education outside the formal school system accounts for more than a quarter of the total. Machlup also does a very thorough and imaginative job of collecting and developing statistics on the communication industries. But it should be noted in passing that his statistics on research and development are essentially a rehash of readily available data compiled by the National Science Foundation.

After presenting the available data on the various knowledge-producing industries, Machlup estimates that, in 1958, the total production of these industries amounted to approximately $136 billion. Turning next to occupations which are related to the production of knowledge, Machlup finds that the incomes of the relevant occupational groups (professional and technical workers, clerical workers, and the like) were approximately 30 percent of total incomes in 1958 and that the percentage has risen significantly in recent years.

In addition to collecting a considerable body of data on the production and distribution of knowledge, Machlup has also provided a number of interesting ideas on public policy. In his chapter on education he suggests that the nation aim to cut down on the average number of years of schooling per student and to increase the length and academic content of each school year. In his chapter on research and development, he argues that perhaps the nation is spending too much on industrial R&D.

His suggestion for compressing the primary and secondary school curricula is based in large part on data (originally developed by Theodore Schultz) which show that the cost to the nation of providing a year of education for a student in his middle teens far exceeds the costs of providing a year of education for a primary school student. A large part of the costs of high school education is not included in the school budgets; instead, it represents earnings that the student foregoes by not entering the labor force. For example, in 1956 the average cost for a year of high school education was approximately $2000 per student; of this amount, approximately $600 represents school costs and $1400 represents earnings the student has sacrificed by remaining in school.

Machlup believes that educational experiments in the United States and the experience of educational systems in other countries strongly indicate we could provide the equivalent of our present 12-year education in less than ten years and that we could thus reduce significantly the costs to the nation of providing such an education. Under the Machlup proposal, students would be younger when they complete their high school education and, hence would enter the labor force earlier. The objections to this proposal are numerous and obvious. Machlup deals effectively with some but not with others.

Machlup's suggestion that the nation may be spending too much on industrial R&D stems from the argument that the supply of scientists and engineers is quite inelastic in the short run and that a sharp increase in industrial R&D, such as we have experienced in recent years, can be obtained only by bidding scientists away from the universities.

In collecting and interpreting a vast quantity of data on the production and distribution of knowledge in the United States Machlup has performed a very valuable service. He also has provided several interesting ideas on public policy issues. If his book does not touch many of the most important conceptual problems of the economics of knowledge, it does provide data that can be used by others to shed some light on these problems.

Research on the Antarctic

Antarctic Research. The Matthew Fontaine Maury Memorial Symposium. H. Wexler, M. J. Rubin, and J. E. Caskey, Jr., Eds. American Geophysical Union, Washington, D.C., 1962. x + 228 pp. Illus. $10.

The Royal Society International Geophysical Year Antarctic Expedition. Halley Bay, Coats Land, Falkland Islands Dependencies, 1955–59. vol. 3, *Seismology and Meteorology*. Sir David Brunt, Ed. Royal Society, London, 1962. xviii + 382 pp. $23.

[*Both of the volumes reviewed here are reports of research carried out as a result of the International Geophysical Year.*]

The AGU's monograph contains the papers presented at the Matthew Fontaine Maury Memorial Symposium, which was held at the Tenth Pacific Science Congress (1961). The volume is dedicated to Maury who, when he was superintendent of the U.S. Depot of Charts and Instruments, urged international cooperation in Antarctic research and attempted to interest his colleagues abroad in such a venture. In April 1861 Maury culminated his efforts by dispatching official letters with detailed discussion of his proposal for international cooperation in Antarctica to the Ministers of Portugal, Italy, the Netherlands, Spain, Great Britain, France, Russia, Brazil, and Austria. But the Civil War intervened, and it was almost 100 years before Maury's dream came true. Then 60 nations did pool their resources in the vast cooperative IGY, and 12 of them also participated in research in Antarctica.

The scientific papers are divided into two parts: (i) Geography, Solid Earth, and Upper Atmosphere and (ii) Meteorology, Oceanography, and Glaciology.

There are ten papers in the first section and 14 in the second. Eleven of the authors are from the United States, six from the U.S.S.R., three from Argentina, two from the United Kingdom, two from New Zealand, and one from Australia.

Because I am a seismologist, I found most interesting George P. Woolard's paper "Crustal structure in Antarctica." Woolard bases his conclusions on seismological, gravitational, and topographical observations. The seismological data come from refraction studies over several traverses. Woolard concludes that the total thickness of the crust under Western Antarctica is about 32 km but that under Eastern Antarctica it is about 42 km; that there is no significant difference in the velocity structure in the upper 5 km of the two parts; and that the continent is in isostatic equilibrium.

The dedication to Maury was written by Harry Wexler, who died in August 1962; the volume also contains a memorial to Wexler and one to Edward C. Thiele who was killed in an air accident in Antarctica in 1961. J. Tuzo Wilson made the opening remarks at the symposium, and these are also recorded in the monograph.

In the introduction to the Royal Society's volume Sir David Brunt, the editor, gives the history of the organization of the IGY, particularly with respect to Great Britain and the Halley Bay Expedition. The list of alphabetical abbreviations that follows was especially pleasing to me; although I have often heard them used, I do not know (or I have forgotten) what they stand for.

Forty-eight pages are devoted to a paper entitled "Seismological observations," by J. MacDowall and E. M. Lee.

