is to develop academic programs that have "personal relevance and economic utility for diverse populations under different conditions." The need is to recast some existing institutions and to develop new ones in such a way as to foster comprehensive, utilitarian, and socially contributive education. Willingham admits to the incompatibility of "teaching a currently useful skill while emphasizing a liberal education to protect the individual from intellectual obsolescence." He does not underestimate, either, the conflict between the "academic-professional" and the "sociopolitical" interpretation of the role and function of higher education. There is no doubt, however, that a societal rather than a purely scholastic philosophy must prevail in more higher institutions of the free-access type, if the accelerated public expectation of equal educational opportunity is to be satisfied.

No one will be surprised to learn that a massive increase in the public funding of higher education will be necessary if the nation is to have more free-access colleges offering programs of optimal relevance to a diverse and ever-growing student population. Since there will certainly be limitations in such funding, should the choices that have to be made emphasize the egalitarian or the meritocratic? There is no doubt that developing public institutions, in their successful emulation of the disciplines-oriented "prestige" colleges and universities, do not serve adequately the needs of their primary and tremendously diverse constituencies, many of which see no relevance in the liberal arts. These institutions must be encouraged and aided to do so, in short, to become more egalitarian. Surely, however, it is not in the public interest to deprive the able and highly motivated student, and the institution *he* chooses, of the opportunities that merit has earned, in order to extend opportunity instead to young people who have no apparent motivation or potential for higher education. When choices must be made in the use of public funds for higher education, first priority must go to subsidy of the individual student on the basis of demonstrable need and demonstrable merit. The real barometer of equal opportunity in higher education is the availability of financial aid rather than the accessibility of colleges.

Free-Access Higher Education affords, to the reasonably informed and sophisticated reader, an eminently useful reference and resource for an understanding of the current status of educational opportunity. The author and his publisher, the College Entrance Examination Board, have made a significant contribution to the long-range planning, both state and federal, that must continue to support new levels of achievement in higher education.

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Unhysterical Antipollution

Advances in Water Pollution Research. Proceedings of the Fourth International Conference, Prague, April 1969. S. H. JENKINS, Ed. Pergamon, New York, 1969. xii, 936 pp., illus. $48.

This is the official record of the fourth conference of the international sanitary-engineering—waste-water-treatment—stream-improvement, and water-quality specialist jet set. It is an earnest and dutiful account and a monument to the determination of its instigators. It can't be guessed what the account would have been like if the original plans for the conference had been carried through and the rebellion of August 1968 had not occurred. As it turned out, the get-together was delayed about eight months, international hostelry and organized transportation prevailed, and nearly everybody that could be spared from the shop during the following spring turned up.

Engineering conferences tend to be hyperorganized, but this accounting indicates a degree of control that probably did not prevail at the Prague meetings. The proceedings represents a massive editorial effort to be fair to 102 authors of 55 papers from 18 countries—delivered and transmitted. Because of the international nature of the conference about a third of the authors represented American institutions and organizations, but everybody pitched in with formal discussions, roughly four discussers per paper. So the treatment was thorough. The edited version indicates that it was also orderly and polite.

Reorganizing and bringing on schedule a disrupted scientific program of this kind requires firmness. Generally, this can be regarded as an improving force since the papers have been pruned to the limit, translations brought into uniformly clear English, and discussions kept to pertinent matters. But the net effect is that of a long trip with all meals at the same chain of restaurants. Only the British seem to have been allowed their identities.

The papers have been arranged somewhat arbitrarily into sections on stream pollution (18 items), wastewater treatment (18 items), and lakes, reservoirs, and the marine environment (19 items). But study interests mix and overlap to make this separation a fiction—the biologists concerned with ocean disposal are as likely to break out with mathematical models as are the engineers working on the treatment of refinery wastes.

There are no breakthroughs in this series—there is the same search for improvement, measurement, and control of waste-water treatment processes and concern with the loading, management, and administration of receiving streams, more efficient aeration, biological and process indicators of success and grief, tracing of waste-waters, bits of eutrophication and effects of runoff-borne nutrients, and heat dispersion. All very sober and completely free of hysteria—not an inspiring political document.

The conference itself was undoubtedly worthwhile in bringing people of comparable interests and responsibilities together under amiable conditions. And the record completes a moral commitment. But it is a bit difficult for one who did not get to Prague to use this record as a professional book. He can only read every word and underline. There is no index and no abstracts. This is a minor matter. But a research man or engineer looking for ideas and information beyond that reported would have to do a great deal of international searching to reach the authors. A roster of the principals with their organization addresses would have been very useful—telephone numbers would be dandy, too.

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Food and Numbers

Animal Populations in Relation to Their Food Resources. A symposium, Aberdeen, Scotland, March 1969. ADAM WATSON, Ed. Blackwell, Oxford, 1970. xx, 478 pp. + plates. $17.50. British Ecological Society Symposium No. 18.

This symposium considered the influence of quantity, quality, and availability of food on the regulation of animal numbers, and it tried to relate behavioral interactions to these effects.

