esses. They serve as shuttles that channel free electrons from broken down or oxidized high-energy compounds into storable forms. Certain species of bacteria that photosynthesize and/or respire possess their own forms of Cytochrome c.

Comparing the distinctive genetic structures of these proteins strongly suggests that their differences have resulted from the same kinds of mutations that spurred evolution in higher life forms. From this, scientists reason that the processes of photosynthesis and respiration have a common origin.

All three processes evolved in response to changes in ancient Earth's environment. The common ancestors were the fermenting bacteria, capable of directly breaking down the high-energy compounds present in the primeval soils and seas they inhabited. They were followed by the first photosynthesizers—the earliest ancestors of modern plants. For hundreds of millions of years these proto-plants released enough oxygen to transform Earth's atmosphere. Some bacteria "learned" how to both photosynthesize and respire.

But some microbes known as purple bacteria only developed respiratory systems. In a low-oxygen environment they might have died out. Atmospheric changes eventually made the dual system redundant. The respirers thrived and probably evolved into mitochondria—the respiratory centers of modern cells. If so, writes Dickerson, a sobering thought occurs: "Human beings are [ultimately] the metabolic offspring of defective purple photosynthetic bacteria."

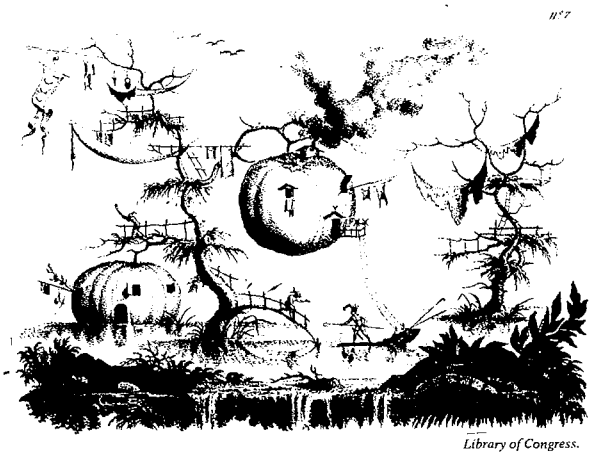
Early Views of Life in Space

"The Origins of the Extraterrestrial Life Debate and its Relation to the Scientific Revolution" by Steven J. Dick, in *Journal of the History of Ideas* (Jan.–Mar. 1980), Humanities Bldg., Temple University, Philadelphia, Pa. 19122.

The roots of modern speculation about life on other worlds go back to the revolutionary theory of Nicolaus Copernicus (1473–1543) that the Earth moves around the sun. If Earth was not the center of the universe, scientists and philosophers mused, then this planet—and the life it supports—were not necessarily unique.

As early as the 17th century, Copernican ideas locked astronomers and churchmen in battle over the possibility that "we are not alone," writes Dick, an astronomer at the U.S. Naval Observatory. Indeed, Johannes Kepler (1571–1630), imperial mathematician to the Holy Roman Empire, believed Copernican theory positively implied the existence of other inhabited planets. Dutch philosopher Christiaan Huygens (1629–95) agreed, arguing that it was "not improbable that the rest of the planets have their inhabitants too."

Armed with a faith in direct observation, these Copernicans trained their crude telescopes on Earth's neighbors. But observation turned up contradictory evidence. English astronomer John Wilkins (1614–72)



In 1760, Sicilian artist Fillipo Morghen depicted the moon as a tropical paradise.

Library of Congress.

thought that the moon's darker surfaces were bodies of water. He reasoned that God would not have made a spotted moon if He intended it only to reflect sunlight toward the Earth. But Huygens' stargazing revealed that the moon's dark spots were pitted, and therefore could not be liquid. His observations of Venus, Mars, Mercury, and Jupiter were just as discouraging.

The notion of extraterrestrial life challenged Church doctrines. Could Adam's original sin, for example, be extended to moonmen, who also required salvation? There was speculation over the role of Jesus Christ as a kind of "planet-hopping Savior."

Worried religious leaders could not suppress the 17th-century search for alien life forms. According to Dick, discussion of extraterrestrial life by the likes of Kepler, Huygens, Wilkins, and, in the 18th century, by German philosopher Immanuel Kant completed the intellectual revolution begun by Copernicus. These thinkers helped to free scientists of their preoccupation with the "closed world" of Earth and roused their curiosity about the larger universe.

Nature's Undersea Laboratories

"Ocean's Hot Springs Stir Scientific Excitement" by Mitch Waldrop, in *Chemical and Engineering News* (Mar. 10, 1980), Membership and Subscription Services, ACS, P.O. Box 3337, Columbus, Ohio 43210.

The recent discovery of two underwater hot springs on the crest of the Pacific's mid-ocean ridge is forcing geochemists to rethink traditional theories about the oceans' chemical history, writes Waldrop, a *Chemical and Engineering News* correspondent.

A Woods Hole Oceanographic Institute expedition discovered the