fruitful, with little clear correlation between rates and behavior except that the longer the time span is considered the less behavior is apparent. The shorter period events in the fossil record are often assumed to be random walks, the accumulations of random steps that often visually appear to have rough shapes or directions like the changes seen in the fossil record, even though the underlying process of random accumulations of change has none. Whether random walks of biological characters actually occur is another question, however, is weakly supported except by assumption. 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. The most interesting 'rate events', though, are the gaps in the fossil record, the events that can not be studied since there no data. Those of the shortest period, the common gaps in the fossil record at speciation, imply rates of change that are infinite and were first described as 'punctuated equilibrium' by Eldredge and Gould (1972) .

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). The data shows an overall tripling in shell size, following a variable transition of variable rapid change connecting relative starting and ending steady states. Malmgren's data was later examined 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 an accumulative range test did not rule out the possibility the data could have been produced by a random walk. This conclusion can now be reversed with good confidence using more direct statistical tests for the properties of random walks and the mathematical opposite of random walks, continuous flows, and also by considering the physical mechanisms available.

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 sediment samples spanning the last 7 million years, including the transition from the G. *pleisotumida* to G. *tumida* beginning around 5.5 Ma. The graphs show the first 86 of the 95 recorded data points to shorten the time axis and focus