A number of the papers do this very well, and for these papers alone the symposium must be considered a success; parts of the book should be read by anyone interested in these aspects of population ecology. The organizers invited papers from the fields of agriculture, nutrition, and behavior, in the hope of giving ecologists new insights from these fields. For this ecologist, at least, that attempt largely failed. On the other hand, a number of the papers by ecologists raise questions that I think would interest the nutritionist, physiologist, behaviorist, and those interested in the coevolution of plant-herbivore systems. The 24 or so papers cover a wide range of organisms —sheep, cattle, various birds, North American deer, African ungulates and hyenas, fish, aphids, various other insects, flatworms, snails, and soil amebae. The book might serve as a source of information and references for workers interested in any of these groups, or in feeding relationships in general, and this purpose will be greatly helped by the presence of four good indexes: of authors, species, geography, and subjects.

The book is divided into three sections. The first, following an introduction by David Lack, examines food selection in various groups (nine papers, 157 pages). I found this mainly dull, though an occasional fact was interesting. The trouble with most of the papers here is that they set out simply to describe the diet of animals, compared with what the animals might have available or in relation to nutritive quality. Most authors did not set out to test hypotheses or to work out population mechanisms, and unless one has a particular interest in the organisms discussed the absence of ideas soon blunts one's interest. This section, incidentally, perpetuates the myth of the Kaibab deer "eruption" and decline, a myth recently laid to rest by Caughley in *Ecology* (1970). Since this part constitutes a third of the book, it contributes to the high price that may well deter many ecologists from buying a book they would otherwise enjoy.

The other two sections deal with the importance of behavior in relating populations to their food resources, and with the effects of quantity, quality, and availability of food resources. Two features are outstanding. The first is a long paper (55 pages) by Watson and Moss giving a thorough, extensive, and excellent review of the role of territorial and other social behavior in determining the density of vertebrate populations. The paper is an object lesson for those who have participated in the controversy over whether food or territory limits bird numbers. Major protagonists of both sides have uncritically accumulated confirmatory evidence for their viewpoint and ignored or rejected contradictory evidence. Watson and Moss present a critical and remarkably dispassionate analysis of the many relevant studies. They also look at the interaction between behavior and food supply, and this, together with papers discussed below, illustrates that ecologists have pitched their discussion of these questions at much too simple a level.

The other main feature is the several discussions of food quality and the interaction between herbivores and the quality and quantity of their food supply. Hughes and Walker, in a return to that favorite habitat of ecologists, the cow pat, show that even here food quality has a profound effect on population dynamics (of flies). Miller, Watson, and Jenkins describe some preliminary but interesting experiments on the effect of food quality (heather) on grouse populations. Indeed, one of the reasons that much of this section is interesting is the experimental approach of a number of the authors. In his brief review of the long-term studies of Wytham Woods in Oxford, Varley makes reference to one of the most interesting recent findings about food quality, namely that the amount of various tannins in oak leaves changes seasonally and essentially the leaves are available as food for caterpillars for only a very brief period in the year, after which caterpillars cannot develop on them. (This has since been described in detail by Feeny [*Ecology*, 1970].) Way and Cammell show that not only is food quality important for aphids, but the density and aggregative behavior of aphids affect the quality of the host plant—the behavior often serving to improve the quality of the plant for the aphids. They discuss how behavior varies among aphid species and plays a key role in adjusting numbers to food supply.

The important message of the symposium, about food quality, behavior, and population limitation, is encapsulated in a fine, terse paper by Dixon. He provides an explanation of limitation of density in aphids caused by interactions among individuals in the population. These interactions are tied to the nutritive quality of the host plant—when quality (amino-nitrogen content) is low, individuals move more and limitation occurs at lower densities. The availability of the food is also affected by the structure or the foliage and the microenvironments this creates. At no time does "energy" (sugars) appear to be limiting. This paper and others in this section suggest that no future study of animals in relation to their food supply will be complete unless it examines food quality and availability. They also suggest that looking for explanations of population limitation in terms of single limiting factors may often be far too simple an approach. Finally, the difference between the earlier and later papers underlines the fruitfulness in ecology of looking for mechanisms and doing experiments, rather than simply describing situations. The book thus represents a significant step in formulating ecological problems.

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Biochemical Analysis

Interacting Macromolecules. The Theory and Practice of Their Electrophoresis, Ultracentrifugation, and Chromatography. JOHN R. CANN. With a contribution by Walter B. Goad. Academic Press, New York, 1970. xii, 250 pp., illus. $12.50. Molecular Biology series.

Macromolecular interactions have assumed increasing importance with the recognition of the subunit structure of large proteins and of the mechanism of allosteric reactions. Such interactions are manifested (sometimes very subtly) as anomalies in the behavior of the macromolecular system when it is subjected to the common techniques used in fractionation and characterization: that is, electrophoresis, chromatography, and ultracentrifugation. The fact that these methods are now universally used, and most of their inherent difficulties so widely understood, may be attributed in large part to the existence of a series of instructive reviews and monographs; in this tradition, Cann's book now takes its place.

The elementary theory of the transport processes is described, and Cann uses rigorous mathematical methods to demonstrate the fundamental relationships; the discussion of the Johnston-