

Charles Darwin — a kind of Darwin, of course — Motoo Kimura, Stephen Jay Gould and Gabriel Dover. Although Volkenstein discusses adaptation by natural selection, he is more enthusiastic about punctualism, nonadaptationism and neutralism — the further from adaptation, the better. This contrasts surprisingly with his admiration of such people as Darwin and Manfred Eigen. He discusses the latter's quasispecies model of replicating molecules at length, for example; the snag is that this is emphatically a model of mutation–selection balance. And we are told: “The amazing capabilities of the human brain originally had no adaptive significance. They emerged as a subsidiary trait as a result of the adoption of upright posture and the development of speech.” Now, there is a lot to be said in favour of the adaptive significance of both of these characteristics. But how could one imagine speech without abstract thinking? Language is as much for internal representation as for communication. Volkenstein also forgets that it is a lot easier to learn something than to invent or discover it in the first place: inventing and discovering usually demand much more mental power.

This distorted view of Darwinian theory means that the author says nothing about the work and thought of J. B. S. Haldane, W. D. Hamilton and John Maynard Smith. I cannot recommend this part of the book to anyone: physicists will get a highly biased and partly incorrect picture of evolution, and biologists will become dissatisfied by the distortions and frustrated by some heavy-going mathematics. The best sections deal with proteins, the neutral theory and the quasispecies model — indeed, these sections are really good (ignoring the mathematical difficulties that some biologists may encounter).

Volkenstein's main concern is the contribution of physics to biological evolution. His survey is partly disappointing. Chaos theory is described at some length, but its serious application to ecology or evolution goes unmentioned. Eigen's quasispecies theory and the hypothetical hypercycles (cyclical systems of molecular mutualists) are seen as cornerstones of the physical approach: “this theory will make it possible to pass over to the physical treatment of evolution at the levels of cells and organisms”. How this could be achieved remains a mystery. The author overlooks the fact that Eigen's theories are largely molecular and chemical (and not strictly physical); that the quasispecies model is isomorphic to a classical population-genetics model of haploid, asexual genomes in mutation–selection balance; and that, contrary to initial expectations, the ‘naked’ (that is non-compartmentalized) hypercycles do not satisfy the criteria for the integration of molecular information dispersed in unlinked replicators.



MORE than 100 million land mines are spread across 62 countries, killing or injuring some 1,200 people every month, over a third of them women and children. The United Nations funds most of the world's mine-clearance programmes, at a cost of \$300–\$1,000 per mine (some antipersonnel mines are worth as little as \$3). The task is slow and labour-intensive, usually involving civilians recruited locally and trained specially. This picture of a mine clearer on the Thai–Cambodian border appears on the cover of *Clearing the Fields* edited by Kevin M. Cahill. The book arose from a symposium held last year that brought together a group of internationally recognized authorities to examine the global threat of these buried and forgotten weapons and to propose practical solutions from ethical, legal, economic, medical and military perspectives. BasicBooks/Council on Foreign Relations, \$25 (pbk).

Volkenstein's account is sometimes dangerously misleading. For example, we are told that the distinction between developmental constraints and stabilizing selection as possible causes for evolutionary stasis is of no real importance (quite the contrary — lack of this insight leads to confusion); that stabilizing selection is aptly described by the Red Queen metaphor (the metaphor in fact applies to coevolutionary dynamics); and that the Eigen theory is a convincing model of the transition from nonlife to life (it is not, since it does not describe the origin of replicators, membranes or metabolism). No school of thought about the origin of life other than that of the Eigen group is mentioned: in particular, the reader remains ignorant of Wächtershäuser's surface metabolism or Gánti's chemoton model (which is based on the idea of metabolizing and reproducing compartments). The chemoton model is even partly explainable in mathematical terms and so should certainly have deserved space in a book arguing for the usefulness of a physicochemical approach.

Another potential contribution of physics to evolution has been inspired by synergetics, a branch of the physics of dissipative systems; it is often mentioned throughout the book but defined (to the annoyance of an innocent reader) only on page 333, which is just a bit too late. Volkenstein outlines a phenomenological

characterization of speciation events in morphological space, using phase transitions as a metaphor. The sad fact is that no attempt is made to couple these ideas to the genetic models of speciation or to the existing literature on the genetics of stasis and punctuation. It will be interesting to see how recent work on adaptive dynamics (by Hans Metz and his colleagues, for example) relates to this phenomenological approach.

The style of the book is very eclectic: long poetic allusions and citations are intermingled with hard-nosed science. I have nothing against either, but the author could have confined the former to footnotes or appendices.

Physicists should be wary of this book: although they will be fascinated by the problems and understand the mathematics, they will come away with an unreliable picture of the science of evolution. Biologists are no better off, for many of them will lack the necessary background in physics, chemistry and mathematics. The translation is good, some lesser-known Russian literature is covered and there are several illuminating sections, but all in all the book generates more heat than light. Sadly, the author failed to do justice to the fields and fulfil his ambition. □

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