On the Evolution of Hierarchical Ordered Systems

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Although the evolution of life toward more highly ordered forms, that is in the direction of decreasing entropy, is from our anthropocentric perspective the most interesting feature of evolution, the mechanism by which it occurs remains obscure. In this short summary of a paper in progress I outline a simple hypothesis which appears to account, at least in part, for the direction of evolution toward more ordered systems.

When organisms change in the direction of greater complexity, they sometimes advance to a new hierarchical level in their structural, behavioral, or biochemical organization. A new hierarchical level of organization also sometimes brings with it a new environmental niche; it is the creation of these new niches that provides the selective pressure toward more ordered systems. This is because the first organisms to successfully achieve a new level of organization, and thereby the first to occupy the corresponding environmental niche, of necessity find that niche empty. Such pioneers then have the opportunity to expand very rapidly in number to fill that niche, freed of the usual constraints of inter-species competition. This creates an enormous de facto selective pressure toward the evolution of ever more highly ordered systems, which balances the extreme improbability of the random emergence of more highly ordered forms. It also means that the advance to each new hierarchical level shares some of the arbitrary character of the origin of life itself, with each major jump to a new organizational level tending to preclude further experiments; once a new hierarchical niche is filled, the possibility of being the first to populate it no longer exists. (Note that no teleology is implied in this process; the change to a more ordered state occurs by strictly random, and doubtless extremely rare, mutations.)

The process of niche creation is easy to visualize for a large hierarchical jump that results in the creation of a new trophic level. The most striking example is the transition that occurred in heterotrophs 1,500 million years ago when the simple prokaryotes, most of which obtain their food by the absorption of dissolved nutrients, evolved into the more complex eukaryotes, which can ingest solid particles. Similarly the next great leap in organizational complexity from eukaryotes to multicelled organisms facilitated the development of predatory heterotrophs.

However the creation of new niches can also occur more gradually. Particularly with the advances in complexity of behavior made possible by improvement in perceptual or nervous system capabilities (i.e. more intelligent behavior), small "behavioral" niches can be created. While not so dramatic as a jump to a new trophic level, and scarcely preserved at all in the fossil record, the filling of these behavioral niches also helps to drive the process toward more ordered systems. The essential point remains that a species gains an advantage not by competition, but by avoiding competition – by the creation of a new environmental niche which is relatively unpopulated, opening up the possibility of rapid unchecked expansion.

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