# Attention to Terms

**Keywords in Evolutionary Biology**. EVELYN FOX KELLER and ELISABETH A. LLOYD. Harvard University Press, Cambridge, MA, 1992. xvi, 414 pp. $45.

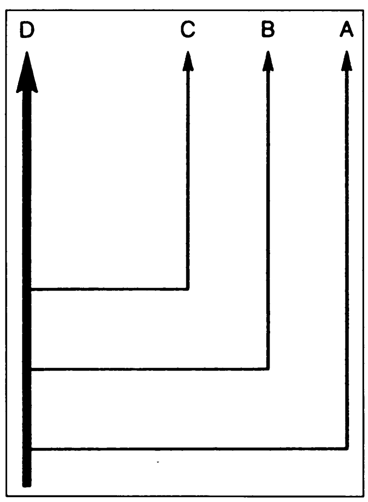
Humpty Dumpty asserts, in *Alice in Wonderland*, that when he uses a word it means exactly what he intends it to mean, neither more nor less. As Evelyn Fox Keller and Elisabeth Lloyd note, scientists intend the same in their use of words, and well they might: unless I define it, my use of "fitness" will be as incomprehensible to my students as Humpty Dumpty's use of "glory" was to Alice. But much of the vocabulary of scientists is as riddled with ambiguities, connotations, and multiple uses as the vulgar vocabulary from which it is often derived. This is especially true of "keywords," meaning here "significant, indicative words in certain forms of thought." Keller and Floyd suggest that analysis of keywords can enable scientists to understand the origins of controversies and provide historians of science with insights into the evolution of science and its interaction with the larger culture.

This book consists of 51 essays, about half by biologists and half by philosophers and historians of science, on 37 keywords or topics in evolutionary biology and ecology, alphabetically arranged (from "adaptation" to "unit of selection"). Several topics are treated in two or three essays. Some plausible candidates for keywords ("population," "function," "isolation") are not included. Perhaps best read in clusters of entries on conceptually related terms, the book should be ideal for graduate seminars, endless hours of debate, and serious study. Hardly anyone will fail to be provoked to thought by the variations in meaning of terms such as "natural selection," "gene," and "character."

The authors vary greatly in approach. Some plumb more deeply than others the conceptual issues residing in their assigned terms. Some present relatively dispassionate explorations; some have axes to grind. Motoo Kimura's self-congratulatory essay on "neutralism" concludes by suggesting "an alternative to the Darwinian term 'survival of the fittest'—namely, 'survival of the luckiest,'" whereas Peter Abrams, after grappling with the meanings of "resource," acknowledges that "it is unlikely that the final word on how to distinguish resources has appeared."

The consequences of definition for clarity of thought and the development of theory are abundantly illustrated. For example, James Griesemer describes the evolution of "niche" through three shifts in meaning, and Robert Colwell shows that two of these meanings persist: the niche is an attribute of the environment and can be occupied by any of several species in Grinnell's and Elton's "environmental niche concept" but is an attribute of the species in Hutchinson's "population niche concept." The first explains certain species' similarity whereas the second describes it; moreover, only the first enables us to speak of, and possibly to study experimentally, "empty niches," which (for all that we abjure them) are integral to some contemporary thought on community assembly and the evolution of diversity. Likewise, "epistasis" in physiological genetics is a relation between genotype and phenotype but in quantitative genetics is a component of a population's variance. As Michael Wade points out, epistasis in the physiological sense could be pervasive but yet be undetectable at the population level.

As the editors note, words in scientific discourse may retain connotations from their social origins that arouse passions. For example, in an essay on "progress" that one would like to think needs recommendation only to high school students and other lay readers, Richard Dawkins fulminates on how it would be as sensible for zoology treatises to present taxa alphabetically as in a phylogenetic order. I agree with his aim, to abolish the notion that some organisms (such as humans) are "higher" than others, but Dawkins does seem rather to minimize the temporal reality of branching events in evolution and the remarkably frequent persistence of numerous "primitive" (plesiomorphic) traits from the Paleozoic to the Recent. Nor does he examine possible meanings of "progress," such as increase in the "efficiency" or effectiveness of certain adaptations within lineages, that remain open scientific questions.




