Classification, Evolution, and the Nature of Biology.

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of the Earth's carrying capacity has indeed kept up with the growth of the human population. In this century alone, developments such as pesticides, green revolution crops, food preserving methods, pollution control, and biotechnology have made the idea of overpopulation seem a problem for the distant future at worst. Why would the endless string of solutions that science has come up with suddenly dry up?

Steiner develops his arguments very carefully. He first draws the attention of the reader to a well-documented set of conditions, events and developments that he sees as evidence of a progressive deterioration of the ability of the Earth to sustain the current level of productivity. He then describes what he sees as inevitable developments in the near future, leading to a catastrophic collapse of our economic structure. What makes this book particularly intriguing is Steiner's belief that it is not too late to move away from this road to disaster. The steps he suggests as necessary in order to avert the worst, however, are so extensive, that believing we can develop the political will to go that route may be more than Utopian.

This book is not a scientific treatise; it proves nothing, yet Steiner's arguments are so well made and so well documented that I strongly recommend that both scientists and economists read it.

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CLASSIFICATION, EVOLUTION, AND THE NATURE OF BIOLOGY.

By Alec L. Panchen. Cambridge University Press, Cambridge and New York. $80.00 (hardcover); $34.95 (paper). xi + 403 p.; ill.; author and subject indexes. ISBN: 0-521-30582-9 (hc); 0-521-31578-6 (pb). 1992.

It is difficult "to disentangle patterns of classifications and patterns of phylogeny" (p. 61). This book is a historical treatise on the relationships between these two concepts and goes further in discussing the potential processes that underlie and produce these patterns. Cladistics was conceived as the technique "for the simultaneous generation of classification and phylogeny" (p. 169). Panchen argues, as did others before him, that the *explanandum* is the observable pattern and the *explanans* is evolutionary theory. Transformed cladists are a particular group of cladists who believe that, based on theory and logic, classification must have historical priority over phylogeny and that we have no chance of understanding the underlying processes of evolution without first knowing the patterns of relationships. "The theory of evolution does not *predict* the existence of a genealogical hierarchy; it is a theory to *explain* a previously recognised hierarchy as genealogy" (p. 179). The book is one long argument (with digressions) about these points.

But first things first—the pattern. Useful for all involved in evolutionary research, the book discusses in some detail the strengths and weaknesses of different methods of phylogeny reconstruction, and particular sets of data. Panchen argues strongly that only cladistic methodology and the parsimony criterion will produce these patterns reliably, dismissing distance and likelihood methods for different reasons. The laudable objectivity of the cladistic method breaks down when Panchen advocates that evolutionary scenarios and evolutionary explanations can influence and override the cladistic analysis and interpretation of characters. He did so himself in a study involving fossil lungfish and the question of the identity of the extant sister group to tetrapods. Panchen, an expert on vertebrate paleontology, further argues that fossils contain important phylogenetic information—information potentially strong enough to overturn neontological morphological evidence for the purpose of cladistic analysis (*contra* Patterson).

I may be biased, but Panchen's discussion of molecular data sets for the purpose of phylogeny reconstruction seems to me to be the weakest part of the book. Many of the methods for the collection of molecular data discussed in this section of the book are not widely used anymore (e.g., immunological distances and DNA-DNA hybridization). Although a historical and methodological overview for these methods seems worthwhile, it should have been balanced against a longer treatment of other currently more commonly used molecular data for phylogeny reconstruction (e.g., DNA sequences). It seems fair to say that these new molecular data are partly responsible for the recent renaissance of and progress in the field of phylogeny reconstruction and comparative biology in general. Panchen clearly is of the opinion that molecular data sets are filled with problems for the purpose of phylogeny reconstruction and, for example, categorically states that "the chronometric molecular clock has been rejected" (p. 233). Although molecular data are not the panacea that some make them out to be, still one often finds regularity of DNA substitutions over time. To assume a priori a "molecular clock" may be presumptuous, and its existence and ticking rate need to be checked whenever possible. Certainly, nobody dares to postulate the existence of "morphological clocks." It is not clear why Panchen does not point out some of the advantages of molecular data over morphological data for phylogenetic reconstruction; for example, their

ease of collection and interpretation, just to mention two.

