Book Reviews

Models of Voyaging

The Settlement of Polynesia. A Computer Simulation. MICHAEL LEVISON, R. GERARD WARD, and JOHN W. WEBB. With the assistance of Trevor I. Fenner and W. Alan Sentance. University of Minnesota Press, Minneapolis, 1973. viii, 138 pp., illus. $10.75.

The origin and dispersal of the peoples known collectively in the West as the Polynesians have been tantalizing historical puzzles ever since the heyday of European voyages of discovery in the 18th century. *The Settlement of Polynesia* is only the latest contribution to a long list of books, some as cautious and scholarly as it is, many others biased and extreme, that have been preoccupied with a number of obvious questions which appeal intensely, nonetheless, to our native human curiosity. Who are the Polynesians? Where did they come from? How and why did they discover the scattered isles of the central and eastern Pacific? Did they stumble on them by chance and good fortune? Or, like the early Europeans, did they seek them out, bravely and deliberately, in the face of great uncertainty and possible death?

From a scientific point of view, it could be argued that these questions are unsolvable, uninteresting, or both. Surely the profound feature of the "Polynesian problem" has to do with what happened to the human species *after* men colonized these islands. Their origins and the migration routes they used to reach new landfalls, although not irrelevant, would seem to be matters that could be taken, for most purposes, as given circumstances rather than topics for continuing debate and speculation. This point of view, although it may be wise, is apparently too staid to attract much of a following, especially when books as entertaining and exuberant as the present one can be marshaled as competition.

The authors introduce a new wrinkle on the Polynesian problem. They use a computer and the kind of Monte Carlo stochastic model made famous in locational geography by the work of the Swedish scholar T. Hägerstrand on human migration and diffusion. Their aim is to determine statistically the most probable paths and the most likely sailing directions among the islands from points as far east as the coast of the Americas, as far west as the fringes of Melanesia, and from Hawaii down to New Zealand.

To construct a computer model of Pacific voyaging before the Europeans, they amassed an impressive body of evidence on the force and direction of winds and surface currents throughout the Pacific over the course of the seasons, estimates of sailing speeds under these varying conditions, the probabilities of human survival on the open sea as a function of time, the maximum landfall range for islands of differing heights and with varying ground cover, the risk probability of storms, and the like. They present their assumptions, doubts, and methods succinctly and with an uncommon lack of pretension. Indeed, their discussion of how they went about building their model and how it works is in itself a model of simulation procedures that have great promise in anthropology and archeology.

From the armchair comfort of the computation lab, the authors cast off 101,016 imaginary drift voyages and 8,052 crew-directed voyages out on to their computer sea from shores located throughout the Pacific. Their observations on the success or failure of these many voyages are too extensive to be summarized here. In general, however, the computer seems to tell them that the ancient Polynesians, like their more recent European counterparts, would have had to be purposeful in the direction of their sailing, if not necessarily clairvoyant, to achieve the major steps in the settlement of Polynesia within the realm of reasonable probability. Polynesian scholars have long argued the relative importance of drift voyaging and directed voyaging in the process of island colonizing. If the computer is telling the truth, then the weight of future arguments in the debate must be altered significantly.

Without doubt, *The Settlement of Polynesia* will have a major influence on all future commentary on the Polynesian problem. Even for those whose research bears on other questions, this book demonstrates the effectiveness of simulation experiments in the study of prehistory.

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Wilderness and Economics

Natural Environments. Studies in Theoretical and Applied Analysis. A workshop. JOHN V. KRUTILLA, Ed. Published for Resources for the Future by Johns Hopkins University Press, Baltimore, 1973. x, 352 pp., illus. $16.50.

Economists writing on environmental problems have concentrated on identifying the "external" costs of economic activity, such as pollution, which are not explicitly borne by private producers but are real costs to society nonetheless. Because the value of goods and services produced is readily observable in market prices, whereas the value of a clean environment is not, the result of unregulated market processes may be too much conventional production and too little environmental protection. Thus by quantifying the external costs of environmental decay and including them with other costs in a common economic metric, economists have sought to identify the optimum balance between production of the traditional kind and other things that contribute to the physical quality of life. As long as all goods and services are reproducible and adverse effects are reversible, appropriate institutional arrangements will permit the economy to adjust as changes in tastes, income, population, and so on cause this optimum balance to change through time.

But whenever decisions affecting the environment will have irreversible results—such as a decision to divert a wild river, strip-mine a mountain range, harvest the redwoods, or destroy a rare species—special analytical problems arise. More precisely, whenever a choice must be made between preserving a unique feature of the natural environment and destroying it through industrial exploitation, the economic analyst faces at least three new obstacles. First,

the values of preservation, such as esthetic and recreational benefits and the scientific value of a more complete natural laboratory or genetic stock, are not as readily observable as the value of exploitation. Second, because the assumption of reproducibility holds for the products of only one of the alternatives (exploitation) a decision in favor of it forecloses future choice in favor of the other (preservation), and so the elimination of options must in itself be regarded as a cost associated with the former. Third, the impact of technological advance adds further asymmetry: it tends to increase the supply and lower the cost of producible goods but not of natural environments, for which only the demand increases as a result of population and income growth.

