The Mermaid's Tale: Four Billion Years of Cooperation in the Making of Living Things

Author: Lamb, Marion J.

Source: BioScience, 60(2) : 157-159

Published By: American Institute of Biological Sciences

URL: https://doi.org/10.1525/bio.2010.60.2.12

broad foundation of general knowledge of slime mold biology—and, moreover, that exclusively using such a reductionist approach may result in obtaining data that are devoid of biological information, or even worse, data that are misleading. For example, Bonner discusses the cellular slime mold family tree generated by Schaap and colleagues (2006) based on the sequence of two genes, SSU rDNA and α-tubulin. Schaap and colleagues separated 75 species of cellular slime molds into four major clades, none of which corresponds to the three traditional genera. According to this tree, the two whorled *Polysphondylium* species, *Polysphondylium violaceum* and *Polysphondylium palladium*, both of which initiate aggregation with a single "founder cell" instead of a group of cells, and both of which use the dipeptide glorin as opposed to cyclic AMP as an intercellular signaling agent, are not closely related to each other.

Bonner is skeptical of the conclusion that this suite of characters arose independently in the two species, and cautions us that the phylogenetic tree deduced from modern molecular research "is based on only two genes, and it will be important to examine their differences involving more genes." While the complete revision of dictyostelid taxonomy called for by Schaap and colleagues may be premature, molecular phylogenies on the basis of many and thoughtfully chosen genes may provide profound insights not only for cellular slime mold evolution but also for all of biology. For example, the evolution of the cAMP (cyclic adenosine monophosphate) signaling system can be elucidated by applying the molecular tools used by Alvarez-Curto and colleagues (2005) to study the cAMP receptors to the study of adenylate cyclases and phosphodiesterases. Bonner suggests that by using the genes that are involved in processes that characterize the unique biology of cellular slime molds in future phylogenies, one will not only obtain a more biologically meaningful phylogeny of cellular slime molds but also insight into the cAMP signaling system.

The book is neither fashionable nor trendy, but *The Social Amoebae* is an enlightening and enjoyable read for the layperson and professional who would like to share in the biological insight and knowledge gained by John Tyler Bonner as a result of his lifelong relationship with cellular slime molds. To summarize, I will conclude with a quote from Mark Antony's oration: "Here is the will…. He has left you all his walks, his private arbors and newplanted orchards—he has left them all to you." And to paraphrase Mark Antony, "Here was a biologist! When comes another?"

RANDY WAYNE
Randy Wayne (row1@cornell.edu) is associate professor in the Department of Plant Biology at Cornell University in Ithaca, New York.

References cited

Avarez-Curto E, Rozen DE, Ritchie AV, Fouquet, Baldauf SL, Schaap P. 2005. Evolutionary origin of cAMP-based chemoattraction in the social amoebae. Proceedings of the National Academy of Sciences 102: 6385–6390.

Schapp P, et al. 2006. Molecular phylogeny and evolution of morphology in the social amoebas. Science 314: 661–663.

AN ODD FISH

The Mermaid's Tale: Four Billion Years of Cooperation in the Making of Living Things. Kenneth M. Weiss and Anne V. Buchanan. Harvard University Press, 2009. 336 pp., illus. $35.00 (ISBN 9780674031937 cloth).

One of the great virtues of Darwin's *On the Origin of Species* is that it presents the case for evolution in a simple, clear, and logical way. Darwin tells us in the introduction what he intends to do, and he does it. He carefully builds up the case for the existence of inherited variations, explains why there is competition between individuals, and describes how the struggle for existence can lead to a slow accumulation of small, favorable modifications that we eventually see as adaptations. As he writes in his final chapter, "this whole volume is one long argument."

doi:10.1525/bio.2010.60.2.12

In the 150 years since *The Origin* was first published, Darwin's argument has been challenged, supplemented, and updated many times. The first major update was the outcome of the early 20th-century advent of Mendelian genetics, which provided a mechanism of heredity that was quite unknown to Darwin. Initially genetics muddied ideas about evolution, but in the 1920s and 1930s, mathematical reasoning was used to show how mutation and selection of genes in populations could explain the Darwinian evolution of phenotypic traits. Population genetics became the basis of the "Modern Synthesis"—the gene-centered view of evolution that solidified in the 1940s and dominated evolutionary thinking for the following half-century. Now, in the light of the discoveries of molecular biology, this version of Darwinism is being reexamined and reassessed. Knowing something about what goes on between genes and the phenotypic traits they influence means that developmental processes can take their rightful place in evolutionary thinking. But how should they be incorporated? What difference, if any, do they make to our basic ideas about evolution?