As the title suggests, the scope of this book is huge and commendably the amount of literature cited is tremendous. Maybe Panchen attempts to cover too much; a more limited scope might have been easier on the reader, since many different threads are loosely interwoven in this book. Despite the points that I found disagreement with, I should say that this was an exciting book to read and it provided a strong historical and philosophical overview of classification and the nature of biology. Panchen dedicates this book to his students who learned to be skeptical. This clearly is a worthwhile book to read in this spirit, as an argument to be skeptical about and to think about. Although the primary audience for this book will be taxonomists, a much larger audience of all biologists who are interested in philosophy, history, and evolutionary biology will profit from reading it.

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LIVING WITH CIVILISATION. *Based on a meeting held in Canberra, December 1991. Proceedings of the Australasian Society for Human Biology, Number 5. Edited by N. W. Bruce. Published for the Australasian Society for Human Biology by the Centre for Human Biology (The University of Western Australia), Nedlands, Western Australia.* $A50.00 (hardcover); $A28.00 (paper). xxi + 505 p.; ill.; author and subject indexes. ISBN: 0-86422-222-X (hc); 0-86422-224-6 (pb). 1992.

The title reflects the contributors' sense of a mismatch between our mainly Stone Age adaptations and the novel environmental problems we have faced since the invention of agriculture and especially since the industrial revolution and recent population explosion. Many of the 50 contributions are primarily of social-science significance but with some biological implications. Others are explicitly biological or medical, on diverse aspects of primatology, paleoanthropology, medical genetics, sex dimorphisms, and many kinds of disease and injury in modern, historic and prehistoric populations.

This book should be of special interest to those working at the interface between evolutionary biology and the behavioral and medical sciences. The editing was well done, a difficult task for such a large and heterogeneous volume. Browsers can make good use of the moderately comprehensive index.

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ADAPTATION IN NATURAL AND ARTIFICIAL SYSTEMS: AN INTRODUCTORY ANALYSIS WITH APPLICATIONS TO BIOLOGY, CONTROL, AND ARTIFICIAL INTELLIGENCE. *Complex Adaptive Systems. A Bradford Book. By John H. Holland. The MIT Press, Cambridge (Massachusetts).* $30.00 (hardcover); $14.95 (paper). xv + 211 p.; ill.; index. ISBN: 0-262-08213-6 (hc); 0-262-58111-6 (pb). 1992.

When discussing "adaptation," biologists typically mean adaptation resulting from organic evolution, where populations of discrete organisms change their genetic composition in response to natural selection. Rarely do they mean adaptation in other modes of evolution, such as preorganic evolution and cultural evolution; even more rarely do they mean adaptation from other modes of adaptation, such as the immune response, learning, and the developing embryo, especially of its nervous system. Yet these processes all do result in adaptation: The property that unites them is a sequential search through a space of possibilities, with progressive movement toward global maxima or minima.

Adaptation in Natural and Artificial Systems is about adaptation in the broader sense. The author, a computer scientist at the University of Michigan and Fellow at the Santa Fe Institute, was a pioneer in the area of Complex Adaptive Systems—the study of nonlinear systems, typically defined by large numbers of individually adaptive agents. Examples of such systems include a variety of other naturally occurring systems, such as biological systems, economies, and ecosystems, and some artificial systems as well, especially adaptation by the genetic algorithm. The book under review is a reprint of Holland's 1975 classic, which played a significant role in the founding of the field of Complex Adaptive Systems. The original text is supplemented by a concluding chapter that describes Holland's research since that time. It is a wonderful book, and it will delight all who have an interest in exploring the limits of evolutionary biology.

The core of the book is the development of genetic algorithms. To get a flavor of what this means, imagine 1000 computer programs in binary form, each represented by a sequence of 0s and 1s. Let each program be graded on its ability to perform some task, giving it a score upon which its fitness will be judged. Now keep the top scorers, and discard the remainder. Select the survivors in pairs to regenerate the next generation of 1000 programs, sometimes copying from one parent and sometimes from the other, occasionally flipping a bit at random, in analogy with genetic recombination and mutation. The process can be repeated as many times (generations) as you wish. One would expect that the future generations of programs will perform better than their progenitors, and indeed, in practice this is typically the case—it depends