materialism. The validity of our present political arrangement, and especially that of the U.S. as a nation, goes virtually unquestioned. History is perceived as essentially determinate. In attempting to present the large picture, Watt deals as much with economics and political and social science as he does with biology, and includes a good bit of history and anthropology, since they are pertinent to his theses.

Lest the reader be misled, this is a highly provocative and serious book, and one that can be strongly recommended for use by intelligent students in liberal arts curricula; but its judicious use will require a high order of critical and technical ability. Arguing as it does that the future, if any, belongs to information technology, this may just possibly be a lodestone for a generation brought up on computer games.

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HIERARCHY: PERSPECTIVES FOR ECOLOGICAL COMPLEXITY.

By T. F. H. Allen and Thomas B. Starr. The University of Chicago Press, Chicago. $27.50. xvi + 310 p.; ill.; author and subject indexes. 1982.

Typical ecological research proceeds as if ecological systems were clearly definable objects, being studied for clearly definable purposes, as one might study the mechanism of an automobile to make the car run, or of a bacterium to determine its biochemical machinery. In many contexts this works well enough, until some unexpected contingency intervenes (the kudzu vine brought in as an agricultural miracle then turns into a major disaster), or until a new context evolves (the mosquito swamps of sixty years ago become the wetlands natural parks of today).

Because of these peculiar disturbances in the simple progress of ecology, there is a long tradition of rather contemplative works that focus on the metatheory or epistemology of ecology, groping for an approach to the subject as a whole rather than focusing on specific problems. In my opinion, the best of them have focused on the language of ecology, in something of the same way that Wittgenstein of the *Tractatus* attempted to address the language of physical science. These works have varied enormously in quality, as might be expected since they are free, to a degree, from the restraints of science itself. Kostitizin, Volterra, Lotka, and others, in the twenties and thirties of this century, assumed that the language of natural history would be replaced by that of mathematics if ecology was to have any hope of conquering its own domain. They then provided what seemed to be suitable language, but without attempting to tie their conclusions too tightly to specific cases. Certainly they were correct and their suggestions may have been heeded too well. Ecology now has a shortage of realistic predictions, and a plethora of mathematical theories. Each new development in the underlying mathematics of physics and engineering became a candidate for the role of metatheoretical touchstone to the language of ecology. Cybernetics, information theory, the catastrophism of Thom, each has had its adherents. Despite these advocates, and despite the intellectual depths of their insights, things did not materially improve.

To others, it appeared possible that choice of particularly important chemical and physical measurements might permit a clear vision to emerge from the swirl of natural history. It developed that if one wanted answers to questions about energy and chemical elements this approach was fine, but the range of interesting questions exceeded these limits.

This book is part of that tradition of the nontraditional ecological metatheory. The authors are aware of the central fact that ecologists as a class are not formally equivalent to automobile mechanics or biochemists as a class.

The authors focus on the elementary, but often disregarded, fact that ecological systems cannot avoid considerations as hierarchies. This analysis is fascinating stuff and deserves the compliment of being read very slowly. The book becomes weaker, or at least less interesting, when actual ecological applications are derived from the basic arguments. I think the reason for this is implicit in the authors' analysis of ecology. Let us return briefly to the automobile example: ecologists are to the natural world what the aggregate of all those who are in any way associated with the production, use, sales, or maintenance of cars are to automobiles. This would include those who are concerned with cars as metallurgical specimens, art objects, sexual symbols, salable commodities or users of space and polluters of air. From this standpoint the automobile in its broadest sense is a set of referenda for study, not just an object perceived in a single way. The conversation among the various possible kinds of experts on automobiles may involve pitfalls and barriers that are unknown to experts within the respective classes—mechanics, or engineers, or art critics. Despite this, the actual gas-drinking car is a discrete focal object. The ramifications and implications of its existence may be problematic, but its existence is not itself a problem.

