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,