COLLEGIUM HELVETICUM

Lynn Margulis

Scientific Guest of the Collegium Helveticum

Events with Lynn Margulies

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Lynn Margulis ist Distinguished University Professor des Departements Geowissenschaften der Universität von Massachusetts in Amherst und wissenschaftlicher Gast des Collegium Helveticum im Sommersemester 2001.

My conversion to science occurred in the College of the University of Chicago. No class accepted more than 24 students, labs were frequent, and tests - suggestive only - didn't «count». Rather, a 9-hour final examination in June was the sole requirement for the final grade, and June seemed infinitely distant from that first day of class in autumn. Since textbooks were an anathema to learning, we read unabridged and uncompromised original works. We ignorant chickens accessed the great scientists: Isaac Newton, Francis Bacon, Galileo Galilei, Charles Darwin, Gregor Mendel, Hans Spemann, August Weismann, and the neo-Darwinists. The preoccupation of the great Natural Sciences II class was «What is heredity? What links the generations? How do the materials in fused egg and sperm generate the development of an animal? How does variation in evolution arise? How do organisms originate? Why do they evolve?» These haunting questions drive me still.

Ever since I learned about the idea that variation in evolution arises by symbiogenesis, I have worked on it. Symbiosis, coined by the German botanist Anton deBary (1873), refers simply to physical contact between different kinds of organisms - in his words, «living together of differently named organisms.» Cohabitation, long-term living together, it was asserted by many, results in symbiogenesis. Symbiogenesis, the concept developed by the Russian, K. S. Mereschkovsky, may be defined as an evolutionary idea: the appearance of new cell organelles, new bodies, new organs, new species as a consequence of symbiosis. Most evolutionary novelty, I have concluded after decades of study, arose, and still arises, from symbiosis. Obviously this contradicts popular textbook ideas of how evolutionary change occurs.

Symbiogenesis, first formulated by K. S. Mereschkovsky (1855-1921) in his 1926 book, Symbiogenesis and the Origin of Species, and by Ivan Wallin, author of Symbionticism and the Origins of Species, refers to the formation of new organs and organisms through symbiotic mergers. All organisms large enough to see, I maintain, ultimately come from merged microbes that became larger wholes. They then lost what we in retrospect recognize as their former individuality.

The symbiogenetic origin of the ancestors of plant, animal, and protoctist cells - those with nuclei - has four postulates. All involve symbiogenesis. Four once entirely independent and physically separate ancestors merged in a specific order to become, for example, the cells of plants. Cells, of course, are units of structure. The slender stamen hairs particularly visible in Tradescantia flowers are made of rows of plant cells. Large, walled green cells preceded plants; they were already fully formed in the green algae, water-dwelling ancestors of plants. That organisms evolved by merger is best appreciated in plants because their component organelles are easily observed. Both merged and free-living forms of the descendants of all four kinds of bacteria still live today. Each of the types of extant bacteria provides clues about the ancestry. Life is chemically so conservative that we can deduce the specific order of the association.

Very little evidence for the theory comes from my work alone; hundreds of scientists continue to contribute. We work these days on the expansion of the theory of the origin of nucleated cells to trace the very first appearance of nuclei and to include the evolution of larger organisms. Only details of the origins of certain cytoplasmic organelles (mitochondria, plastids) in cells have been resolved. The current best guesses for the four bacterial components of algal and plant cells are Thermoplasma (sulfur reduction, fermentation), Spirochaeta (motility), alpha-proteobacteria (oxygen respiration) and Synechococcus cyanobacteria (photosynthesis). Most of the DNA found since the 1960s in the cytoplasm of animal, plant, fungal and protoctist cells are not «naked genes»: rather, they are a palpable legacy of a violent, competitive, truce-forming past. They originated as genes of bacteria, bacteria that became organelles. The reason the early plant geneticists discovered genes in the chloroplasts of algal and plant cells is that these organelles are large, usually brightly colored, and they are omnipresent in all algal and plant cells. Green descendants of cyanobacteria are in every plant cell at all times.

During my stay at Collegium Helveticum, I plan to complete our book,co-authored with my son Dorion Sagan, modestly entitled, Origin of Species: Inheritance of acquired genomes. The main thesis is that microbes, live beings too small to be seen without the aid of microscopes, provide the mysterious creative force in the origin of species. The machinations of bacteria and other microbes underlie the whole story of Darwinian evolution. Free-living microbes tend to merge with larger forms of life, sometimes seasonally and occasionally,sometimes permanently and unalterably. Inheritance of «acquired bacteria» may ensue under conditions of stress. Many have noted that the complexity and responsiveness of life, including the appearance of new species from differing ancestors, can be comprehended only in the light of evolution. But the evolutionary saga itself is legitimately vulnerable to criticism from within and beyond science. Acquisition and accumulation of random mutations simply are, of course, important processes, but they do not suffice. Random mutation alone does not account for evolutionary novelty. Evolution of life is incomprehensible if microbes are omitted from the story. Charles Darwin (1809-1882), in the absence of evidence, invented «pangenes» as the source of new inherited variation. If he and the first evolutionist, the Frenchman Jean Baptiste de Lamarck, only knew about the subvisible world what we know today, they would have chuckled, and agreed with each other and with us.

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Monday, 18.6.2001, 14.00-19.00h, Symposium organized by the Chair of Philosophy and Social Studies of Science and Collegium Helveticum

Thursday, 28.6.2001, 7.15h, Raths Steiger Vorlesung des Departements Angewandte Biowissenschaften der ETH am Collegium Helveticum