SYMPOSIUM ON VARIATION—IX

PROBLEMS IN THE INTERPRETATION OF VARIATION WITHIN THE FOSSIL RECORD

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Abstract

According to evolutionary theory, the fossil record is supposed to show the development of life over long periods of time. However, construction of evolutionary phylogenies often depends on conclusions drawn from fossil morphology alone. With more detailed morphologic analyses, with comparisons of fossils to living species, and with genetic analyses of both fossil and living representatives, large-scale changes and unequivocal transitions are difficult to perceive. Using several recent studies, this lack of change is attributed to limits on variation through time and among similar organisms.

Introduction

Interpretation of variation in fossil plant and animal groups is a controversial topic among paleontologists and evolutionary biologists. Do the observed differences represent: (a) intermediate forms of a species in transition; or (b) genetic variability in an otherwise stable population? The issue often reduces to the appropriateness of making conclusions from morphology alone. In addition, creationists see a difficulty in explaining the transition of one morphological type into another. This paper explores the significance of these difficulties by reviewing several recent studies which pay special attention to the analysis and comparison of fossils with their living representatives or supposed descendants.

Human "Evolution"

An excellent example has emerged from the ever-contentious arena of human evolution (Bower, 1990). In their study of 100,000-year-old bones from caves at the mouth of South Africa's Klasies River, Rachel Caspari and Milford H. Wolpoff conclude that these fossils differ significantly from anatomically modern humans living in southern Africa several thousand years ago. Consistent with their polyphyletic view of human evolution, they propose that the bones belong to a transitional, archaic form of *Homo sapiens* evolving independently from a geographically isolated *H. erectus* population. Critics of this interpretation argue that the Klasies fossils fall within the range of modern humans, and may even resemble those of modern Eskimos. Consistent with the prevailing monophyletic view, most evolutionists would suggest that the Klasies fossils represent, not transitional forms, but variants of an anatomically modern human population descended from an archaic *sapiens* ancestor which arose in Africa 100,000 years earlier (e.g., Cann, et al., 1987). Here, the problem revolves around the distinction between "archaic" and "modern" features. Each interpretive framework must deal with the difficulty in determining the supposed trend from *H. erectus* to *H. sapiens* when temporal variations in fossil specimens approximate geographic variations in modern populations.

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Marine Invertebrates

The problem of variation also arises in the debate between gradualistic evolution and punctuated equilibrium. This is exemplified in a recent study by Jackson and Cheetham (1990) on cheilostome Bryozoa–a diverse group of predominantly sessile colony-forming marine invertebrates. These organisms have many living representatives, and the preserved remains of Bryozoan calcareous or chitinous housings are ubiquitous in the fossil record. However, because different fossil cheilostome groups can only be identified based on morphology, it has been argued that these morphospecies are not necessarily equivalent to biological species. Hence, inferences regarding the evolution of these organisms are thought to be constrained by the lack of correspondence between morphospecies and biospecies.

Through breeding experiments and enzyme comparisons, Jackson and Cheetham purportedly resolve this issue by finding a good correlation between morphologically and genetically defined species in three diverse extant cheilostome genera. Further, although the authors were able to determine morphologically indistinguishable (cryptic) species or subspecies, possibly representing populations undergoing gradual change, no such intermediates were found. These results led the authors to justify their observation of morphological stasis punctuated by relatively sudden appearances in the fossil record of new morphospecies in the cheilostome *Metrarabdotos.* Presumably, the study also affirms their assertion that: "Many fossil species appear in the fossil record fully differentiated morphologically and persist for millions of years with little or no indication of transitional morphologies" (p. 579). However, the authors recognize that cryptic species have apparently been observed in other animal groups, and recommend an examination of each major taxon on an individual basis.

