training—later, shorter, and more specialized. Several others make the same point.

A concluding chapter by Walter Adams and Joel Dirlam proposes an eight-point "agenda for action." Their recommendations may help in getting people's thinking headed in the right direction, but they suffer from an excess of rhetoric and a want of realism. Adams and Dirlam do not accept the oft-made proposal that gaining countries should compensate losing countries for the human capital involved in migration. The most important step the developed countries can take (vis-à-vis the less-developed countries, at least) is to stop their "diversionary concern" about the brain drain, put their priorities right, and raise economic aid to a respectable level. The assumption is that higher aid levels will speed development and that only with development can brain-losing countries generate the absorptive capacity that will provide satisfying employment for their educated elites. Indeed, what popular speech has called the "brain drain" is here correctly identified more as an overflow of unusable graduates from inflated and irrelevant higher educational systems than as a drain of "scarce" resources—at least for most of the less-developed countries. It is only when one moves up close to the problem and looks at migration of the "elite of the elite"—of irreplaceable men—that one sees a drain that hurts. As a result, most of the migration statistics sound alarums on a numbers problem that does not exist and are silent on the real problems of critical individuals and educational reform.

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Space, Past and Future

Rockets, Missiles, and Men in Space. WILLY LEY. Fourth edition. Viking, New York, 1968. xviii + 557 pp., illus. $10.95.

The Promise of Space. ARTHUR C. CLARKE. Harper and Row, New York, 1968. xxii + 325 pp., illus. $8.95.

Well known to many American readers, lay and professional, are the writings of Willy Ley and Arthur C. Clarke. Both of their latest volumes deserve serious attention. Two-dimensional viewpoints appear to dominate today's dialogue concerning science, technology, and public policy. Both Ley and Clarke provide much-needed historical perspective upon the recent past and for considering the future of space exploration and exploitation.

Ley's updated classic is really not, particularly in the light of all that has transpired during the past decade, "a definitive account of the history of space flight," as is blurbed on its dust jacket. But his faithfulness to fact and to careful explanation remains highly recommended. Having gone through 21 printings and four complete revisions since it first appeared as *Rockets* in 1944, Ley's now standard reference has a history of its own. The 1951 edition, *Rockets, Missiles, and Space Travel*, infected scores of American readers with eagerness for the coming space venture. "Space" was then a dirty word except to a handful of physicists interested in the ionosphere, to a few missilemen and their engineering compatriots, to aeromedical men projecting the human pilot to supersonic and near-vacuum flight, and, of course, to the cosmologists. Then came Sputnik.

No one could have predicted the dimensions and pace of the race for the first intercontinental missiles with thermonuclear warheads that began in earnest in 1954. No one could have foreseen the application of rocketry to space as it happened—the modest beginnings as a part of the International Geophysical Year or the dramatic response to the Sputniks in 1957 and the first orbiting of the Earth by the late Cosmonaut Gagarin on 12 April 1961. Effects of these pivotal events were clearly apparent in the first phases of the United States space effort. Lest we forget, this included notably the creation of the National Aeronautics and Space Administration in 1958 to advance nonmilitary efforts, including scientific prestige, and, after 1961, the accelerated program to achieve a manned lunar landing in order to deny politico-technological initiatives to the Soviet Union, peacefully and as soon as possible. Communications, meteorological, navigation, and other satellites useful to man came into being, not to overlook the reconnaisance and impending landing of men on the Moon, the first soundings of Venus and Mars, and quantitative data on the solar environment of the Earth.

How this all came to pass is a complex and important story. To cover in one volume the thousand years of gunpowder rocketry, and man's reflections on his extraterrestrial environment before and after the telescope, Darwin, and the industrial revolution, as well as the achievements of space science and technology the past ten years—this indicates both the severe constraints on and the useful perspective offered by Ley's volume. His tracings from antiquity to the 20th century remain superb, as do his memoirs and study of the European origins of liquid-fuel rocketry leading to the technological jump of the V-2 at Peenemünde (he came to the U.S. in 1935). Ley amplifies his treatise with new uncoverings. One need not look, however, for a comparable detailing of the pioneering labors of the Clark University physicist Robert H. Goddard (who in 1926 first demonstrated a liquid-fuel rocket), or of the Caltech group under Theodore von Kármán. Nor will one find adequate treatment of the highly sensitive ballistic missile development in the U.S. and the U.S.S.R. or of the diverse scientific thrust toward space experimentation aborning in the International Geophysical Year. Ley's updated bibliography (pp. 533–48) is notable, and his 114 pages of appendices are very informative. Ley does succeed in cramming facts and technical explanations into a coherent treatment of the past decade.

Arthur Clarke's writings also have deep roots. His seminal paper "Extraterrestrial relays" (*Wireless World*, Oct. 1945), which he wrote as a recent radarman of the Royal Air Force and as a member of the British Interplanetary Society, well forecast the technical feasibility and utility of communications satellites. His influential *Prelude to Space* (1948), an engaging novel whose hero was a historian, was but one of the first of over a dozen nonfiction space and oceanology volumes, 19 science-fiction volumes, a score of short stories, and, most recently, the script for the Stanley Kubrick film "2001: A Space Odyssey." Clarke's *Exploration of Space* was a Book-of-the-Month-Club selection in 1952, making him a literary compatriot of Ley in spreading the space message to a wider audience before Sputnik.