This third phenomenon, especially, is the subject of investigation in several of the essays in the volume under review. Preservation of wilderness is not the most pervasive of environmental concerns; nor, probably, is it the most crucial for the future well-being of society. Indeed, nature preserved in its pristine condition is almost a North American luxury; and, if we follow the analysis of one of the contributors to this volume, the benefits will be enjoyed largely by purists who are also among the most affluent. Nevertheless, in an atmosphere of rapidly growing public concern for wilderness protection, as reflected, for example, in the recent Wilderness Act and the Wild Scenic Rivers legislation, and in the context of highly politicized confrontations of preservationists, industrial developers, and governments, these studies offer the first real promise for a rigorous analytical approach to decisions involving environmental modification.

All but one of the nine studies are products of research sponsored by or undertaken at Resources for the Future, in Washington, D.C., where a group under John V. Krutilla has been pursuing empirical and theoretical investigations of a conclusion he tentatively reached in an analysis published six years ago—that private market processes are likely to preserve less than the optimum amount of natural environment and that the optimum amount is likely to increase. The book is an impressive statement of the progress of research since then. The most important papers report on economic studies, but three final papers offer a biologist's exhaustive review of numerical methods of classifying inland waters, a landscape architect's somewhat mechanical discussion of wildland typology, and a brave attempt by a psychologist to develop objective (or, more correctly, consistent) assessments of esthetic features of landscapes.

Like most compendia of conferences, the level and quality of presentation vary, the more so in this case because of the multidisciplinary nature of the subject matter coupled with the intradisciplinary specialization of the contributors. Hence, the audience that will appreciate the full range of the essays—from the highly esoteric economic analysis of decisions involving irreversible environmental modification to limnological taxonomy—will not be large. And, as in any new research field, we must be patient with sophisticated proofs of the obvious, such as a highly theoretical paper demonstrating that (with reasonable assumptions about the stability of consumer tastes) technological advance which enhances the production of some goods but not of others will cause the relative price of the latter to rise.

But it is the uncompromising disciplinary rigor of the studies that is the strength of the volume. In setting a high objective standard for further investigations in this contentious area of public policy the volume is a landmark in research on wilderness preservation.

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Entomologists on Their Past

History of Entomology. RAY F. SMITH, THOMAS E. MITTLER, and CARROLL N. SMITH, Eds. Published in cooperation with the Entomological Society of America by Annual Reviews, Palo Alto, Calif., 1973. viii, 518 pp., illus. $12.

The entomologists of today generally pride themselves on their biological professionalism; it would be interesting to know how many of the authors of this volume would resent being described as amateurs in their capacity as annalists and historians. The relative roles and interrelations of amateurs and professionals in the development of the subject, and the effect on it of the increasing professional dominance in the present century, are topics which none of the contributors consider specifically. However, the 25 authors, representing Australia, Austria, Britain, Canada, Denmark, France, Germany (both east and west), Israel, Japan, Sweden, the United States, and the Soviet Union, among them deal more or less authoritatively with many aspects of entomological history, and almost any entomologist with historical interests can hope to learn something new and interesting from the book. Particularly interesting to this reviewer were Günter Morge's account of Greco-Roman and medieval European entomology, Tuxen's "Entomology systematizes and describes," and Richard on the behavior of insects; others with more professional tastes might prefer Spencer Brown's "Genetics—the long story," or Wigglesworth on insect physiology. There are articles on early entomology in East Asia (by the Japanese Konishi and Itô) and in the Middle East (by Harpaz from Israel) which have ideological and religious resonances lacking in the rest of the volume.

With so many authors writing independently, there is inevitably a fair amount of overlap in coverage; thus von Frisch's work on *Apis* behavior is considered at some length in the article on apiculture as well as in the one on insect behavior, and early silk cultivation is discussed under entomology in the Far East as well as under sericultural science. Another inherent drawback of this type of treatment is that individual specialists, writing about the history of their own field, will tend to present it as leading to and culminating in their own theories, even where (as for example in the article by Andrewartha and Birch) these are controversial. The editors themselves admit that some aspects of entomology are not covered in this book, and they promise an attempt to remedy some of its omissions in future volumes of the *Annual Review of Entomology*, of which this book might well be considered a special issue.

It is a temptation any reviewer would find it hard to resist to suggest further topics that should be considered in this connection. One has already been suggested, the role of amateurs in the development of the science; two more that I think deserve consideration are the development and changing roles of entomological societies, which would involve some consideration of national schools and traditions in the subject, and the history of entomological publication, with particular reference to scientific periodicals and to faunal works.

In fine, this is a useful and interesting work, and, apart from Essig's