

variations.) Optimal control of systems with time-varying parameters. Optimal control of systems with initially adjustable parameters.

One chapter deals with systems with restricted phase co-ordinates. Unfortunately the proofs are extremely elaborate, and this chapter is very unreadable. It would have been helpful if some simple examples had been given (the so-called examples given are actually extensions of the theory to related problems.) Some of the results, while of considerable academic interest, seem unlikely to be of practical use owing to the complexity of the algorithms arrived at, for example, the problem of optimal processes with a delay, and the problem of optimal pursuit of a controllable target.

The final chapter deals with a statistical optimal control problem. It is a pursuit problem, in which the pursued object is assumed to move randomly in the phase space, and only its initial position is known. The pursuer is to be controlled so that the probability of interception is maximized. The chapter is unsatisfying, because the problem itself seems unrealistic, the mathematics is extremely involved, and the final result is too complex to be used, yet is only approximate. However, as an exercise in mathematical manipulation it compels admiration.

The standard of translation is excellent. We must be grateful to the translators for their scholarly attention to detail, and to the publishers for the rapidity with which the book was brought out.

To sum up, Pontryagin's maximum principle has effected a revolution in the calculus of variations, and in the theory of control. The present book is the most complete account of the theory yet available, and is likely to become a classic. Simpler expositions will be written, but we shall often find ourselves returning to this book to discover what has or has not been proved.

A. T. FULLER

ALASKAN ARCHÆOLOGY

The Archæology of Cape Denbigh

By Prof. J. L. Giddings. Pp. xv + 331 + 73 plates. (Providence, R.I.: Brown University Press, 1964.) 12.50 dollars.

CAPE DENBIGH is on the northern Behring Sea coast of Alaska, and at several places interesting Stone Age sites have been discovered and studied. There are two main areas where stone tools occur, namely, at Nukleet and Iyatayet, on the north-west side of the Cape. The former has yielded an Eskimo industry, and the place seemingly was occupied from the twelfth to the eighteenth century. Iyatayet is much more interesting. On top there is a level similar to that at Nukleet, but below there are two older levels, the upper of which has been called Norton and the one below it the Denbigh Flint Complex. The Norton level is not too sharply defined, as it seems to have been partially cut into by the overlying Nukleet folk, and in turn the Norton culture itself has disturbed the top of the Denbigh Flint Complex below.

The Norton people seem to be early Eskimo, and their industry includes bone and flint tools, as well as stone lamps and pottery. The latter differs somewhat from that found at Nukleet. But the level underneath is something different. The stone industry contains a number of undoubted burins of various types and there is no pottery. Indeed, in Europe one could consider it to be a late palaeolithic or early mesolithic culture. At the same time, there is little or no evidence to suggest that there was any vast gap in time between the Norton level and that below. Carbon-14 dating points to a considerable antiquity, however, suggesting an age of nearly 6,000 years ago.

Are we to suggest that the Denbigh Flint Complex represents a very early pre-Eskimo stage of culture without pottery itself ultimately derived from an upper palaeolithic stage of Western Europe? As the climate in Western Europe ameliorated at the close of Magdalenian times, these reindeer-loving peoples seem to have moved north following the animals. Did they penetrate into what is now northern Russia and Siberia? In Siberia early Eskimo industries have been recognized; will further investigation unearth still earlier pre-Eskimo levels? So far, there is no direct evidence for this, but little investigation has yet been made. The author of this very interesting volume has demonstrated at Cape Denbigh a succession of cultures with more or less normal Eskimo industries on top and reaching down in the lowest level to an industry which shows distinct late palaeolithic affinities.

The theory that the latest palaeolithic cultures of Western Europe migrated north and east following the reindeer when the climate ameliorated is not new; it was suggested many decades ago, but at that time there was no scrap of evidence to uphold it, except the fact that the culture of the Eskimo seemed not too unlike that of our Magdalenians. There are still many difficult questions to answer and the matter is by no means clear; it is to be hoped that continued investigation will throw more light on the problem and provide some satisfactory explanation of the interesting facts disclosed.

The volume is well illustrated with more than 75 full-page half-tones. A few good drawings of the implements would perhaps have helped. Prof. Giddings is to be congratulated on his work.

M. C. BURKITT

RIVER POLLUTION

Fish and River Pollution

By Dr. J. R. Erichsen Jones. Pp. viii + 203. (London: Butterworth and Co. (Publishers), Ltd., 1964.) 52s. 6d.

THIS most useful book should be read by all concerned with the well-being of our fishes and all industrialists who are, or may be, passing trade effluents into our natural waters.

Dr. Jones has reviewed very competently the research work on the toxicity to fish of a large variety of substances. There are chapters on fish and oxygen and the reactions of fish to water of low oxygen concentration. Here are described several pieces of apparatus to test these responses. It is of interest that some fish do not have an innate ability to avoid low oxygen concentrations and in fact seem to be unaware of the lack of oxygen. On the other hand, Chinook salmon (*Oncorhynchus tshawytscha*), Coho salmon (*O. kisutch*) and the large mouth bass (*Micropterus salmoides*) under experimental conditions avoided low oxygen concentrations, the degree of avoidance increasing with the reduction in oxygen concentration.

A chapter on the measurement of toxicity in the laboratory is mainly of academic interest, as these results cannot be applied without qualification in the field because most of our rivers are already polluted. If a substance is found to be toxic it should not be put into rivers until it has been exonerated by long-term field experiments.

There is a most useful chapter on the effects of lead, zinc and copper; here Dr. Jones includes many of his own excellent observations on a zinc-polluted stream in Wales. When discussing the salts of metals the author stresses "that concentration on tolerance limits must be applied with caution, for the extreme limits of toxicity, even at one specified temperature, have been determined for few substances and few fish", and that experimentally it has been shown that different fish react very differently to metallic salts at toxic concentrations.