may be primarily means to some higher goal, rather than primary goals in themselves. Indeed, he envisions a mixture of primary and secondary goals with a requirement that they all be consistent. The common striving to find and state our explicit long-range goals, and then to work for them, would presumably reduce international rivalry and enrich individual understanding as well.

Feinberg believes that most of the present sources of human misery in the world are hangovers from the days of bare subsistence economics and that "most of our immediate problems will be solved in a relatively short time by the march of technology and the worldwide spread of those aspects of Western culture that are responsible for our high living standards." Thus, while many will still be preoccupied with solving these problems, society must also get on with setting the long-range goals against which short-term decision-making can then be assessed.

Feinberg recognizes that our technological prowess can be exceedingly dangerous as well as benign, and that we may have arrived at a watershed in the development of society. He insists that decisions affecting the future course of humanity require in their formation the broadest possible public participation rather than being left to elites, whether scientific or political. He thus shows that he is well aware of the need to preserve both the hard-won traditions of democracy and the humane goals of science. But he seems far too little concerned with the immediate problems that confront our society. He believes our deepest problems to be "human finitude and the meaning of individual lives" and generally dismisses our more temporal troubles with an airy optimism. He hardly considers the very serious question of the increase of the human population and the way in which this increase exacerbates, and often generates, various other social ills. In asserting that we will "soon be faced with world-shaking decisions" he forgets that we already have been faced with some rather trying decisions (for example, during the Cuban crisis of 1962) and that many in our society are painfully aware that an extensive agenda of difficult decisions confronts us now. Though we may seem to lurch from crisis to crisis, our society has developed elaborate self-protective institutions whose workings Feinberg ignores, including a government that is directly charged with serving the interests of the people and that, in our nation at least, provides a very substantial measure of social self-determination. Moreover, the problem of reconciling short-term decisions with long-term goals is far from trivial, and the record of human history shows that such a reconciliation may not provide an altogether reliable mechanism for the daily decisions either of our personal or our national lives.

Although Feinberg's ideas are stimulating, the prescriptions appear to be decidedly wrong-headed. Each of the basic assertions is arguable and not demonstrable. Belief has surely declined, but it does not necessarily require replacement. Granted that we face some baffling dilemmas in keeping our technology under control, programs with a hundred-year lead time are not obviously necessary or sufficient. It may simply be that an informed common sense is sufficient to control our suicidal impulses, in which case the elevation of long-range goals is not required. It may be less a question of what values humans *should* maximize than of what values we *do*.

Most distressing is Feinberg's assurance that our advancing knowledge of natural science has or soon will have equipped us to carry out the kind of detailed analysis of causes and effects, costs and benefits, that any assessment of long-range goals would require. Our knowledge of human behavior is certainly much less complete, and is in many ways more important, for the setting of the limits of human aspiration. Indeed, it may be that before we overrun the rest of the peoples of the world with our "Western civilization" we would do well to stem the onrush of our technology and try first to understand those peoples and let them understand us (if they so desire).

Feinberg's explicit program calls for the organization, first, of a series of broadcasts in the mass media, addressed to all the peoples of the world, then of small discussion groups that would debate a wide variety of goals; then finally the establishment of a worldwide coordinating agency that would promote various kinds of discourse until it finally could announce to the world what the long-range goals of mankind should be. This book is intended to provide the initial spark. It will be interesting to see if it does.

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Plants and Environment

Climate and Agriculture. An Ecological Survey. JEN-HU CHANG. Aldine, Chicago, 1968. xvi + 304 pp., illus. $9.75.

For the conquerors of space to run short of food and oxygen would be embarrassing. Our technological society therefore has begun to turn some attention to the way they are produced by the "earth's green mantle." This attention has uncovered some surprising areas of ignorance, one of which is the relation of plants to their environment. How do they get what they need from it?

Jen-hu Chang discusses this question with respect to crop plants. His approach is a genuinely physical one. It wastes little time on the hoary descriptors air temperature and rainfall, which exist as billions of punched cards and which have only indirect relevance to the exchanges of energy, water, and carbon dioxide that characterize the world of plants.

Most of the few defects of the book, which occur in one chapter, reflect the way many agronomists have uncritically accepted local, empirical formulas for estimating solar radiation or the net exchange of energy in radiation of all wavelengths (so-called "net" radiation). The inadequacy of these formulas is naturally no fault of the author's, but it might have been noted that some are inconsistent with others and that some oversimplify the physics.

But these defects are minor. Chang's treatment of the radiation environment of crop plants has a broad sweep, from photosynthesis in the field through the distribution of radiant energy in crop communities (with long-overdue attention to their geometric and geophysical properties) to the resultant temperatures of leaves and soil. All are presented with research data relevant to physiologic processes.

The second part of the book carries on with radiative and other forms of energy as they support transpiration and the circulation of water in the soil-plant-air system. The water exchanges lead to methods that may in time rationalize many traditional practices in cropland management, including irrigation and crop spacing. The soil-moisture budget, as a practical means of characterizing one aspect of the plant's environment, receives probability treatment.