The Mermaid's Tale: Four Billion Years of Cooperation in the Making of Living Things is one of many recent books to offer a new take on evolution. Its authors, Kenneth Weiss and Anne Buchanan, are researchers in anthropology and biomedical genetics in the Department of Anthropology of Penn State University. According to its first sentence, "this book is a biography of life," but anyone expecting an historical account of life on Earth over the past four billion years will be disappointed. In their preface the authors explain that this biography is about a set of general principles that they

believe can account for the changes in organisms that have occurred over evolutionary time, as well as for what happens within cells, among the cells within an organism, and among individual organisms.

From the outset, Weiss and Buchanan tell us that they are going to stress the principles of "cooperation" (a word that they include in the subtitle) and "chance." Darwin and Wallace's theory of evolution through natural selection depends on competition, which they say "has been applied too widely and too often in a simplified way to adequately account for the characteristics of life on its other time scales." Cooperation, rather than competition, is the key to understanding life. In addition, we are told, "The role of chance, usually dismissed as incompatible with adaptive change, has been underestimated and misunderstood." At this point in the book I began to worry about where Weiss and Buchanan were coming from and where they were going. After all, cooperation has been a topic of discussion among evolutionary biologists from Darwin (1859, chapter 7) onward, and it is fundamental to late 20th-century theorizing about the transitions to new levels of biological complexity (Maynard Smith and Szathmáry 1995). Similarly, Darwin (1859, p. 81) recognized that some variations would have no selective effect and would fluctuate in frequency, and the role of chance was being discussed by orthodox evolutionists even before Sewall Wright's studies of the 1930s (Beatty 1992).

The remaining six of Weiss and Buchanan's eight principles of life—inheritance with memory, modular organization, sequestration, coding, contingency, and adaptability—are presented and discussed briefly in chapter 3, which is followed by two chapters on inheritance and change over time. Here they try to show how their principles apply to genetics. Genetics is seen as a collage of codes. We are told not only about the usual DNA triplet code for polypeptide chains but also about the sequence codes in DNA-protein binding, the codes for amino acid capture (transfer RNAs), and so on. In fact, according to the appendix of *The Mermaid's Tale,* there are no fewer than 15 different codes in DNA and RNA. So, is this an appropriate way of looking at the relation between genes and phenotypes? It can be argued that because of all the splicing and editing that goes on in the cell, the coding concept is inappropriate and unhelpful even when talking about "the" genetic code (Sarkar 1996). I can see no value in extending it still further. Indeed I feel that talking in these terms fosters the idea that the genome is a set of deterministic instructions, although it is clear from elsewhere in the book that this is certainly not the message the authors want to convey.

The following section of the book is devoted to the time scales of development and ecology. Cells, cellular structures, and cell signaling are described in some detail, and the authors make a gallant attempt to use the framework of their eight principles. For example, they describe mitochondria and chloroplasts as "actively produced, replicably organized, modular, sequestered, interacting, and semi-independent but cooperating units inside the cell." The chapters about life on the eco-scale cover the immune and nervous systems, where it is easier to apply their principles of coding, modularity, sequestration, contingency, and cooperation.

In the final section of *The Mermaid's Tale* the authors try to show why and how evolutionary theory has to change. Here they make their "ecodevoevo" synthesis. After a rather labored account of the difficulty of distinguishing between evolutionary change due to chance and that due to natural selection, they suggest that luck plays a big part in deciding which of the many viable combinations of alleles survive. Who would disagree? They look at prezygotic selection, behavioral adaptability, habitat choice, niche selection, and other trendy topics, saying that they are all consistent with their general principles. Indeed they are, but they are also consistent with old-fashioned Darwinian selection theory. Weiss and Buchanan then correctly insist that it is cooperation, rather than competition, that predominates at all levels of organization, but they ignore the evolutionary problems associated with this. Names such as William Donald Hamilton and Robert Axelrod are missing from the book's lengthy reference list.

Although there are good and interesting parts in *The Mermaid's Tale*, it does not form a very coherent whole: unlike *The Origin*, it is not "one long argument". It also contains too many errors. For example, we are told that *Caenorhabditis* is a flatworm, and that the central dogma refers to the concept that a stretch of DNA equals a protein; a figure illustrating "sequestered organelles in a hypothetical cell" shows a chromosome and chromatin as distinct, separate entities. The book is aimed at a general readership, so references to original sources are generally found only in the few endnotes and in the good, descriptive "suggested reading" list. The latter is marred by citations such as "Lamarck (1984)" or "Darwin (1900)," which are presumably the dates of reprints. Editors should not allow this!