"The bold main line of evolution surges ever upward toward *D* (often man), and every now and then it throws off a living fossil. *A*, *B*, and *C* successfully 'arrive on the scene' and then stop evolving. This is a misleading picture. There is no such thing as a main line of evolution." [From Richard Dawkins's essay "Progress" in *Keywords in Evolutionary Biology*]

Are unity and precision of definition always to be prized? The authors seem to vary on this point. Some, such as John Beatty on "fitness" and John Endler on "natural selection," terms laden with highly consequential variations in meaning, seem to strive for definitive definitions. David Hull, explaining how the common-sense notion of "individual" fails to describe vegetatively propagating plants, parthenogenetic crustaceans, and debatably "individual" entities such as species and nations, argues that the ontological status of "individuals" is theory-dependent and that analysis of the term is theoretically productive. Philip Kitcher, on the other hand, notes that the term "gene" is almost obsolete in molecular biology, argues that evolutionary biology could do without a precise definition, and cheerfully concludes that "a gene is anything that a competent biologist chooses to call a gene."

I find myself in sympathy with the perspective of Michael Donoghue ("homology") on the role of definitions. The similarity in position, structure, and ontogeny of the mandibles of horses and humans is explained by derivation from a common ancestor. Cladistic systematists employ a purely historical definition of homology: a character is homologous in two or more species if it is judged, from its mapping on a phylogeny based on more inclusive information, to have been uniquely derived in their common ancestor—and not if it is not so judged. From a developmental point of view, however, homology is deeply puzzling, because phylogenetically homologous characters can have different genetic bases and ontogenies (as in the case of Meckel's cartilage in different vertebrate classes), and ontogenetically indistinguishable, perhaps causally identical, character states can originate by parallel evolution. As Kurt Fristrup remarks in discussing "character," there is a gulf between observables (character states used in systematics) and the units that play causal roles in evolution. Developmentally oriented evolutionary biologists seek a causal understanding and definition of homology that differs profoundly from the phylogenetic systematists' definition. As Donoghue remarks, "the choice of a definition is, at least in part, a means of forcing other scientists to pay closer attention to whatever one thinks is most important"; but fortunately "attention to the variety of legitimate concerns . . . is not entirely dependent on the choice of a definition."

Within biology, is ambiguity (or richness) of meaning endemic to ecology and evolutionary biology? Is it a sign of unclear thought, of weakness in the science? Are the functional-biological disciplines, such as molecular biology and physiology, "harder" sciences marked by greater conceptual and semantic clarity? This seems unlikely, given the issues uncovered by philosophers of science in their preoccupation with both evolutionary biology and physics, which between them embrace a fair spectrum of "hardness." Are terms such as "function," "induction," and "recombination," "hormone," "enzyme," and "biochemical pathway," or, for that matter, "eye," "lung," and "malate dehydrogenase," all staunchly unambiguous? Or would an analysis of keywords in functional biology be as thought-provoking as the volume that Keller and Lloyd have assembled?

***Douglas J. Futuyma***
*Department of Ecology and Evolution,*
*State University of New York,*
*Stony Brook, NY 11794*

## Biogenesis: Some Like It Hot

**Marine Hydrothermal Systems and the Origin of Life.** Report of SCOR Working Group 91. N. G. HOLM, Ed. Kluwer, Norwell, MA, 1992. iv, 242 pp., illus. $133. Reprinted from *Origins of Life and Evolution of the Biosphere*, vol. 22 (1992).

