RELATIVE IMPORTANCE OF MOLECULAR, MORPHOLOGICAL AND PALEONTOLOGICAL DATA IN UNDERSTANDING EVOLUTIONARY INNOVATIONS

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Recently there have been increasing efforts to integrate morphological, molecular and paleontological data in assessing evolutionary relationships. In some instances molecules appear more reliable than morphology. For example, a DNA-DNA hybridization phylogeny of clypeasteroid echinoids appears superior to conflicting morphological phylogenies, because: 1) Of all the nodes on the morphological tree, the one drawn into question by the DNA data is the least supported (the characters are few and of relatively low quality; character quality was judged using Remane's *a priori* homology recognition criteria). 2) A case can be made for the conflicting characters being functional correlates. 3) The morphological tree only finds support in 1% of 500 bootstrap analyses of the DNA data. 4) On the DNA tree sister groups occupy the same paleobiogeographic realm while on the morphological tree sister groups occupy completely disparate paleobiogeographic realms.

However, in other instances morphology appears more reliable than molecules. For example, a recent 18S rRNA phylogeny of amniotes unites birds and mammals to the exclusion of crocodiles. Paleontologically this result seemed highly unlikely and it was suspected that some sort of substitution bias was responsible for the 18S rRNA result. Not only were pronounced substitution biases found, but when the 18S rRNA sequences were analyzed with an algorithm designed to deal with substitution biases a paleontologically more 'reasonable' tree resulted (birds were closer to crocodiles, not mammals).

By comparing independent data sets, it appears that both morphological features and molecules may evolve less than parsimoniously. More significantly, in these cases the unanticipated parallel evolution has an identifiable biological 'signature'. It is perhaps disappointing that the evolutionary process may produce more parallel evolution than is implied by most-parsimonious trees. But when analyzed carefully there appears to be a coherency to the unanticipated parallel evolution, a coherency that may help us understand the structure of the adaptive landscapes within which evolutionary innovation arises.

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