Allan and Starr have seized on the notion that the object studied by ecologists does not have a simple existence. It really is decomposable into a hierarchical array in which different research pro-

cedures, and different laws of nature, are expected to be appropriate on different levels of the hierarchy. The laws regulating population often cannot be derived by multiplying the terms in some equation that describes a single organism of the population. A multi-species aggregation is deeply different from a large aggregation of members of a single species, for example. What one is able to say, how one says it and what one can do to learn about, or manage, an ecological system depends enormously on the items in the hierarchy that are considered. Further, the weak points—namely, the places from which unpleasant surprises might arise—are generally next higher, next lower, or adjacent entities in the hierarchy.

The authors refer to particular entities of interest in the hierarchy as "holons." I am compelled to conquer my distaste for neologisms in this case, a distaste based on ontological rather than philological considerations: I fear that the structuralists might be correct, and that new words may always engender new things and we have a dazzling confusion of things already. Ecology, psychiatry, and politics have particularly suffered from neologisms, created to summarize complex arguments or conclusions that then have broken free of their theoretical moorings and drifted about smashing things. Consider the damage done by the free-floating words "fitness," "ego," and "freedom." The authors carefully allay my fears by denying any ontological content to holons. They claim pure pragmatism. In this context they confront the following: One of the problems faced by planners of almost anything (defense, cities, and such) is that presently unimaginable contingencies are almost a certainty. When these arise it becomes necessary either to demonstrate that someone else was responsible, to show that no one was responsible, to have a general plan for unexpectable contingencies and to apply it immediately, or to start the research to provide a new plan to meet the new question.

The problems of most planners are almost minor compared with those of ecologists who pretend to practical relevance. Why this is so is addressed, in part, by this book. Facing this problem is the book's great strength. Perhaps not facing it as squarely as possible is its greatest weakness.

There are infinite numbers of ways of constructing the ecological hierarchy and a very large number of ways of choosing holons for examination within each such hierarchical construct. Few of these are very exciting. Ontological reifications, banished in one way, can reappear by another. There may be a tendency to focus on the uninteresting. While the authors are clear in not attributing ontological significance to the hierarchy or holon specification, it is a much more difficult thing to avoid ontology in the choice of study objects. That is, the act of defining a question cannot avoid some kind of reification. Is there a reason for choosing one question over another? I can think of three reasons. The first is an intellectual fascination. The second is an attempt to answer a question of demonstrated importance to some problem outside of ecology itself. These two have motivated most of my research over three decades and I am committed to them. The third reason is more complicated—it starts with the assumption that it is possible to "understand" an ecological system so that one can provide immediate answers to any questions that will arise in the future. I don't believe that this will be possible. The multitude of possible questions that might arise about ecosystems is no smaller than the number of ways holons can be defined. In fact, the least interesting questions seem to be those whose importance is defended in terms of what might arise in the future as a problem.

I suspect that what is to be meant by "understanding" an ecological system can only mean having the background information to perform the quickest and cheapest ad hoc investigation that will permit an answer to an explicit problem posed from outside of ecology, and that the way to achieve this understanding is to focus on the intellectually fascinating. I feel they do that in most of this book but I, at least, felt the chapters on the analysis of ecological communities to be less than exciting. The final chapter on scale as an object of investigation is, however, extremely stimulating. It is all certainly worth reading carefully, and with the courtesy of concentrated attention.

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RAINFOREST CORRIDORS: THE TRANSAMAZON COLONIZATION SCHEME.

By Nigel J. H. Smith. University of California Press, Berkeley. $25.00. xvii + 248 p.; ill.; index. 1982.

This is a masterfully synthesized overview of many of the diverse sociological, economical, biological, agronomical, and political factors that have affected "the most ambitious colonization scheme ever attempted in the humid tropics"—Brazil's construction of the 3,300 km-long Transamazon Highway, begun in 1970, and the accompanying settlement project. Written in lucid and