The Mermaid's Tale is not the first book-length attempt at a synthesis of ecology, development, and evolution. The benchmark for many years to come will probably be Gilbert and Eppel (2009). According to Weiss and Buchanan, the mermaids of their title are impossible creatures because they are assembled from parts coming from different sequestered branches of developmental and evolutionary trees. In contrast, Gilbert and Eppel suggest that probably all development is codevelopment—that every individual develops as a community made up of organisms from different evolutionary lineages. This does not produce mermaids, but recognizing this type of cooperation really does change how we have to think about evolution.

MARION J. LAMB
Marion J. Lamb (marionlamb@btinternet.com) was formerly a senior lecturer in biology at Birkbeck College, University of London.

References cited

Beatty J. 1992. Random drift. Pages 273–281 in Fox Keller E, Lloyd EA, eds. Keywords in Evolutionary Biology. Harvard University Press.

Darwin C. 1859. On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life. John Murray.

Gilbert SF, Eppel D. 2009. Ecological Developmental Biology: Integrating Epigenetics, Medicine and Evolution. Sinauer.

Maynard Smith J, Szathmáry E. 1995. The Major Transitions in Evolution. Freeman.

Sarkar S. 1996. Decoding "coding": Information and DNA. BioScience 46: 857–864.

NEW TITLES

The BioChar Debate: Charcoal's Potential to Reverse Climate Change and Build Soil Fertility. James Bruges. Chelsea Green, 2010. 128 pp., illus. $14.95 (ISBN 9781603582551 paper).

Biology and Management of Dogfish Sharks. Vincent F. Gallucci, Gordon A. McFarlane, Gregory G. Bargmann, eds. American Fisheries Society, 2009. 423 pp., illus. $69.00 (ISBN 9781934874073 cloth).

The Biology of Coral Reefs. Charles R. C. Sheppard, Simon K. Davy, Graham M. Pilling. Oxford University Press, 2009. 352 pp., illus. $120.00 (ISBN 9780198566359 cloth).

doi:10.1525/bio.2010.60.2.13

Brain Sense: The Science of the Senses and How We Process the World Around Us. Faith Hickman Brynie. AMACOM, 2009. 288 pp., illus. $24.00 (ISBN 9780814413241 cloth).

Cellular Mechanotransduction: Diverse Perspectives from Molecules to Tissues. Mohammad R. K. Mofrad, Roger D. Kamm, eds. Cambridge University Press, 2009. 494 pp., illus. $135.00 (ISBN 9780521895231 cloth).

Control Theory and Systems Biology. Pablo A. Iglesias, Brian P. Ingalls, eds. MIT Press, 2009. 345 pp., illus. $45.00 (ISBN 9780262013345 cloth).

Darwin in Galápagos: Footsteps to a New World. K. Thalia Grant, Gregory B. Estes. Princeton University Press, 2009. 376 pp., illus. $29.95 (ISBN 9780691142104 cloth).

Experimental Evolution: Concepts, Methods, and Applications of Selection Experiments. Theodore Garland Jr., Michael R. Rose, eds. University of California Press, 2009. 752 pp., illus. $45.00 (ISBN 9780520261808 paper).

Gaia in Turmoil: Climate Change, Biodepletion, and Earth Ethics in an Age of Crisis. Eileen Crist, H. Bruce Rinker, eds. MIT Press, 2009. 389 pp., illus. $27.00 (ISBN 9780262513524 paper).

Global Climate Change: Convergence of Disciplines. Arnold J. Bloom. Sinauer, 2009. 398 pp., illus. $59.95 (ISBN 9780878930272 paper).

The Great Dinosaur Discoveries. Darren Naish. University of California Press, 2009. 192 pp., illus. $29.95 (ISBN 9780520259751 cloth).

Holocene Extinctions. Samuel T. Turvey, ed. Oxford University Press, 2009. 364 pp., illus. $99.00 (ISBN 9780199535095 cloth).

The Humans Who Went Extinct: Why Neanderthals Died Out and We Survived. Clive Finlayson. Oxford University Press, 2009. 273 pp., illus. $29.95 (ISBN 9780199239184 cloth).

Invasive Species Management: A Handbook of Principles and Techniques. Mick N. Clout, Peter A. Williams, eds. Oxford University Press, 2009. 320 pp., illus. $59.95 (ISBN 9780199216338 paper).

The *Origin* Then and Now: An Interpretive Guide to the *Origin of Species*. David N. Reznick. Princeton University Press, 2009. 448 pp., illus. $29.95 (ISBN 9780691129785 cloth).

Philosophy after Darwin: Classic and Contemporary Readings. Michael Ruse, ed. Princeton University Press, 2009. 592 pp., illus. $39.50 (ISBN 9780691135540 paper).

Plastid Biology. Kevin Pyke. Cambridge University Press, 2009. 212 pp., illus. $49.00 (ISBN 9780521711975 paper).