In as thorough a treatment of a subject as would be expected in these volumes, one is bemused at being able to delineate additional pertinent areas of research where coverage is almost totally lacking. The catabolism of corticoids is not dealt with, nor is corticoid transport in the blood. One could assume that the decision to exclude this information was based on "topographic" considerations—the adrenal cortex *sensu stricto* is the subject matter, rather than the fate of its products once they enter the systemic "field." However, the mechanisms of action of aldosterone and of glucocorticoids are included, as are some assessments of the physiological role of the secretory products. Inasmuch as the concentration of free corticoids, as opposed to conjugated and bound steroids, is of fundamental significance in comprehending the "control of hormone synthesis and secretion" (the stated emphasis of this series of monographs), one can only regret the exclusion of the missing topics (which are certainly of great biochemical and molecular interest). Comparative endocrinologists will note the lack of reference to the admittedly limited material available on corticosteroidogenesis in nonmammalian vertebrates.

Regardless of possible omissions—and an editor is entitled to his license in the selection of material for his 1176 pages—these two volumes are commendable for their sophistication and for their utility. It is hoped that this monograph and those that follow will result in the recognition by academic biochemists that biochemical endocrinology presents increasingly relevant subject matter which they could well afford to make available to today's biologists in the form of instructional offerings.

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Feed and Food

Comparative Nutrition of Wild Animals. Proceedings of a symposium, London, 1966. M. A. CRAWFORD, Ed. Published for the Zoological Society of London by Academic Press, New York, 1968. xxii + 430 pp., illus. $19.50. Symposium of the Zoological Society of London, No. 21.

The 26 papers of this symposium fall more or less readily into three groups: nutrition and malnutrition in "captive environments," adaptations and maladaptations to native environments, and wild herbivore as food for man. Many of these are summaries of published work, some of which has been summarized earlier. For example, composite rations for zoos (Wackernagel) and laboratories (Short) have a considerable history. Use of these rations, especially for ruminants, is supported by balance studies on deer (Nordan *et al.* and Maloiy *et al.*) and, of course, on domesticated animals. Similarly, nutritional bone diseases of cebids and hapallids (du Boulay and Crawford), of felids (Scott), and of canids (Hime) also are well known, as are suggestions that atherosclerosis is a response to "essential fatty acid" deficiency (Sinclair). However, the scheme (Bilby) by which diets are to be determined from preferences exhibited by zoo animals for fruits, vegetables, and processed foods is, at best, novel, and the discussion of nutrition for captive wild herbivores (Adams) disappointingly vague.

Adaptations to native habitats presumably reflect many unknowns. Thus, Icelandic ptarmigan select a diet superior to that selected by ptarmigan from an equivalent flora in Scotland and have a higher reproductive rate (Moss). However, adaptive difficulties of other animals—for example, reindeer in Scandinavia (Gaare, Steen) and elephants in Africa (Sikes, Laws and Parker)—can be attributed to man. Laws and Parker also find that elephant populations respond to social pressures by reduced productivity and increased mortality, as has been described for other mammals.

African ruminants also receive considerable attention. Attempts to understand adaptations range from a study of stomachs in relation to feeding habits—as in grazers versus browsers (Hofmann)—to minimum water requirements (Taylor), and food selection (Field) and utilization (Rogerson, Crawford *et al.*). Lipid digestion in ruminants and nonruminants differs strikingly (Lough and Garton).

The papers on wild herbivore as food for man are more limited, but a report on wildlife management in the Scottish Highlands and Islands (Boyd) emphasizes the lack of basic information and the obstacles presented by the reluctance of peoples to alter their food patterns. Such inertia is, of course, characteristic of man and will interfere with the production of meat from any wild species: hippopotamus or buffalo (Ledger), manatee (Bertram and Bertram), or semidomesticated eland (Treus and Kravchenko). At the same time, the formal papers and discussions of this symposium emphasize that an understanding of nutritional requirements of wild animals, how these are satisfied in native environments, and how wild animals may become a stable source of food for man is equally handicapped by sentimentality and unchanneled enthusiasm that are a result of current ignorance.

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Plant Group

The Algae. A Review. G. W. PRESCOTT. Houghton Mifflin, Boston, 1968. xii + 436 pp., illus. $7.95. Riverside Studies in Biology.

The algae are a diverse assemblage comprising not only green plants but plants which are brown, red, blue, yellow, and even black. Each of the 9 to 11 divisions of the group corresponds in diversity to the spermatophytes. Thus to review them all, as Prescott has attempted to do in this volume, is a gigantic task. While the classification of algae is admittedly fluid, the scheme used here is startling to one accustomed to the arrangement made familiar by Papenfuss and Silva, who recognize the Bacillariophyta and Charophyta as separate divisions or phyla, but not the Chloromonadophyta. Then, too, some attempt is usually made to arrange the divisions in an evolutionary sequence.

How successful is this book in reviewing the algae in all their diversity? Are there good pictures? Line drawings of 263 different species are included, but there are very few photomicrographs, and none taken with the electron microscope. In a modern treatment of the algae, the absence of electron micrographs, of which spectacular examples are available from the work of Bouck, Gibbs, Manten, Reimann, Ringo, and others, is a serious omission, especially since whole groups of algae are small, many of them unicellular.

