Book Reviews

Ad Astra per Aspera

The Story of Jodrell Bank. BERNARD LOVELL. Harper and Row, New York, 1968. xvi + 265 pp., illus. $5.95.

Timid souls who may read the absorbing, well-written story that Sir Bernard Lovell has to tell will surely conclude: "Never, never try to be a pioneer in big science!" That Lovell himself never so concludes is evidence of the determination and the singleness of purpose of the man.

Jodrell Bank is an area of farming countryside some 20 miles south of Manchester in England where the University of Manchester owned 11 acres of fields. Here, in the fall of 1945, Lovell arrives with two trailers of radar equipment and a portable diesel generator. With his colleague John A. Clegg he develops the radar astronomy of meteors. The end of 1947 sees them operating a fixed paraboloid of 218-foot diameter which they have built themselves. By the spring of 1952 Lovell has conceived the idea of a fully steerable paraboloid of 250-foot diameter and has found a consulting engineer, H. C. Husband, who is ready to design it. The cost agreed to with the Government's Department of Scientific and Industrial Research (DSIR) is the equivalent of $932,400. Construction begins in September 1952 accompanied by the high hopes of all concerned. Yet in February 1958, with the telescope already in use, the Chairman of the (Manchester) University Council is tactfully warning Lovell that the Government may sue him (Lovell) for $900,000 and that the alternative to payment is imprisonment. The sad fact is that some $1,800,000 has been committed or spent and the project is $730,000 in debt.

How such a deplorable situation came about is a tale so complicated that it defies summary. As I read, I could not decide who the prime contractor was: Husband's company or the University? It is true that the project is the first of its kind in the world and there are no precedents to go on. A large number of contracts for parts of the telescope have to be let separately, and each one causes complications and delays. Meanwhile inflation increases prices every day. Eventually the Treasury and the Public Accounts Committee, the House of Commons' watchdog on public expenditure, turn very unsympathetic eyes on the whole project. My own interpretation of the root of the trouble is that changes in design were made during the building of the instrument. Certainly one of these was sparked by Lovell's desire to make the central part of the dish capable of registering 21-centimeter radiation. But I wonder if any telescope could have been completed according to Husband's original design, illustrated in figure 6. The final structure (fig. 32) seems to involve a quite different support system for the dish. Anyway, Lovell and the University push on inexorably with the construction. But meanwhile the necessary financial adjustments are not properly made and the crisis of 1958 results.

Lovell and the telescope are saved fortuitously by the October 1957 launching of the first Sputnik. The instrument is hastily adapted to operate as a radar and proves to be the only instrument in the country capable of detecting the ICBM carrier that had launched the satellite. The British press quickly abandons its previous hostility; the Prime Minister (Harold Macmillan) refers in the House of Commons to "*our* great radio telescope" (my italics). How wryly Lovell must have smiled when he read that remark! By 1958 the telescope is also involved in the American space effort, which provides a most welcome source of income.

Half of the final debt was met by DSIR in the fall of 1958. The other half of the money came partly from public subscriptions that ranged from $28,000 down to a few cents and partly from a gift of $140,000 from Lord Nuffield and the Nuffield Foundation. Thus in May 1960 the first great radio telescope on earth was finally launched on its productive career. When Lovell tried to thank him, Lord Nuffield replied: "That's all right, my boy, you haven't done too badly." Every radio astronomer in the world today will surely applaud Lord Nuffield's sentiment.

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Story of an Element

Helium, Child of the Sun. CLIFFORD W. SEIBEL. University Press of Kansas, Lawrence, 1968. xiv + 138 pp., illus. $4.95.

This year marks the centennial of the simultaneous discovery of helium in the spectrum of the solar chromosphere by Norman Lockyer and Pierre Janssen. This book, intended to commemorate the anniversary and to relate the story of helium and its production, was written under the auspices of the United States Bureau of Mines by Clifford Seibel, retired assistant director of the Bureau's helium program. The author is uniquely qualified for the task inasmuch as he was intimately associated with the development of helium production for almost 50 years, from the time that the entire U.S. supply of about half a cubic foot was stored in flasks in his chemistry laboratory at the University of Kansas.

From the commencement of large-scale helium production during World War I until the end of World War II, the predominant use of helium was in lighter-than-air craft. The Bureau of Mines became involved at the beginning in efforts not only to locate prospective supplies of helium but also to determine the most economical method for the extraction of helium from natural gas. After World War I the Bureau was made solely responsible for helium production. This agency designed and supervised the construction of pilot, production, and purification plants and also conducted research into the properties of the gas. In view of the drastic reduction in the production of helium in the late 1930's resulting from the loss of the dirigibles *Akron* in 1933 and *Macon* in 1935, the Bureau's eminently successful efforts to meet the demands occasioned by World War II are particularly noteworthy.

Rather than declining after 1945, helium production increased enormously owing to new applications, particularly in heliarc welding, in metallurgical processes using inert atmospheres, and in the rocket industry. The author's description of some of the new uses is amplified in an epilogue by Henry P. Wheeler, Jr., the present assistant director of the Bureau's helium program. It seems apparent from these accounts that helium will be required in increasing quantities as activities in space exploration, in oceanography, and in low-temperature research expand. In view of this forecast the helium conservation program commenced in 1960

assumes new importance, although the author estimates that about three billion cubic feet are still lost to the atmosphere each year in burned natural gas.

