New Titles

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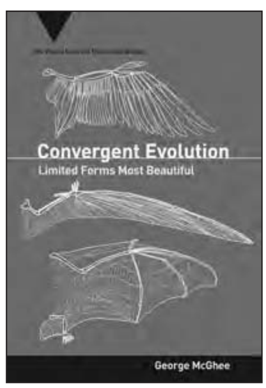
genealogical lineages often converge in both form and function. The similarity of evolved characters in different lineages reveals evolution's repeated paths.

Repetition of similar forms is easily understandable in terms of structure and function: Given the same function in similar habitats, evolution will produce a similar form to serve that purpose. The exemplar of convergence is that of the ichthyosaur and the porpoise. The two creatures have a fusiform body, snout, and fins that are remarkably similar. However, the former evolved from lizards some 240 million years ago, and the latter evolved from a mammalian lineage some 190 million years later. Indeed, McGhee surmises that if large animals were to be found under the methane seas of Titan, they would also have a fusiform body.

When the saber-toothed cat once roamed North America, Europe, and Asia, so too did its analog: a marsupial mammal of South America that looked morphologically almost identical. There are the retractable claws of both dinosaurs and cats and the raptorial beaks of diverse bird species. Flying squirrels have emerged independently all over the globe. The wings of birds and the wings of bats are a case of parallel evolution: The former developed from modified dinosaurian forelimbs, the latter from mammalian.

It was once thought that convergence was mainly a result of similar function, but developmental constraints also result in convergence. McGhee explains that some cases are based on a developmental bias or genetic channeling; others are caused by what he terms *deep homology*. For example, an ancient, highly conserved regulatory gene in the animal genome (the *Pax-6* gene) has been modified many times in evolution, resulting in convergent traits such as the many kinds of eyes in animals. As such, eyes evolved as 49 independent lineages. One of the most remarkable examples of convergence in animals is the evolution of *viviparity*—the development of the embryo inside the mother, which results in a live birth of offspring. This convergent trait has also evolved many times in animals. There is ecological convergence—when different species play similar roles in different ecological communities—and the evolutionary convergence of various social behaviors, nest building, and tool use throughout the animal kingdom, as well as self-awareness evolved independently in various lineages, including primates, corvid birds, and cetaceans. Convergence in the evolution of plants is exemplified by the development of seeds and by various relationships that plants have with animals. McGhee also discusses the convergent molecular evolution of proteins, and he even includes conjectures on directed evolution of the genetic code. The scope and significance of convergent evolution (often resulting from horizontal gene transfer) in the microbial world is not explored in the book, however.



Taking issue with those who view evolution to be unpredictable, McGhee addresses the false dichotomy between the factors of contingency and chance on one hand and directed evolution based on supernatural forces on the other. In the history of evolutionary biology, it is chance, the struggle for existence, and contingency that have always been on the side of evolution; goal-driven physiological change was always on the side of supernaturalism and the antievolution movement. This dichotomy has been maintained by an ongoing conflict between scientists and creationists, but life can be directional without being teleological. As McGhee observes, "Water flows downhill, from a state of higher potential energy to a state of lower potential energy under the influence of gravity. It is mindless" (p. 272).

Evolution does not involve an intelligent design toward a predetermined goal for McGhee any more than it does for other evolutionists. Still, he argues, one can speak of "improvement" in evolution: "Natural selection has a direction only in the sense that it will, in general, operate to move evolving organisms up the slopes of the adaptive landscape to higher states of adaptation" (p. 272). The phenomena of convergent evolution abundantly demonstrate that the environment does have a priori standards of overall value. "The laws of physics impose the functional constraints, the a priori standard, that fast-swimming organisms must be fusiform in shape and that flying organisms must have wings, and so on, for all the myriad examples of convergent evolution…" (p. 273). *Convergent Evolution* is a timely synthesis—an engaging book that will surely be widely read and discussed among evolutionists.

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