They describe the Halley Bay Station, which was located on a floating ice shelf. (This will shock the young seismologists who prate of "granite.") They also describe the Willmore seismographs that they used. The magnifications were obtained (as usual nowadays) by determining one point on the curve and accepting the maker's form for the curve. Copies of the records for two South American earthquakes are reproduced. With only the report of one station there was not much that could be done with the records except read them. Also, the position of the instruments on the ice shelf resulted in troublesome local disturbances. MacDowall and Lee note that usually the only clear phase on the records was *P*. Microseisms (contrasted with the effects of ice movements) which were observed in the summer months could be correlated with onshore winds.

The authors then present the readings from the seismograms, or the station bulletins, in two parts. The first bulletin, 1 July 1957 to 31 December 1958, presents and names all identifiable phases based on shocks for which epicenters had been located by the U.S. Coast and Geodetic Survey. The second bulletin covers 1 June 1957 to 31 December 1958 and gives readings of phases not given in the first bulletin. No effort was made to identify them.

Pages 49 to 381 are devoted to meteorological observations. The authors are MacDowall and J. A. Smith. The principal headings are: (i) Total Ozone Observations, (ii) Surface Ozone Observations, (iii) Ozone Soundings, (iv) Radiation Observations, (v) Upper Air Meteorological Observations. The data are presented in 436 tables.

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For Amateur Astronomers

Moon Atlas. V. A. Firsoff. Viking, New York, 1962. 32 pp. Illus. Maps. $10.
Moon Maps. H. P. Wilkins. Faber and Faber, London; Macmillan, New York, 1960. 38 pp. Maps. $6.

These two handsomely reproduced books are obviously the result of current interest in the moon that has been stimulated by the prospect of manned lunar landings sometime during the present decade, or shortly thereafter.

There are no photographs with the Wilkins maps; the other side of the moon is presented as a drawing based on the Lunik III photographs of the invisible side. The charts show altogether approximately 90,000 objects, and the accompanying gazetteer lists approximately 900 named objects, indicates the map section on which they are found, and provides notes concerning the principal features of interest. An enormous amount of labor was expended in the preparation of these maps. Unfortunately, this does not make them look like the moon in the same way that a good photograph looks like the moon. Similarly, a road map does not look like a good aerial photograph. Nevertheless, a road map does serve to show geometrical relationships and the like, and Wilkins's maps serve the same purpose. The maps are presented in an ingenious foldout arrangement, which makes it possible to place any map and any page of the text flat side by side. This makes the charts more convenient for use at the telescope than any other known to me.

Firsoff's *Moon Atlas* is beautifully printed, and it contains both photographs and charts. There are two very large foldout charts, a relief map, and a selenological map based on some of Firsoff's own work. The quadrant maps are hand drawn, but, unlike the Wilkins maps, they are not corrected to mean libration. The accompanying gazetteer lists the formations in each quadrant separately. The photographs include one page of standard Mount Wilson, Lick, and Greenwich photographs showing the moon at different phases. Seven pages are devoted to "spherical projection photographs," showing regions of the moon near the limb, without foreshortening. These were obtained by photographing a projection of a photograph of the moon on a white sphere. In the introduction Firsoff describes the difficulties of doing this, and the results bear out what he says. Kuiper is using this technique to produce an extensive series of photographs at the Lunar and Planetary Laboratory of the University of Arizona. It will be interesting to see how his results compare with those published by Firsoff. There is a full-page reproduction of the well-known Lick photograph of the full moon, and the Lunik III photograph is also included. Firsoff's *Atlas* is too large (12 by 14 inches) for convenient use at the telescope.

Wilkins's *Moon Maps* and Firsoff's *Moon Atlas* will doubtless be very useful to amateur astronomers, who may be unable to afford Kuiper's more expensive *Photographic Lunar Atlas*. The latter, however, will prove to be a much more valuable tool to those who are interested in the scientific study of the lunar surface.

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Marine Science

Ichthyology. Karl F. Lagler, John E. Bardach, and Robert R. Miller. Wiley, New York, 1962. xiii + 545 pp. Illus. $12.50.

Ichthyology has shared the growth that has marked so many fields of science during the past 50 years, particularly in the post-war period. Where one ichthyologist labored 25 years ago there are now four or five. Many schools now offer courses and advanced programs in ichthyology. Knowledge of fishes has increased rapidly in all areas, be it anatomy, physiology, behavior, or systematics.

Need for a textbook has grown apace. Jordan's *Guide to the Study of Fishes* long has been out of print and is outdated and cumbersome at best. Norman's *History of Fishes* is a popular natural history, and the two-volume anthology on fish physiology is a special reference work. To fill this void is the timely intent of authors Lagler, Bardach, and Miller—fishery biologist, physiologist, and systematist, if their wide interests permit classification.

Ichthyology fulfills well its role as a college textbook. It introduces the many facets of the field, it treats them concisely, and it should provide the starting point and stimulus needed by many students. Selected references are provided at the end of each chapter. All original illustrations are by the talented William Brudon.

With *Ichthyology* the lecturer can free himself from presentation of much introductory material and can emphasize recent findings and special topics. The student will readily find much information that, even though introductory, was previously widely scattered.

Criticism of *Ichthyology* likely will center not on what the authors have written but on what they have left unsaid. And these comments will reflect the pet interest of the critic. Yet the satisfaction of such critics means the conversion of an authoritative and read-