Many barriers between the physical and biological sciences in this area have

come down because "climatologists are no longer content with the analysis of data designed only for weather forecasting." They have gone beyond, developing budgets of energy and water that render "the seemingly noncomparable climatic elements amenable to precise and unifying physical interpretation." Chang's experience with such climatologists as C. F. Brooks and C. W. Thornthwaite, his own research on soil temperature, evapotranspiration, and geographic-scale distributions, and his association with the advanced agriculture of Hawaii and its university have enabled him to make an important contribution toward our fuller understanding of those indispensable organisms, the domesticated plants.

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Ecosystems

Fundamentals of Forest Biogeocoenology. V. SUKACHEV and N. DYLIS. Translated from the Russian edition (Moscow, 1964) by J. M. Maclennan. Oliver and Boyd, Edinburgh, 1968. viii + 672 pp., illus. £ 12. 12s.

Twentieth-century Russian scientists have contributed importantly to the development of the science of forest ecology, and now English-reading ecologists have access for the first time to the data and thinking of the current generation of Soviet scholars in this field. Sukachev and his colleagues write about the forest ecosystem, but describe it as a "biogeocoenose," preferring the latter term as specifically emphasizing "the fact that here we have a unit of organisms closely inter-related with their environment" and avoiding the term "ecology" in dealing with community studies because in the Soviet Union it is identified primarily with autecology.

The ten chapters are separately authored by scientists in the Forestry Laboratory and in the V. L. Kamarov Botanical Institute of the Academy of Sciences of the U.S.S.R. The late V. N. Sukachev wrote the first and last chapters and is listed as the senior editor. N. Dylis, his senior research assistant, is senior author of the longest chapter (156 pp.), dealing with the vegetation component of the forest ecosystem, and junior editor of the entire work.

Chapters 2 through 6 deal separately and in detail with the atmospheric, plant, animal, microorganism, and soil components of the forest ecosystem. They provide an individual guide into much basic Russian work, which is fully covered by the excellent Russian bibliography presented. The data derive from studies similar to those carried out contemporaneously in Europe and North America, and so afford important comparisons from a major portion of the world's temperate forests. Such matters are dealt with as evapotranspiration losses from different types of forests, leaf mass and leaf surface in various forest stands, and characteristics of microorganisms in forest soils. Both forest animals and soil microorganisms are dealt with exhaustively.

The treatment of succession (chapter 7) is brief and general, as is that of the other synthetic elements of ecosystem (or biogeocoenose) analysis. The reader will look in vain for a treatment of forest geography in the U.S.S.R., but the development of the principles of forest classification is traced from Morozov's 1912 book on "forest science" to the All-Union Congress on Forest Typology in 1950 and on to the Ninth International Botanical Congress in Montreal in 1959. Russian plant sociologists have made unique contributions in the classification of forest types. Their more comprehensive approach should be compared to the use of lesser vegetation as type indicators in similar boreal forests by the Finns and Scandinavians.

Compared to much Russian writing on ecology, *Fundamentals of Forest Biogeocoenology* is remarkably free from political dialectic, personal attacks on other scientists, and nationalistic bias. Sukachev does attack Nesterov as making statements which are "often undefined, indecipherable, and occasionally ill-written" but dismisses his classification of forest merely as "an unsuccessful eclectic combination of several of Morozov's suggestions." Those Western scientists whose views are quoted are generally treated with intelligence and respect.

The reading is heavy, for Russian ecology has a dialectic all its own and considerable space is devoted to its elucidation or perhaps confounding. Nevertheless, this is by far the most readable, intelligible, and complete guide to Russian forest ecology available. As such, it will be an essential part of the library of every serious English-speaking ecologist concerned with forests.

It is notable that a lengthy "non-Russian" bibliography is appended and that the 14 collaborators have gone to considerable effort to select illustrations from these listed works. A kind conclusion is that this commendable effort is no more unsuccessful than that of English and German authors with regard to Russian literature in the same field. Much important U.S. work is ignored, and the items that are listed appear to have been chosen at random or perhaps because the library of the Botanical Institute happened to have the reprints. At least the authors tried, and this is about all I can say for my coverage of Russian research in my own book on the same topic.

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Biochemical Agents

Antimetabolite des Nucleinsäure-Stoffwechsels. Biochemische Grudlagen der Wirkung. PETER LANGEN. Akademie-Verlag, Berlin, 1968. 220 pp., illus. DM 38.

The last major book on antimetabolites, by the late D. W. Woolley, appeared in 1952 when only a few nucleic acid base analogs were available. In the meantime many of these drugs have become useful chemotherapeutic agents in the treatment of cancer (6-mercaptopurine, 5-fluorouracil, cytosine arabinoside), immune reactions (azathioprine), virus diseases (iododeoxyuridine), and gout (allopurinol). In addition, many antimetabolites have become of considerable interest as biochemical tools. A book evaluating the contribution of these agents to biological and medical science would be most welcome if it treated the subject in depth. Langen's specialized monograph, however, only summarizes the biochemical actions of the structural analogs of purines, pyrimidines, and a few related compounds. The author reviews enzyme inhibition due to substrate replacement by analogs at the active and allosteric sites, the incorporation of the drugs into DNA or RNA or both, mechanisms of resistance, and routes of degradation. Another chapter describes the problems associated with the relative nonselectivity of these agents in tumor chemotherapy and the approaches that are being considered to improve their effectiveness on the basis of an understanding of their biochemical properties. The last section of the book lists the major