"Heat has been justly regarded the mother of all generations," wrote Jean-Baptiste Lamarck in his 1804 *Philosophie Zoologique*. He added that "it cannot be doubted that suitable portions of inorganic matter, occurring amidst favourable surroundings, may by the influence of Nature's agents, of which heat and moisture are the chief, receive an arrangement of their parts that foreshadows cellular organization, and thereafter pass to the simplest organic state and manifest the earliest movements of life." Deep-sea hydrothermal vents fit well this description: they are hot, they are rather wet, and, according to several contributors to this volume, they are the spot where life may have begun four billion years ago.

Giant clams, crabs, and other organisms from the Galápagos hydrothermal vent. [Visuals Unlimited; F. Gaill, Woods Hole Oceanographic Institution]

In 1977 an expedition led by John B. Corliss found the first active hydrothermal vent in an oceanic ridge not far away from the Galápagos Islands. The lure of deep-sea hot springs is not limited to their proximity to one of the holy shrines of evolutionary biology. As is made clear in the opening chapter by Nils G. Holm, hydrothermal vents are truly remarkable places: the images obtained by small submersibles and remote-controlled vehicles equipped with video cameras have revealed spectacular landscapes with black smokers surrounded by stinking, red-blooded clams, blind white crabs, and flocks of sulfur-metabolizing bacteria swimming in dark waters. The discovery of this unique submarine world rapidly awoke in some scientists a sense of the primordial, and speculation on the role of vents in the origin and early evolution of life was soon sparked.

The first detailed hypothesis suggesting a hydrothermal emergence of life was published in a 1981 supplement of *Oceanologica Acta* coauthored by Corliss, John A. Baross, and Sarah E. Hoffman. Although none of these three has contributed to it, some of their basic ideas appear to culminate with the publication of this book, which includes the papers written by the members of a working group formed in 1988 under the auspices of the Scientific Committee on Oceanic Research to study from an interdisciplinary perspective the possible connection between deep-sea hydrothermal vents, abiotic synthesis of organic compounds, and the appearance of life.

At first glance, submarine hydrothermal systems appear to be ideally suited for creating life. More than a hundred vents are known to exist along the active tectonic areas of the Earth, and at least in some of them huge amounts of catalytic clays and minerals interact with an aqueous reducing environment rich in $H_2$, $H_2S$, $CO$, $CO_2$, and possibly $HCN$, $CH_4$, and $NH_3$, which are known to react under possible prebiotic conditions to produce amino acids, purines, and other biochemical monomers. As Roy M. Daniel documents, deep-sea hot springs are also an important source of many new hyperthermophilic autotrophic and heterotrophic bacteria that seem to thrive quite happily at temperatures between 80° and 110°C. Their discovery raises once more the issue of the physical limits to the growth and survival of organisms, but is also of considerable evolutionary significance. Molecular phylogenies based on ribosomal RNA and other biological macromolecules have shown that all heat-loving prokaryotes occupy the short, deepest branches of universal evolutionary trees; that is, they are the oldest recognizable organisms. Hyperthermophily, primitiveness, and submarine volcanic springs seem to fit together like hand in glove.

An abyssal, hot hydrothermal vent instead of Darwin's warm little pond? Not everybody accepts this possibility. A few years ago Stanley L. Miller and Jeffrey L. Bada argued that the high temperature leads rapidly to an irreversible hydrolysis of organic compounds and thus to very short lifetimes for amino acids, nitrogen bases, and other biochemical molecules that are generally assumed to have been essential for the first organisms. This appears to be an insurmountable obstacle for any theory attempting to explain the emergence of life under hot vent conditions. However, the skeptical attitude of Miller, Bada, and others has worked as an intellectual challenge for several contributors to this book, who discuss in considerable detail the possibility of abiotic synthesis of life precursors in hydrothermal systems, advocating non-equilibrium conditions, supercritical fluids, and the percolation of water through catalytic mineral assemblages. It is unlikely that life is originating *de novo* in extant marine vents, but, as James P. Ferris notes, the issue of the prebiotic significance of these