Paleobotany

Extreme cases of morphological invariance are often provided by so-called living fossils. One recently discovered example comes from the field of Paleobotany (Eyde and Qiuyun, 1990). The subfamily Mastixioideae, of the dogwood family Comaceas, all possess fruit-stones with an intrusive germination valve. Fossilized mastixioid fruits feature prominently in European lignite beds, while 19 extant species occur in Southeast Asia and islands of the western Pacific. All living species belong to the genus *Mastixia,* and have fruits with fleshy outer layers. By comparison, the eight fossil Mastixioideae genera have fruits with relatively hard outer layers. It has long been thought that these "woody-fruited" genera became extinct four million years ago. However, Eyde and Qiuyun discovered that the fruit-stones of *Diplopanax stachyanthus,* a plant confined to the mountain forests of eastern Asia, closely resemble the fossilized remains of the woody-fruited *Mastixicarpum.* In part, this resemblance was obscured because *Diplopanax* had been placed into the ivy family Araliaceae incorrectly. Although this is an unusual example of paleontology reclassifying a living species, it illustrates the difficulty in gaining a proper perspective of the relationship between fossil and extant organisms.

Fossil Taxa

The problem of morphological identification of fossil taxa can be widened beyond the species level. For instance, Briggs and Fortey (1989) have attempted to show the following through cladistic analysis: (a) that arthropods which evolved during the Cambrian radiation show no more apparent morphological diversity than living groups; (b) that trilobites and chelicerates are relatively advanced compared with crustaceans; and (c) that problematic arthropods, while not readily assigned to living higher taxa, conform to the diversity expected in early stages of adaptive radiation. The authors interpret their cladogram as supporting a monophyletic origin (as opposed to a polyphyletic "lawn" suggested by others), and as explaining the "clear morphological separation between the living crustaceans and chelicerates" (p. 242). This study is not only an admittedly counterintuitive attempt to incorporate extreme diversity within a continuum, it is also an example of the challenge to evolutionary scenario building provided by well-preserved, yet seemingly unique, fossil taxa.

No doubt part of the problem in assessing variability can be attributed to the lack of preservation of genetic material in the fossil record. Until recently, the oldest DNA came from a ground sloth reported to be 13,000 years old. That figure has been pushed back to 20 million years by the analysis of an 820-base pair DNA fragment extracted from an extraordinarily well-preserved magnolia leaf found in the unoxidized, water-saturated lacustrine Miocene Clarkia fossil beds of northern Idaho (Golenberg, et al., 1990). The DNA came from the chloroplast gene *rbcL* which encodes the large subunit of the common photosynthetic molecule ribulose 1,5 bisphosphate carboxylase/oxygenase ("rubisco"). Analyses show only 12 transitional mutations between the rubisco of the fossil plant, *Magnolia latahensis,* and modern *Magnolia* species. This finding places the fossil well within the Magnoliidae and seems to reflect small rates of change over geologic time.

Conclusions

In summary, the preceding examples expose limitations to deductions based solely on morphology. These shortcomings often lead to arguments over the significance of variation, and to continuing modifications of phylogenies. Most importantly, the sample studies show limits on the amount of variation within contemporaneous populations, limited variation over time—especially at the genus level, and a lack of continuity between species. The measurement of genetic differences between apparently similar species, and the analysis of fossil DNA, serve to reinforce these conclusions.

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In that respect Saint Francis or the medieval man was not modern at all. But it is precisely that non-modernity of the medieval man which should be most helpful to modern man. In his contempt for tradition, for continuity, in his maddening resolve to raze to the ground almost everything in every forty or fifty years, in his craving for novelty for novelty's sake, modern man is obviously destroying the ground under his very feet. Whether he will be ready to turn to the medievals for a much-needed medicine remains to be seen.

If he does avail himself of that medieval medicine, modern man may also find a cure for his most serious sickness. It is his mastering of the realm of quantities to the extent of losing his sense of purpose and values. Modern man is so much a slave of quantities that he recognizes only patterns, and wants to see patterns where they simply cannot exist. Patterns—physical, economical, social, psychological, and even some cognitive patterns—are always quantitative, in principle at least. But no wizardry with quantities, numbers, and statistics is going to yield so much as a drop of value and purpose.

The result is the imprisonment of modern life in sheer relativism, a very logical result because there can be no essential difference among patterns. No pattern as such can be better in the valuational sense than any other pattern. Failure to recognize this is what constitutes the modern slavery to relativism through pattern worship. That slavery supports the fashionability of such new-fangled expressions as bi-sexual and hetero-sexual, so many verbal shields to make us see mere patterns and not moral disasters in realities denoted by such words as lesbian and homosexual.

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