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. □

Philip Kitcher is Director of the Minnesota Center for the Philosophy of Science, University of Minnesota, 355 Ford Hall, 224 Church Street SE, Minneapolis, Minnesota 55455, USA. His most recent book is Vaulting Ambition: Sociobiology and the Quest for Human Nature *(MIT Press, 1985).*

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 astonomer. 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. □

Andrew H. Knoll is a Professor in the Department of Organismic and Evolutionary Biology, Harvard University, 16 Divinity Avenue, Cambridge, Massachusetts 02138, USA.

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G.L. Brown and A. Roshko

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