Bewitchment of the biologist

Philip Kitcher

Unfinished Synthesis: Biological Hierarchies and Modern Evolutionary Thought. By Niles Eldredge. Oxford University Press: 1986. Pp.237. £22.50, \$24.95

TOWARDS the end of his life, George Berkeley, famous Idealist and Bishop of Cloyne, wrote a discourse on the virtues of tar-water, in which claims about its curative power were mingled with lofty speculation on the main threads of Western metaphysics. Niles Eldredge's book recommends a cure for the ills of evolutionary theory, and, like Berkeley, Eldredge has a fascination with metaphysical abstractions. In both cases, the advertisements for the product seem somewhat overblown.

Eldredge's title introduces his principal theme and the central characters in his story. The modern synthesis is incomplete — in need of extension, he insists, not of replacement (pp.4 and 118). To complete it we must recognize the hierarchical structure of life, indeed we must see that organic nature is hierarchically structured in two different ways. Part of this necessary reconceptualization will involve changing the ontology of evolutionary theory to accommodate biological entities that have been ignored in the work of Dobzhansky, Mayr, Simpson and (especially) most of their followers (p.7). In this way, we shall be in a position to address some of the "additional topics" that the synthesis let slip from its field of vision — "such as the main events in the history of life" (p.206).

From the start we are plunged into the kinds of metaphysical thickets that give logical positivists nightmares. Eldredge argues, again and again, that the main deficiency of the modern synthesis is not to be exposed through the assembly of striking explanations of particular phenomena, familiar from the macroevolutionary studies of Stanley, Williamson and, perhaps most notably, Gould and Eldredge himself. Instead, the decisive argument against the synthesis lies in exhibiting its depleted ontology, specifically its failure to appreciate the "reality" of supraorganismic entities or, at best, its treatment of those entities as "classes" rather than as "individuals".

What does this mean? In my judgement, Eldredge has formulated his ideas and arguments using one of the least-promising suggestions in recent philosophy of science. Those who hail the thesis that species are individuals as a doctrine of revolutionary importance typically have

their attention fixed on a number of characteristics of species taxa: species are spatiotemporally bounded, they have "beginnings, histories, and terminations" (pp.144 and 158); species are held together by cohesion among their "parts", the "glue" in this case being the reproductive relations among constituent organisms — no sex, no species (pp.144 and 200). There is another suggestion, which I believe to be more significant, that Eldredge sometimes alludes to in passing discussions of the "individuality" or "reality" of an entity: genuine individuals "play an active role in the evolutionary process" (p.142).

If these are the important aspects of the individuality of species, then we should ask how appreciating them alerts us to the incompleteness of the synthesis. Were Dobzhansky, Mayr and Simpson logically compelled to deny that species have beginnings (to take the example where Eldredge has the strongest *prima facie* claim for incompatibility)? I think not. The criterion of reproductive isolation furnishes an objective principle for dividing an unbroken lineage — even if we are unable to apply it in particular cases — and the initial branching that gives rise to the lineage serves as a natural origin from which species taxa are objectively defined. Thus, even those who believe in gradual anagenesis do not have to deny that species have beginnings. (Histories, terminations and the reproductive nexus are easy.)

The real issue behind Eldredge's thesis of an unfinished synthesis is not a question of ontology at all. The dispute is about causation. Indeed, this is readily visible in Mayr's capsule presentation, which Eldredge quotes early in his book (p.5), and alludes to repeatedly thereafter: a main tenet of the synthesis is that macroevolutionary phenomena can be causally explained in terms of the known microevolutionary forces (primarily selection) acting on the known microevolutionary entities. One way to oppose this doctrine would be to argue that there are "higher-level individuals" that "play an active role in the evolutionary process" and to elaborate that point in terms of the importance of species selection. The debate would turn on both conceptual and empirical issues, but, thanks to Sober's analysis of causal concepts in evolutionary theory, and the studies of palaeontologists who have drawn inspiration from Eldredge, Gould and Stanley, we have some clear view of how it might be pursued. Instead, in *Unfinished Synthesis* Eldredge deploys (murky) philosophical arguments to turn his back on "multi-level selection" (pp.132, 137, 159) and hitches his wagon to a metaphysical cloud.

The patient reader who is prepared to penetrate the second-hand philosophy will discover insights of an imaginative

biologist. Eldredge starts with a discussion of four major works that inaugurated the synthesis, the first two editions of Dobzhansky's *Genetics and the Origin of Species*, Mayr's *Systematics and the Origin of Species* and Simpson's *Tempo and Mode in Evolution*. Although the stress on ontology sometimes distorts things, as in the attribution to Mayr of a schizophrenic view of species (pp.59 and 89), Eldredge provides a useful review of the explanatory projects undertaken and the explanations actually offered by the "founding fathers".

Similarly, in subsequent chapters, there are interesting *aperçus* of the later development of the synthesis and of the discoveries that are supposed to show the need for reform. Eldredge's (low) estimate of the importance of the debates about units of selection, about neutralism, even about punctuated equilibrium, is coloured by his disastrous fascination with ontology, but his comments on these debates are sometimes illuminating.

The main, original arguments in the book appear in the last two chapters. Eldredge uses his claims about "individuality" to suggest that there are two hierarchies of nested "individuals". The genealogical hierarchy comprises genes, chromosomes, organisms, demes, species and monophyletic taxa; the ecological hierarchy consists of molecules, cells, organisms, populations, communities and regional biotas. To understand evolution, we need to recognize the processes that link the levels in these hierarchies as well as the cross-hierarchy connections. Eldredge considers two extreme possibilities (pp.187–188), but his project is not that of formulating some definite version of evolutionary theory but of assembling the possible structures.