The book is a good narrative account of the development of the production of helium by the Bureau of Mines, although it is disappointing in certain respects. The scientist or historian of science will find no account of the research responsible for the progressive understanding of helium's unusual properties, nor even a satisfactory explanation of them. The historian of technology must be content with a one-paragraph description of the helium-extraction process without learning the details of its evolution. The economic historian will search in vain for any cost analysis of helium production, and no inkling is given as to the economic efficiency of the government-owned plants. Finally, there is no bibliography, particularly of the government documents examined by Seibel, which might have been useful in any future study. Nevertheless, this book should serve to focus public attention on the important work of the Bureau of Mines in the production of one of the least advertised resources of the United States.

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Northern Life

Ecological Development in Polar Regions. A Study in Evolution. M. J. DUNBAR. Prentice-Hall, Englewood Cliffs, N.J., 1968. viii + 119 pp., illus. $4.95. Concepts of Modern Biology.

The title of this book is perhaps a little pretentious. Its author is a marine zoologist with most of his experience from Arctic Canada, and this explains why plants, terrestrial animals, and the southern polar region receive comparatively little attention. Within its limits the treatment is quite interesting, and some of the author's conclusions have general application beyond the material serving as primary objects of study.

The delimitation of the Arctic and the Subarctic regions (in the northern hemisphere) presents certain difficulties. In the sea, the Subarctic is defined as the zone with mixed Arctic and non-Arctic water; for land, the author follows the usage of Kimble and Good (1955), which implies that the southern limit of the Subarctic is that of "the full boreal forest" and that the inhabitants of Edmonton, Winnipeg, and Quebec City in North America and of Oslo, Stockholm, and Helsinki in Europe barely escape the fate of living in a "subarctic" country. The Old World practice is entirely different, and Hustich (1949), among others, has eagerly stressed the desirability that in North America, too, the term "subarctic" be restricted to the forest-tundra area.

The determination of the southern limit of the Arctic is more important and not purely academic. Dunbar (p. 51) uses the current definition: the 50°F (10°C) isotherm for July, or the timber limit, with which it largely coincides. It is therefore surprising that, later on (p. 97), a close dependence of the tree line upon climatic factors is denied in favor of "the process of soil increment." However, during the postglacial climatic optimum, notably in Scandinavia, the tree limit was situated much farther north than it now is, a fact which seems to corroborate a major influence of climatic factors.

One of the author's main theses is that the importance of low temperature as the primary biologically acting factor in the Arctic has been exaggerated; this is expressed in its sharpest form on page 92: ". . . the low temperature of the polar regions is the least important of the various polar characteristics. . . ." The reader's attention is drawn instead to three groups of other factors characterizing the Arctic: large seasonal oscillation, low production of nutrients (except in the Antarctic), and the youth of ecosystems. Here, again, examples are drawn largely from marine animals, and the conclusions, as far as these are concerned, seem sound enough. And, to do the author justice, he admits, in several contexts, that for terrestrial organisms the thermal factors are more important, especially in connection with hibernation. The author thinks that adaptation to low temperatures (influencing metabolism, growth, reproduction, and so on) is more easily achieved than is usually assumed and that the "difficult" taxonomy of many Arctic animals (terrestrial as well as marine) is an expression of continuous adaptive processes going on simultaneously in many taxonomic groups. My own experience with insects shows that certain taxonomic groups may be entirely Arctic or Arctic-Subarctic, in which case adaptation to a cold environment must have taken place long ago, in pre-Pleistocene time, no doubt in the alpine zone of mountains. And this may very well have been the history of entire ecosystems. Therefore Dunbar's leading principle, that Arctic ecosystems are young, "immature," "non-saturated," which apparently holds true in the sea, is not necessarily valid for terrestrial organisms. The author's final remark, that perhaps ecosystems may "act as units of selection," could therefore, under certain terrestrial conditions, be translated to mean that they act as "units of dispersal," at least in the Beringian region, where the influence of Pleistocene glaciations was slight.

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Anatomist of the Small

Jan Swammerdam (12 February 1637–17 February 1680). His Life and Works. A. SCHIERBEEK. Translated from the Dutch edition (1947). Swets and Zeitlinger, Amsterdam, 1967. vi + 204 pp., illus. $7.

Jan Swammerdam needs little introduction to historians of biology. He was, according to F. J. Cole, the historian best qualified to evaluate him, "the greatest comparative anatomist of the seventeenth century." He developed a number of new dissection techniques for the study of anatomy, especially of minute structures of insects. He was the first to observe a number of organs in invertebrates and in vertebrates, and the first to describe the cleavage of the egg. But perhaps his greatest importance was, as Cole tells us (and Cole expresses debt to Boerhave for the judgment), that "he was . . . one of the first anatomists to develop the *technique* of research." His principal work, the *Biblia Naturae,* completed around 1675, was published only in 1737–1738, through the good graces of Boerhave.

It is astonishing, in view of Swammerdam's excellence, that no modern biography of him exists; the chief source of information about his life remains Boerhave's introduction to the *Biblia Naturae.* Schierbeek's book is an English version, somewhat abbreviated, of a volume published in Dutch in 1947. It gives an account of Swammerdam's life, leaning heavily on Boerhave, and of his somewhat eccentric personality, and then it discusses his work. The content is very awkwardly arranged within the chapters, and the analysis difficult to follow. An attempted bibliography of Swammerdam's works is included. There