

way of oceanographic research. No small group of men could themselves amass sufficient information to be able to theorize accurately on the great marine problems of the day. Invariably therefore the scientists fell back on the generosity of the government to provide ships and men. If there was a person in the Admiralty with an interest in marine science—a Pepys or Wharton, for example—the scientists' path was made somewhat easier. Normally governments were unwilling to commit themselves to expenditure which would produce little direct material return.

In the broadest sense the evolution of marine science is shown to parallel the development of science in general. In the second half of the seventeenth century the Aristotelian and Cartesian approach, in which theory outpaced factual knowledge, is eclipsed by the rise of empiricism and the emergence of Newtonian methods. Robert Boyle in particular was concerned that theorizing on subjects such as salinity and tides should follow, not precede, observation and experimentation. In the nineteenth century oceanography gathered strength in line with general interest in other environmental sciences, and indeed profited from advances in those sciences.

Scientists and the Sea deals rather cursorily with developments in marine science in Europe and America, and for this reason it is not a general history of oceanography; rather it puts the history of British marine science in its international context.

Generally the book is lucid and well organized, although the reader emerges at the end of the nineteenth century without a very clear idea of how near to being resolved some of the basic problems of marine science were. It does not always make exciting reading but it is thorough, informative, scholarly and well documented. This is a valuable work on an aspect of the history of science which has been rather neglected hitherto.

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Origin of Blood Cells

Haemopoietic Cells. By D. Metcalf and M. A. S. Moore. Vol. 24. Pp. xiii + 550. (North Holland: Amsterdam and London, 1971.) Hfl. 120; \$35.25.

DURING the past decade available information about the origin and inter-relationships of the cells in the blood, and of factors that regulate their proliferation and differentiation, has greatly increased. This advance has been possible because morphological studies, which had for so long been difficult to interpret, could be supplemented by the use of cell markers (chromosomes or isotopes) and by methods for cloning

cells *in vivo* and *in vitro*. To the latter, in particular, Metcalf and Moore have made notable contributions, and this book is a heroic attempt on their part to review an enormous mass of accumulated information on the origin of haemopoietic cells.

The development of stem cells within the yolk sac blood islands of the embryo seems to be a unique process; it is the only stage when haemopoietic tissue develops from a more undifferentiated precursor population not itself possessing stem cell capacity in the various assay systems used. As yolk-sac haemopoiesis declines, the expanding stem-cell population in foetal liver contributes to the circulating stem-cell pool and leads to colonization of spleen and marrow, while continuing to supply stem cells to primary lymphoid tissue.

The most useful cloning technique has been that of Till and McCulloch, who

in 1961 described the formation in the spleens of irradiated animals, by stem cells occurring in low frequency in bone marrow, of macroscopically visible colonies of differentiating erythroid, granulocytic or megakaryocytic cells. Chromosome markers suggest that the great majority of such colonies are clones, and that since most colonies are of mixed type the stem cells must possess the capacity to differentiate in different directions. It is now clear that the microenvironment of the cell strongly influences the pathway which differentiation will take.

In addition to reviewing detailed evidence in support of these conclusions, Metcalf and Moore discuss a spectrum of factors controlling growth and differentiation, ranging from those that are respectable and well defined, such as erythropoietin, through colony-stimulating factor (or CSF, which un-

Hybrids



Cover picture from the greatly enlarged new edition of *Mammalian Hybrids* by A. P. Gray (Commonwealth Agricultural Bureaux, Slough, 1972; £4.00).