RELIGION & PHILOSOPHY

tion of the unique, non-Buddhist shrine at Ise (near Osaka), and to the final transformation of Shinto into an independent, purely Japanese faith. But Kuroda contends that the *kami* came to be viewed by most as the secular form in which the Buddha taught and saved humans. Even priests at Ise were students of Buddhism. In Japan, as in Tibet and elsewhere in East Asia, Buddhism absorbed native beliefs and gave them a new authority, without obliterating them.

Only in the 15th century, as the imperial system started to deteriorate and heresy fragmented Japanese Buddhism, did Shinto begin to depart from orthodox Buddhism. The split widened during the 17th century, with the spread of a Confucian brand of Shinto. Its central concept of "dō" (a "political or moral norm") further secularized Shinto.

The idea of Shinto as Japan's indigenous religion developed in the 18th century, among scholars of the National Learning School, who urged the Japanese to cleanse their culture of foreign influences. Finally, in the late 19th century, the Meiji emperor formally separated Shinto and Buddhism and tried to suppress the latter. Ironically, says Kuroda, it was this isolation that gave Shinto its "primitive" quality —for the Meiji emperor had severed Shinto's long-standing bond with a deeper religious philosophy.

SCIENCE & TECHNOLOGY

A Third Branch

"Archaebacteria" by Carl R. Woese, in *Scientific American* (June 1981) 415 Madison Ave., New York, N.Y. 10017.

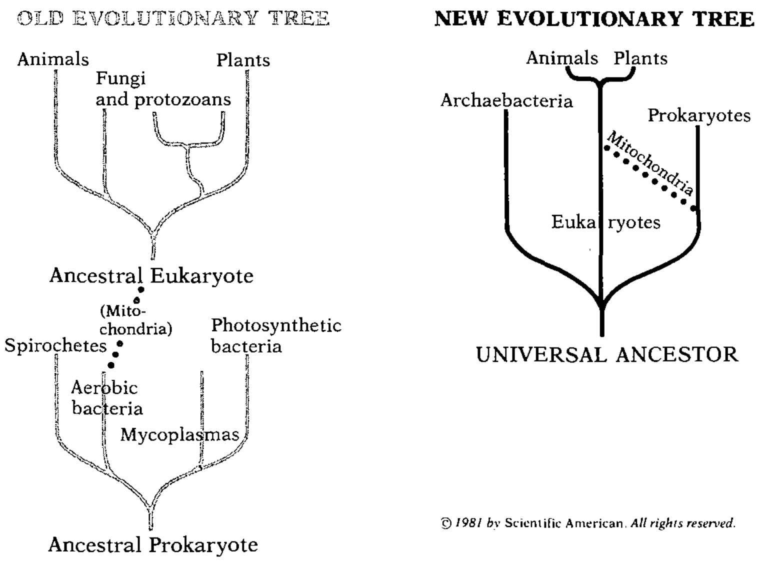
Until recently, scientists divided all living matter into eukaryotes (cells of which all animals and plants are made) and prokaryotes (bacteria). But Woese and fellow biochemists at the University of Illinois have found bacteria that constitute a hitherto unsuspected branch of life. The discovery of these "archaebacteria" may upset conventional theories about life's beginnings on Earth.

Eukaryotes are relatively large (0.0000393-inch-long) organisms with well-defined internal structures such as nuclei and mitochondria (the respiratory mechanisms of animal cells). Prokaryotes are only one-tenth as long and lack such structures. Sketchy fossil evidence has long led researchers to believe that the ancestor of both was a fermenting prokaryote, which appeared at least 3.5 billion years ago, when the Earth was less than one billion years old and its atmosphere consisted mainly of carbon dioxide and hydrogen.

Eventually, bacteria evolved that could manufacture energy from sunlight and release oxygen in the process. Earth's changing atmosphere, scientists thought, spurred the evolution of the more advanced eukaryotic cells. Different kinds of prokaryotes carry their own genetic material and correspond roughly with different parts of the eukaryotic cell; some scientists speculated that these prokaryotes became "entrapped" in larger cells of unknown origin, established a symbiotic relationship, and evolved into new eukaryotic cells.

But what was the trapping cell? This remained a mystery until Woese began examining the genetic structures of modern bacteria. He found some kinds of bacteria that were as different from other bacteria as they were from eukaryotes. Though they looked like regular bacteria, they represented a third form of life, the archaebacteria. Their genetic make-up suggests that they are even more ancient than the prokaryotes. Moreover, those archaebacteria that "breathe" methane would have been perfectly suited to primitive Earth's atmosphere.

The existence of archaebacteria indicates to Woese that the universal ancestor cell was not a prokaryote but a "progenome"—an organism so simple that its primitive genetic mechanisms constantly misfired and produced mutations. Since the eukaryotic nucleus contains genes resembling those of both archaebacteria and prokaryotes, it was probably composed even before the first true prokaryotes appeared. Hence, the eukaryotic nucleus may represent not an advance over the prokaryotes but simply another "mistake" made by the genetically primitive universal ancestor.



Most theories of evolution hold that eukaryotes (plant and animal cells) developed when prokaryotes (such as aerobic bacteria) became components (e.g., mitochondria) of larger cells. But the discovery of a new branch of life, archaebacteria, suggests that eukaryotes originated much earlier, from the genetic quirks of a universal ancestor.