Book Reviews

Achievement in Canada

The Mackenzie-McNaughton Wartime Letters. MEL THISTLE, Ed. University of Toronto Press, Buffalo, N.Y., 1975. xxiv, 178 pp. $12.50.

Canada declared war on Germany on 10 September 1939, a week after the United Kingdom and more than two years before the United States. Her deep commitment to the war was to strengthen profoundly her science, technology, and industry and thereby her power status. C. J. Mackenzie is convinced that if the United States had declared war in September 1939 the status of Canadian science would be very different today. For during the 28 months of United States neutrality, Canada was for the first time in the position of engaging in a research and development enterprise without the overpowering competition of American industrial and marketing resources. In these conditions Canada's scientists and engineers could and did produce highly sophisticated weaponry as efficiently as any other country. Without this head start Canada might have come out of World War II with little more capability in current science and industrial technology than she had after World War I and the current high standards and prestige of Canadian universities, research institutions, and industry would not have been achieved until much later (p. 151).

Between the two wars, Canada had been essentially a "scientific colony," having a good deal of modern technological knowledge available through branch factories of non-Canadian industries but having little competence in industrial research or innovation. Yet in these years the National Research Council of Canada (NRC), founded in 1916, laid the foundations for the post-1939 progress both by breeding researchers through scholarships and grants and by establishing its own laboratories to provide the long-term applied research on which industrial innovation must be based. In these years of preparation the NRC struck a good balance between basic and applied research, altering the balance from time to time to meet the changing needs of a changing society. Through the NRC industry, universities, and government cooperated at a working level, and the NRC had become "a supple and flexible institution capable of dealing resourcefully with any circumstance that history might offer."

Scientists of all disciplines, medical men, and engineers apparently mingled on equal terms. Indeed, much of the credit for the great success of the NRC goes to two engineers, Mackenzie and A. G. L. McNaughton. It is their wartime correspondence concerning this enterprise that makes up this book. General McNaughton left the army to become president of the NRC in 1935, and when he returned to command the Canadian forces in Europe Mackenzie took his place.

Both men were farsighted. McNaughton, convinced as early as 1937 of the inevitability of war, had encouraged research on certain war projects, and he had seen, as few people except Keynes did, that war planning must be in terms of man-hours, power, equipment, and supplies rather than dollars. Mackenzie had a strong grasp of the research strategy for war and for the postwar period.

At the outbreak of war, the total staff in NRC establishments was only 300, and at the end of the war it was less than 1300. With these small numbers the NRC achieved much. It did excellent work, for example, on radar, gauges, optical glass, gas, synthetic rubber, refrigeration, and medical aspects of aviation. It created crown corporations to manufacture some of the products of its research. At the beginning of the war the British had not concealed their belief that nothing at all intricate could be made in Canada, and the radar achievements of the Radio Section of NRC surprised them and the Americans. The chief engineer of Westinghouse could not believe that this section had done in nine months a job he thought would take at least two years. He considered the Canadian work to rate a $1-million building, whereas the NRC had two buildings which cost $50,000 and some tents and shacks.

Apart from the work in its own establishments, the NRC welded together the wartime research of the armed services, universities, and industry; the cooperation was often informal but remarkably effective and harmonious. From 1940 there was also excellent cooperation with the distinguished British scientists who became liaison officers in Ottawa.

Mackenzie was the linchpin of it all (including the complicated Anglo-Canadian atomic project, which scarcely figures in the book). He was, McNaughton wrote, the source and inspiration of the magnificent NRC record.

This correspondence across the oceans is marked by humanity and simple dignity. Its style is refreshingly clear and straightforward, albeit rather formal. Together with the foreword by Thistle, the introduction by Mackenzie, and the epilogue based on his journal, it makes a rewarding book.

MARGARET GOWING
Linacre College, University of Oxford, Oxford, England

Environmental Adaptations

Physiological Aspects of Deep Sea Biology. A. G. MACDONALD. Cambridge University Press, New York, 1975. xiv, 450 pp., illus. $49.50. Monographs of the Physiological Society, No. 31.

The organisms of the deep sea live as much as 11 kilometers beneath the surface layer of primary productivity, are shielded from sunlight, remain at a constant low temperature, and are compressed by several hundred bars. Each of these environmental attributes presents challenges which deep-sea creatures have met successfully. This book examines the deep-sea life-style by critically discussing and interpreting research in the field. Three-quarters of the monograph is an analysis of how organisms have adapted to exist at high pressures, to obtain food, to communicate, and to maintain their position in the water column. The remainder of the text is a chapter called "Deep sea bio-engineering" that illustrates how deep-sea conditions (especially high pressure) affect the experimenter himself, as in diving, and the design of gear to retrieve organisms and of experimental apparatus to simulate the deep-ocean environment.

The text is generously illustrated with graphs and tables presenting data from the literature. There are block and flow

diagrams to clarify the discussion of relationships. The narrative is usefully interrupted with summaries and conclusions of a theme or with suggestions for and indications of the direction of future research. The author's own research has been with unicellular and multicellular organisms and with the retrieval of the latter from ocean depths. This experience has given him an intuition for the problems of life in the oceans.