When organisms have been ordered to our satisfaction, we turn naturally to questions of where they live and how. The last third of *The Algae* is devoted to these matters, including a chapter on economics and one on culture techniques. Do not expect a rigorous discussion of algal physiology,

however. This fascinating subject is given short shrift. There is no mention of the revolutionary discovery of Emerson that two different light reactions cooperate in photosynthesis, the result of his experiments with *Chlorella* and *Porphyridium*. The studies of extranuclear inheritance in the algae *Chlamydomonas* and *Acetabularia* by Sager, Granick, and Gibor do not appear, nor do the experiments of Joyce Lewin on silicon metabolism in diatoms or any of the work on energy transfer in photosynthesis or on phototaxis (Haupt, Halldal). It is of course necessary to be selective in covering such a huge subject. Those interested primarily in the classical treatment of taxonomy and ecology of the larger freshwater algae will be satisfied with Prescott's choice.

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Creative Engineering

Education for Innovation. Based on a conference, Woods Hole, Mass. DANIEL V. DE SIMONE, Ed. Pergamon, New York, 1968. x + 182 pp. $6.

Engineering education, to judge by its practice of continual self-assessment, is evidently among the most introspective of professions. Whereas engineering itself was originally an art, its educators have noted in turn the lack of sufficient mathematics, humanities, and science in the undergraduate curriculum, and have moved concertedly to fill the gaps. Matters have now come full circle, and the current trend is toward strengthening the art—without, however, losing what has been gained in the other three educational stems. The book under review is noteworthy evidence of this trend.

In the summer of 1965 the National Academy of Engineering, the National Science Foundation, and the Department of Commerce sponsored at Cape Cod a conference on creative engineering education among an invited group of 86 educators, executives, inventors, innovators, and entrepreneurs. Eight of the participants spoke individually on various aspects of the subject, and then the entire group broke up into five panels for the workshop type of discussion. The editor of the book, director of the Office of Invention and Innovation in the National Bureau of Standards, finally assembled the taped proceedings, eliminated inessential repetition, and correlated the papers and discussions from the floor as sequent chapters of the book.

Because most of the talks were extemporaneous, their edited versions still have an attractive and informal spontaneity. By the same token, they vary considerably in depth and in the degree of innovation they themselves manifest. All, however, adhere closely to the schedule formulated by the editor in his introduction:

> In sum, we shall concentrate on six principal themes or propositions: (1) Inventors and innovators are the vital elements of technological change, which is the business of creative engineering; (2) the art of creative engineering has been orphaned in the engineering schools; (3) the creative requisites of invention and innovation can be encouraged and an understanding of these processes can be taught; (4) research on the processes of technological change, including a synthesis of existing knowledge, is needed and should be undertaken on a comprehensive multi-disciplinary basis; (5) improving the climate for creative engineering education requires positive inducements to faculty and students; and (6) greater cooperation among the universities, industry, foundations, professional groups and government is essential to the development and support of creative engineering education.

The very effective opening chapter, "Creative engineering and the needs of society," is by J. Herbert Hollomon, then assistant secretary of a federal department and now a university president; he pleads therein for a broadening of engineering to include problems of civilization—whether social, political, or economic—not normally considered technological but requiring much the same approach for their solution. C. Stark Draper, in "Education for creativity," draws upon his long experience with the development of guidance systems to emphasize the necessity of identifying and cultivating the limited number of potential creators as they reach college age. Under "Engineering and the many cultures," a professor of law, John C. Stedman, delineates the obstacles to creativity and shows that cross-disciplinary activities are required to strengthen the creative effort.

"Factors influencing creativity" are seen by Calvin W. Taylor, a professor of psychology, to be negative more often than not: authoritarian teaching, desire for conformity, ridicule by one's peers, pedagogical emphasis on knowledge rather than thought. William Bollay, an aeronautics professor, points to Zwicky's "morphological approach," the case method, project laboratories, systems studies, and design theses as significant "new directions in engineering education." "The process of invention" is depicted graphically by a highly successful inventor, Jacob Rabinow, in one of the most enjoyable chapters of the book. Richard S. Morse, corporation executive, illuminates in "Innovation and entrepreneurship" the important role played by the generation of new enterprises. And "Trade-offs and constraints," by Robert C. Dean, Jr., a professor of engineering, discusses the implementation of six experimental workshops in creativity conducted across the country under the auspices of the Commission on Engineering Education and the National Science Foundation in the summer of 1965.

The first of the six panel discussions is summarized by B. Richard Teare, Jr., formerly an engineering dean, under the title "Educational objectives in the preparation of engineers"; except for lack of originality, little fault can be found with the conclusions. Robert B. Banks, with the Ford Foundation in Mexico, reviews the findings of the same panel on "The motivation and development of faculty": in essence, the need for greater recognition of, and reward for, creative engineering education. The panel on "Strategies and teaching methods," as reported by Ray E. Bolz and Dean, enumerates and discusses a dozen or more new ways and means for nurturing creativity now in use at leading colleges in the country. In the firm belief that creativity can be taught, Rabinow's panel makes a number of salient recommendations for "educating prospective inventors" in high school and college, and Morse's panel does much the same for "preparing innovators and entrepreneurs." Finally, under the heading "Improving the environment for creativity," Taylor's panel report not only rises above the usual limitations of group effort but prompts a lively closing discussion that is by no means devoid of novelty.

An appendix listing the participants and their connections reads like a Who's Who in Engineering Education and Related Fields. Such apparent catholicity makes it the more puzzling to note that the list includes essentially none of those primarily responsible for the recent (1968) "Final Report of the Goals Committee" of the American Society for Engineering Education!

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