leads him to consider that the aim of abolition, even in the long term, is unrealistic. Indeed, by his principles, there need be no moral objection at all to experiments on anaesthetized laboratory-bred animals continuing indefinitely.

Should we accept his principles? There is no doubt they will be hotly contested. His suggestion that man is something more than an animal is distinctly odd and even demonstrably misguided in so far as it rests on the allegedly paradoxical idea that man is both "part of" nature and yet stands "outside" it (p. 19). For there is surely no paradox in supposing that man belongs wholly within nature while at the same time having the capacity to reflect on his position. Again, Fox's crucial claim that animals lack intrinsic value seems to rest on the unsupported proposition that only beings capable of *assigning* value can have intrinsic value. What his theory of value does support is that animals only have intrinsic value if humans assign it to them. The most he can then argue is that they cannot be assigned an intrinsic value equal to that of humans.

Although marred occasionally by unworthy and on the whole irrelevant attacks on animal welfarists for being misanthropic, sentimental or irrational, a sincerity of tone runs through this book, nowhere more so than in the brave but unsuccessful attempt to reconcile the practice of experimentation with the claim to be humane; unsuccessful, because being humane implies being kind, and the deliberate infliction of avoidable suffering on an animal is not compatible with being kind to it. We must simply face the fact that the attempt to alleviate human suffering may involve the inhumane treatment of animals. Nor can the point be turned by the oft-repeated but hollow claim that animals stand to benefit as much as humans do. For the life of me I cannot see why an animal should be supposed to be more excited about being sacrificed to alleviate the suffering of another animal than it is about being sacrificed to alleviate the suffering of a human being. □

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Living alternatives

James E. Lovelock

Origins of Life. By Freeman Dyson. Cambridge University Press:1986. Pp.81. £7.50, \$7.95.

Origins: A Skeptic's Guide to the Creation of Life on Earth. By Robert Shapiro. Summit, New York:1986. Pp.332. \$17.95.

EVERY so often a great physicist is perturbed by a curiosity about the meaning of life and is drawn in from that remote, personal Oort cloud where cosmology and subatomic particles can be considered in splendid detachment. One such was Erwin Schrödinger, whose small volume *What is Life?*, published by Cambridge University Press in 1946, still circulates and enlightens; it was, I would say, the book that most influenced my own thinking about science. Freeman Dyson's *Origins of Life* is modelled on Schrödinger's book, and like it is beautifully and economically composed.

Robert Shapiro has written about an entirely different search for the origins of life. Shapiro is a chemist intimately familiar with the experiments and theories concerned, and he writes like someone who lived when chemistry had soul, when chemicals could be handled personally and when it was permissible to wonder about their strange odours and crystalline forms. His book, he says, is intended to be an explanation "of what science does and does not understand about how life first began".

Schrödinger is best remembered for having sown the seeds of molecular biology. The great success of that undertaking has tended to make us forget that it was only part of his message, for Schrödinger also drew our attention to the fact that life processes are a legal avoidance of the second law. He asked the right question, "What is life?", rather than the equivocal one, "What are its origins?". Ancient happenings like the origin of life can never be known in detail by ordinary physical means. A message travelling through space and time attenuates until it is indecipherable. There is evidence about the state of the Earth when life began, but only because the persistence of life itself provides a limited but noise-free channel of communication back to our original ancestor. The geological record of the rocks of those times is almost absent.

Like a message passed by word of mouth, the chain of life back to the remote past carries precise but inaccurate information. But it is the only way we have to conjure up what the origin might have been. Shapiro describes the alternative guesses through the eyes of an enthusiastic explorer, with a friendly sceptic as a companion. It is so well done that one feels

like a privileged visitor watching experiments in progress on the laboratory bench. Dyson goes further and provides a model of a pre-nucleic-acid chemical evolutionary system. He calls it his "toy" model, but it is full of insight as good and simple models should be.

The efforts to discover the origins of life may be as unrewarding as those to discover our own personal forebears. They resemble another recent scientific quest, one touched on by Shapiro, the search for life on Mars. Such expeditions start out looking for something imagined but not defined. We know there is no life on Mars; indeed we knew it long before the Viking spacecraft landed there. The value of such journeys comes indirectly. The discovery that Mars is not alive is the neutral background against which the Earth was more clearly seen to be a living planet. Similarly, the voyage into the past to the origins of life may never reach its goal, but the preparation for the expedition powerfully concentrates the mind on the nature and properties of life.

The two books are a constant reminder of how complicated life is, and that it has no definition. The successes of molecular biology are so beguiling that we forget the organism and its physiology. Schrödinger's disciples, who founded the church of molecular biology, have turned his wisdom to the dogma that life is self-replicating and corrects its errors by natural selection. There is much more to life than this naive truth, just as there is more to the Universe than atoms alone — grandmothers live and enjoy the shade of Lombardy poplar trees not knowing that they and the trees are deemed by this dogma to be dead. Looking in from the outside, Dyson sees homeostasis to be as important a characteristic of life as replication. I would go further and suggest that, as well as matter, life has bulk properties and needs to be considered on a planetary scale. It is so tightly coupled to its environment that the boundaries of life extend far beyond the organisms they enclose. A tree or a coral reef are both more than 90 per cent dead matter yet they are alive.

These two books are a continuation of the quest started by Darwin and Schrödinger. Implicitly, both are more about the meaning of life than about its origins and both deserve to be widely read. They are personal yet scholarly accounts of a difficult subject, and are wonderfully open in the way they illustrate how science is really done. They indicate an alternative view to the profitable but nonetheless narrow orthodoxy of molecular biology. Not least they are the best possible answer to the mischievous myths of Creationism, even though that was not their first intention. □

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