The chapter on deep-sea nutrition is perhaps singularly significant. The variety of food available to deep-sea animals is characterized and the problem of a limited food supply is defined. One result of adaptations for existing with little food is thought to be a low rate of oxygen consumption. Researchers thus often have difficulty knowing whether to attribute a given adaptation to a limited food supply or to an increased hydrostatic pressure or to both. This chapter lucidly shows, moreover, that there are additional difficulties that hinder the posing and answering of physiological questions. For example, the determination of the standing stock of marine microbes remains refractory. Thus we can only inadequately estimate the value of these organisms as a food source and only awkwardly use them in studies of microbial physiology.

The author notes the meagerness of the research effort on the physiology of deep-sea organisms. The research this book itself will stimulate should augment our knowledge considerably. Students in the field as well as those already doing research in it will profit from reading the book. It is sufficiently well written to be read in two or three sittings, yet the detail in which the problems of deep-sea life are presented is conducive to lingering for hours on a page.

A. A. YAYANOS
Scripps Institution of Oceanography, La Jolla, California

Neurobiology

'Simple' Nervous Systems. An International Symposium. Glasgow and Edinburgh, Apr. 1973. P. N. R. USHERWOOD and D. R. NEWTH, Eds. Arnold, London, and Crane, Russak, New York, 1975. xviii, 490 pp., illus. $35.

I have mixed feelings about this symposium volume. In some respects it is unusually good: the editors and authors have made an obvious effort to review their subject matter thoroughly and to eschew own-laboratory chauvinism; the topic is, to the biased eye of this reviewer, a significant one; and some novel approaches to it are included in the form of papers on developing systems and the seldom-reviewed lower invertebrate groups. Yet the book exhibits both major defects of symposium proceedings: there is little relationship among the contributions, and the authors have been handicapped by the way in which topics have been divided. Moreover, it is an abominable job of book production. The bibliographies following the individual articles are inconsistent, and several use the annoying no-titles format; there is no index; and the half-tones (especially the electron micrographs) are muddy.

There is much to praise about certain of the papers. Anne E. Warner presents an excellent account of the origin of electrical differentiation in the nervous system, and A. Roberts then supplies a scholarly and thorough treatment of the development of electrical responses and synaptic connections in amphibian embryos. The review of coelenterate neurobiology by Elaine A. Robson moves from an intriguing historical view to a very complete summary of contemporary work. P. J. Mill and D. A. Dorsett do very well with annelids and mollusks, respectively. These papers all have the advantage of a fresh approach; all were written by English workers from whom less has been heard than from their American counterparts.

The treatment of arthropods is much less successful. Here the level of research activity is high enough to have forced a topical division into small taxa, and the result is a trio of papers that confine themselves either to Crustacea or to insects. Even though all three of the authors have worthwhile things to say, their ability to focus on process is severely compromised. W. J. P. Barnes, writing on crustacean locomotion, cannot make as much use as he should of the excellent work on bilateral interaction and intersegmental coordination in insect walking. F. Huber, who is responsible for the chapter on cyclically recurring behavior in insects, carries self-denial much further: he refers to no work on Crustacea at all, though he makes extensive use of concepts (such as command interneurons) that were developed in studies of crustaceans. The result is an artificial separation that handicaps both papers. M. Burrows's excellent account of motoneurons in insects suffers less, because his own work provides such a complete view of the subject.

The opportunity to deal with subject matter defined functionally rather than taxonomically was not well used by two of the authors who had it. D. M. Guthrie, who covers the fascinating subject of regeneration and neural specificity in invertebrates, has produced a long and occasionally interesting paper that unfortunately misinterprets work on axonal degeneration and its sequelae, fails to discuss the important effect of axotomy on electrical excitability, and overstates the present evidence for specificity of regenerated connections in arthropod ganglia. E. Florey, discussing chemical neuromuscular transmission in arthropods, begins with an account of tension control by inhibitory junctional potentials that offers no really new insights; this is followed by a typically provocative hypothesis about cotransmitters.

At the end, the volume includes two papers about unambiguously complex systems. That by M. J. Wells on the evolution of learning in mollusks is thoughtful and interesting, though it did not persuade me that we have yet learned much from all the work on octopus brains. That by D. Michie and colleagues is about a machine named Freddy that can classify shapes in a way that seems octopuslike to its owners. The less said about Freddy the better.

Should there be a moratorium on symposia on this subject? Some of us, overexposers and overexposed alike, have thought there should be: One more leech ganglion, one more crayfish junction, one more *Tritonia* brain, or one more locust leap seems almost too much. The present volume, at least, has avoided the fate of staleness by including new material and new investigators worth hearing.

DONALD KENNEDY
Department of Biological Sciences, Stanford University, Stanford, California

Interactions of Polypeptides

Subunit Enzymes. Biochemistry and Functions. KURT E. EBNER, Ed. Dekker, New York, 1975. xii, 332 pp., illus. $24.50. Enzymology, vol. 2.

This book is a group of independent essays with no cross-referencing or explicit interrelationships. Unlike most such collections, however, this one justifies itself by the implicit relationships between the subjects treated. In contrast to most compendiums of this type, it can actually be read with profit as a book. The topics are well selected to illustrate diverse aspects of interactions between proteins or among protein subunits, and anyone interested in this field will find it valuable.