Ideas on evolution going through a revolution among scientists

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NEW YORK — Biology's understanding of how evolution works, which has long postulated a gradual process of Darwinian natural selection acting on genetic mutations, is undergoing its broadest and deepest revolution in nearly 50 years.

At the heart of the revolution is something that might seem a paradox.

Recent discoveries have only strengthened Darwin's epochal conclusion that all forms of life evolved from a common ancestor. Genetic analysis, for example, has shown that every organism is governed by the same genetic code controlling the same biochemical processes.

At the same time, however, many studies suggest that the origin of species was not the way Darwin suggested or even the way most evolutionists thought after the 1930s and 1940s, when Darwin's ideas were fused with the rediscovered genetics of Gregor Mendel.

Exactly how evolution happened is now a matter of great controversy among biologists. Although the debate has been under way for several years, it reached a crescendo last month, as some 150 scientists specializing in evolutionary studies met for four days in Chicago's Field Museum of Natural History to thrash out a variety of new hypotheses that are challenging older ideas.

The meeting, which was closed to all but a few observers, included nearly all of the leading evolutionists in paleontology, population genetics, taxonomy (the science of classifying organisms) and related fields.

No clear resolution of the controversies was in sight. This fact has often been exploited by religious fundamentalists who misunderstood it to suggest weakness in the fact of evolution rather than the perceived mechanism. Actually, it reflects significant progress toward a much deeper understanding of the history of life on Earth.

At issue during the Chicago meeting was macroevolution, a term that is itself a matter of debate but which generally refers to the evolution of major differences, such as those separating species or larger classifications. Most agree macroevolution is, for example, what made crustaceans different from mollusks. It is the process by which birds and mammals evolved out of reptiles. It is also what gave rise to major evolutionary innovations shared by many groups, such as the flower in higher plants or the eye in vertebrates.

Darwin suggested that such major products of evolution were the results of very long periods of gradual natural selection, the mechanism that is widely accepted today as accounting for minor adaptations. These small variations, considered products of microevolution, account for such things as the different varieties of finches Darwin found in the Galapagos Islands. Under human control, or "artificial selection," microevolution has produced all the varieties of domestic dog, all of which remain members of a single species.

Darwin, however, knew he was on shaky ground in extending natural selection to account for differences between major groups of organisms. The fossil record of his day showed no gradual transitions between such groups but he suggested that further fossil discoveries would fill the missing links.

"The pattern that we were told to find for the last 120 years does not exist," declared Niles Eldridge, a paleontologist from the American Museum of Natural History in New York.

Eldridge reminded the meeting of what many fossil hunters have recognized as they trace the history of a species through successive layers of ancient sediments. Species simply appear at a given point in geologic time, persist largely unchanged for a few million years and then disappear. There are very few examples — some say none — of one species shading gradually into another.

Eldridge, along with Stephen Jay Gould, a Harvard University paleontologist, reiterated the hypothesis that new species arise not from gradual changes but in sudden bursts of evolution. As they see it, species remain large, stable for long periods and then suddenly change dramatically. The transition happens so fast, they suggest, that the chance of intermediate forms being fossilized and found is nil.

The popular, told example of horse evolution, suggesting a gradual sequence of changes from four-toed, fox-sized creatures living nearly 50 million years ago to today's much larger one-toed horse, has long been known to be wrong. Instead of gradual change, fossils of each intermediate species appear fully distinct, persist unchanged and then become extinct. Transitional forms are unknown.

Eldridge and Gould represent a school of thought called "punctuated equilibrium," and although many paleontologists are adherents, many evolutionists from other backgrounds still consider themselves gradualists closer to the traditional Darwinian mold.

One paleontologist who stoutly defended the gradualist view was Thomas J.M. Schopf of the University of Chicago. He contended that species may not be as static as they seem. Fossils, he noted, represent only the hard parts of the organism, such as bones or shells.

Schopf argued that the soft parts, which are not fossilized, may be undergoing significant gradual changes that the paleontologist can never see. He recalled an instance in which the shells of certain marine organisms looked identical and were classified in the same species until live specimens were found. Their internal organs differed so much that they had to be regrouped as separate species.

"The so-called living fossils that people like to cite as examples of evolutionary stasis are largely a myth," Schopf said. For example, he noted, the species of horseshoe crab common today is unknown in the fossil record. Fossils of other species of horseshoe crabs are known from millions of years ago, but they are extinct now. The living horseshoe crab is a modern evolutionary development. The same is true of sharks, cockroaches and other species offered as "living fossils."

Others who dispute the punctuated equilibrium idea include population geneticists, who breed vast colonies of fruit flies, following the course of mutations to see how they change the species over many generations.

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