Why should anyone accept Eldredge's vision of evolutionary theory? *Unfinished Synthesis* provides two sorts of reason. The general argument from ontology looms large throughout, but I doubt that many scientists will find it compelling. Nor should they, for, despite the frequency with which Eldredge claims that certain theses are "obvious" or "forced on us" (see pp.89–91 and 104 for two among many examples), logically valid arguments cannot be generated by such simple means. Here the muddled metaphysics takes its toll, leading Eldredge to mistake a psychological conjunction for a logical tie.

The reason that is likely to appeal more to the empirically minded is to be found in the last 18 pages of the book. The new hierarchical view is used to account for two "specific evolutionary patterns": the prevalence of sexual reproduction and the progressive modification of surface "ornaments" in a trilobite lineage. In brief, Eldredge's answer to the first question is that species are "a simple and

necessary consequence of sexual reproduction" and that species are "difficult to dislodge" (p.200). His response to the second is that phacopine trends should be seen "in ecological context", with a prominent role given to "relatively major cross-genealogical, ecological" events that intensify extinctions (pp.211–212). Both explanations are provocative and interesting, but there seems no particular reason to attribute either to the power of hierarchical thinking or even to suppose that they are best articulated in Eldredge's preferred idioms.

For the issues are indeed questions about causation. What has sustained sexual reproduction against the apparently contrary force of individual selection (or genic selection)? What has caused the pattern we perceive in the part of the trilobite fossil record that Eldredge examines? The suggestions we are offered in *Unfinished Synthesis* seem not so much to be news — witness the kinship with Stanley's explanation of the persistence of sex and with the claims of Raup, Sepkoski, Gould and others for the importance of disruptions of ecosystems in the history of life; rather, they appear as forced translations of recent ideas, translations that impede the further development of intriguing, but incomplete, explanations. What causal forces does the synthesis (or contemporary orthodoxy) actually acknowledge? Do new proposals from macroevolutionary theorists compel us to introduce new forces? Questions such as these are at the heart of the current controversies about the need for a new evolutionary theory. *Unfinished Synthesis* does us the service of assembling some of the points around which discussion must proceed, but it does not analyse the issues with the precision, clarity and delicacy that they deserve.

There is undoubtedly grandeur in Eldredge's view of life, and the sense of grandeur has inspired some of his colleagues to hail it as a new departure in evolutionary theory. Others are likely to find the discussion grandiose and to miss the biological intelligence behind the metaphysical infatuation. In the 14 years since he and Gould offered novel ways of thinking about evolution, Eldredge seems to have mislocated what was most important in his contribution. Readers of this book may hope that he will return to the fertile ground that he helped first to explore. *Unfinished Synthesis* will aid the development of evolutionary theory if it encourages scholars to examine more closely the questions about causality that it assembles. □

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Wishing on a star

Andrew H. Knoll

Nemesis: The Death-Star and Other Theories of Mass Extinction. By Donald Goldsmith. Walker, New York: 1985. Pp. 166. \$15.95.

A HERD of hadrosaurs grazes calmly, apparently unconcerned by a nearby tyrannosaur. Suddenly, a fireball streaks across the sky; there is a huge explosion, a conflagration erupts and a curtain of darkness descends across the landscape. In the six-month night that follows, the dinosaurs all die, as do innumerable, less evocative creatures. Science fiction? Some scientists think so, but an impressive body of data supports the idea that this is how the Cretaceous Period ended. More controversial evidence suggests that similar events have occurred every 26 million years or so, extirpating much of the Earth's biota and realigning patterns of evolution.

Donald Goldsmith has prepared a layman's guide to the intricacies of the extraordinary and controversial Nemesis theory of periodic mass extinctions. He begins appropriately with an exposition of the Alvarez hypothesis that a bolide hit Earth and precipitated mass extinctions 65 million years ago, then proceeds to the case for periodicity in the fossil record of extinctions, as well as periodicity arguments for impact craters. Dissenting views are presented, but sceptics come off as wrong-headed curmudgeons who "snort in disapproval" (really) at statistical arguments. This may reflect measured scientific judgement, but Goldsmith's treatment is too brief for readers to draw their own conclusions.

From acceptance of the principle of periodicity, it is but a short jump to cosmic explanations for mass extinction, and Goldsmith presents informative discussions of both the Nemesis theory in which

cometary orbits are perturbed by an as-yet-undetected companion of our Sun and the competing idea of cometary perturbations caused by the Solar System's regular passage through the galactic plane. Goldsmith takes the galactic oscillation hypothesis more seriously than most astrophysicists of my acquaintance, but his heart clearly lies with Nemesis. His precise description of the "death star" is fascinating — oddly reminiscent of St Augustine's vision of the City of God, but with physics lending rigour to faith.

Goldsmith's perspective is decidedly that of an astronomer. He is at his best explaining how fair-minded scientists using the same imperfect data can arrive at radically different estimates of periodicity. Less satisfactory is his discussion of the data sets themselves — their problems, limitations and biological implications. Indeed, in *Nemesis* mass extinctions are largely an interesting means of learning something new about the cosmos. Certainly, they are potentially that, but they are much more.

Goldsmith's leitmotiv is that the personal (and often unscientific) motivations of individual scientists collectively result in the system of observations, experiment and debate that is science. Several of his points are well made, but because he discusses this subject in abstract terms rather than through the personalities of the protagonists in the debate about Nemesis, his lessons have a detached, pedagogical ring to them. Perhaps this is why the book is ultimately less riveting than the best scientific chronicles, such as *The Eighth Day of Creation* or *Ice Ages: Solving the Mystery*. Still, *Nemesis* provides non-specialists with a concise introduction to one of this century's most exciting and potentially far-reaching debates about Earth history. □

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