The Promise of Space, more spritely if less detailed than Ley's book, provides a historical launching pad for its author's stimulating and biased projection of what today's space capabilities and potential could mean for the intellectual and practical affairs of mankind in the future. Clarke's history is brief, accurate, and vivid. Like James E. Webb, he delights in quoting Daniel

Webster, who refused to vote a single cent for the opening up of the American West because it would always be a howling wilderness and no use to anyone but savages. Edward Everett Hale, author of *The Brick Moon* (first mention of a manned Earth satellite, 1869), is correctly identified: "he later became the first, and doubtless the last, science-fiction writer to be chaplain to the U.S. Senate." And Clarke cannot ignore the recently appreciated fact that the leading early theorists of the liquid-fuel rocket and space mobility—Tsiolkovsky of Russia, Goddard of the U.S., and Oberth of Rumania—were each stimulated by a reading of Jules Verne's *From the Earth to the Moon* (1865).

Clarke is at his best in digesting the "first harvest" of gains in space science and technology during the past decade, despite the incorrect identification, in a picture caption, of the 20-nozzle Soviet booster for Gagarin's Vostok I as that of Sputnik I. His four sections of four chapters each contain the best available summary of scientific and imaginative theory regarding space potentials: Around the Earth; Around the Moon; Around the Sun; and Around the Universe. Collectively they offer a most persuasive rationale, at least to this reviewer, which may be rebutted only with difficulty by critics of the space venture, who might profit most by its reading.

The Promise of Space, Clarke freely admits, was calculated to help restore the long-term view to space mobility recently diminished by the initial cost of capital investment already made and by the temporary sublimation of the international "space race," which characterized the beginning of the space program and may not be required for the future. Clarke's message is clear enough: the U.S. space program, at least in its earlier days, was certainly prodded by "gusts of emotion."

Some of this criticism is valid; some in itself is emotion—understandably so, in the age of scientists who may see billions going into space when they cannot get thousands for their own pet projects. However, much is based on a total failure to grasp the long range implications of space flight. After all the lessons that the history of our age has given us, this failure is inexcusable; and to those who continue to make it, it may be disastrous.

Clarke suggests that every revolutionary idea—in politics, science, art, or whatever—seems to evoke three stages of reaction: (i) "It's completely impossible"; (ii) "It's possible but not worth doing"; and (iii) "I said it was a good idea all along." Whetner this volume will "smooth the transition" of astronautics from the second to the third stage in the United States, as Clarke intends, remains for the future historians to determine.

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Invertebrates

Chemical Zoology. MARCEL FLORKIN and BRADLEY T. SCHEER, Eds. Vol. 1, Protozoa. GEORGE W. KIDDER, Ed. xvi + 912 pp., illus., $38. Vol. 2, Porifera, Coelenterata, and Platyhelminthes. xx + 639 pp., illus., $29. Academic Press, New York, 1967–1968.

The editors in their introduction to this new series call attention to a principal problem encountered by the biochemist who attempts to extend his investigations to a variety of animal forms—namely, the scattered nature of the literature on the chemistry of the invertebrates. Providing a remedy for this situation constitutes the primary aim and principal justification for this new series.

Volume 1 does this very well indeed for the protozoa. A brief but adequate summary of protozoan taxonomy introduces the volume; it is followed by several chapters on the basic biochemistry of the protozoa, each of which surveys our present knowledge of the occurrence, nutritional requirements, and metabolism of a major class of chemical compounds. The chapter on low-molecular-weight nitrogenous compounds is both comprehensive and critical. The chapter on protozoan growth factors not only does ample justice to this topic but also discusses knowledgeably some of the problems encountered in attempts to cultivate protozoa. There are also adequate reviews of nucleic acids, lipids, and carbohydrates, but strangely enough there is no mention of the present status of our knowledge of protein biosynthesis among members of this phylum.

The remainder of the volume consists of reviews of more specialized aspects of protozoan biochemistry. There is a very welcome summary of the literature on the biochemical ecology of the protozoa and an interesting chapter on chemical aspects of membrane transport in protozoa, including a discussion of phagocytosis and pinocytosis. Chapters on carbohydrate accumulation and its relation to morphogenesis, on digestion and hydrolytic enzymes, on biochemical genetics, on the biochemistry of cilia and flagella, on the chemistry of host-parasite relationships, and on protozoan development complete the volume. The wisdom of including the rather lengthy chapter on protozoan development, which is devoted almost exclusively to morphology and contains only a smattering of anything which can be called chemistry, appears questionable, particularly since its inclusion must contribute to what is the one major fault of this book—its price.

Volume 2, which covers some of the lower invertebrates, utilizes essentially the same format as volume 1. Each phylum is introduced by a chapter on its taxonomy and general biology, followed by chapters devoted to the basic biochemistry of the group. Chapters on specialized aspects of the biochemistry of the phylum (luminescence, toxins, and so on) complete each section. About half of the volume is devoted to flatworms, with particular attention to parasite forms. The remainder of the book covers sponges, the coelenterates, and, very briefly, the mesozoa.

On the basis of these initial volumes the series can be highly recommended to advanced students and to investigators in both biochemistry and zoology.

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Paleopathology

Diseases in Antiquity. A Survey of the Diseases, Injuries, and Surgery of Early Populations. DON BROTHWELL and A. T. SANDISON, Eds. Thomas, Springfield, Ill., 1967. xx + 766 pp., illus. $39.75.

There has been an increasing interest in paleopathology in the past few years as new prehistoric skeletal populations have been described which contain pathologic specimens, and some of the recently developed techniques of medicine and anthropology have been applied to the examination of these remains. With an increasing emphasis on human genetics and demography, anthropologists are more inclined to consider prehistoric diseases and injuries as events affecting populations rather than individuals and to interpret them as selective forces acting upon continuously evolving breeding groups.

This impressive volume reflects this shift in emphasis in the interpretation