they led to unsatisfactory conclusions, and I have long since decided that, on the analogy of generalized Lagrangian coordinates in classical mechanics, only a posteriori meanings can be found.

The exposition is mainly verbal, but mathematical formulas are quoted as needed, usually without detailed proof. There are also 22 notes at the end of the book that expand in detail points raised in the text. It is clear from his comments that North understands the underlying mathematical theory very well. Nevertheless it must be recorded with regret that the formulas contain a quite unusual number of misprints. Plus and minus signs are interchanged, indices are omitted or incorrectly printed, capital letters become lower case in successive lines, brackets are misplaced, and so on. The misprints are merely a source of irritation to the expert reader, but they might well prove to be a serious obstacle to a student. It is also surprising to see Oxford University Press allowing, in the text, so many misprints of the "fron" for "from" variety. I believe that the book is of permanent value, and it would be highly desirable to correct all misprints before further printings are made. I have also noticed two places where I cannot follow the mathematical argument. On page 108, I am unable to deduce equation (30) —in which "sin" is misprinted for "sinh"—from (29) and the information contained in equations (27) and (28). If τ (or should it be T?) and R are independent coordinates, the derivation cannot be made. There must be some unstated condition about the relation between τ and R. On page 346, I do not believe that the attempt to prove the transitive property for luminosity distances is legitimately made from equations (17)—here R^k is misprinted for R_2. Luminosity distances are applicable to a set of luminous sources viewed at the same instant of time by a single observer. North wants to combine luminosity distances calculated by observers located at different places and at different times. I would say that this is an illegitimate use of the concept of luminosity distance. Nevertheless, in spite of these defects, the book can be heartily recommended to all students of cosmology.

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Science and Technology and the Less-Developed Countries

Science and Medicine in Central Africa (Pergamon, New York, 1965. 1008 pp., $30), edited by George J. Snowball, is a collection of papers that were presented at the Central African Scientific and Medical Congress held at the College of Further Education (Lusaka, Northern Rhodesia) in August 1963. The Congress brought together scientists of widely divergent interests in the manner of the United Nations Conference on the Application of Science and Technology for the benefit of the less-developed countries.

The subject matter covers the physical, biological, social, and medical sciences. Some of the papers are presented in full, others in abstract form only. At the beginning of most papers there is a short explanatory statement which will assist the reader in selecting the papers of particular interest to him; these statements will also enable the reader to understand the overall complexity of attempting to change cultural patterns.

There is a fascinatingly wide range of information in this book for anyone interested in the problems of newly emerging nations. The authors represent a judicious mixture of scientists steeped in African affairs and scientists from the wider world.

Agricultural education is discussed in an opening paper, with emphasis on a three-tier system of agricultural education in Britain, the needs of the fundamental research worker, the critical gap between the research scientists and the farmer, the educational needs of the farmer, and the need for some degree of specialization. The lessons of Britain have meaning for Rhodesia.

The need to teach the fundamental sciences to all school pupils is stressed in another paper. The planning of medical care services is discussed in relation to lessons learned from the mistakes of the National Health Service planning in Britain: namely, that the need for medical care does not decrease, but increases and becomes more expensive.

There is an article on airframe icing on a scheduled flight over the Sudan; geological and ground water research is discussed. A novel method of waterborne sanitation appropriate to much of Africa is presented—a combination of aqua privy and stabilization pond. The sands of Kalahari-type are analyzed and discussed in relation to their origin.

A standard method of vegetation classification is put forward for consideration—a method that does not involve specialist knowledge and will be a boon for all those working in vector-control, for example. Even the dragon fly, and its role as an economic factor, comes in for discussion. Did you know that crocodiles eat adult dragon flies? Or that termite mounds may be partly created by the erosion of the surrounding land surface, not necessarily by the addition of material from above?

The impact that a changing cultural environment makes on the individual and the stresses engendered by living in two worlds, old and new, is presented. Papers on medicine occupy one fourth of the book.

In toto, this volume attempts to equate the reader with the interaction of the sciences, education, and economics. It presents the need for research in applied science and pure science. Education is a constant theme. But the greatest lesson that this Congress teaches is the interrelationship of the various disciplines, that Africa needs men of broad vision, as well as the specialist, who can relate the contribution of science to the betterment of human life. It is a must for those interested in Africa. More such interdisciplinary conferences are required; but they should be convened with defined objectives and a strictly limited series of papers.

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Respiratory Physiology

Cerebrospinal Fluid and the Regulation of Ventilation (Davis, Philadelphia, Pa., 1965. 456 pp., $16.50), the proceedings of a symposium held at the Downstate Medical Center, State University of New York, in April 1964, has been published under the editorship of Chandler McC. Brooks, Frederick F. Kao, and Brian B. Lloyd. The symposium brought together scientists, from western Europe and the United States, who were interested in the role of the cerebrospinal fluid (CSF) in regard to respiratory physiology. Fourteen papers presented at the con-

ference, and the discussion by participants following each paper, are included in the text, and Dawson, Bering, and Welch have submitted supplementary papers on the formation, circulation, and drainage of the CSF and on the transport of materials by the choroid plexus.

The keynote of the opening remarks was a word of appreciation for Hans Winterstein who originally expressed the possible interrelation of the hydrogen ion of the CSF on respiratory ventilation. More than 50 years have elapsed since the formulation of his reaction theory embodying this concept (1911), and this symposium stressed that the complete stimulus to respiration is still not understood. The editors reflected that all authorities invited to the conference concluded that the state, composition, and nature of the CSF affected ventilatory functions. However, certain authors still held the classical concepts of peripheral and central ventilatory controlling devices as the key factor and could not accept the hydrogen ion of the CSF as the sole driving mechanism. Much new and refreshing interest in the CSF was engendered, and an interesting thesis was submitted—that the brain cell environment is the important factor in determining ventilatory reactions and the control of respiration is entirely secondary to affording a brain cell its proper chemical environment. Great interest was centered about the role of the chemoreceptor cells, which are either close to or interconnected with the CSF. Pappenheimer expressed this well in the following statement: "With regard to surface receptors, this I think is at the heart of our symposium and is extremely important to it." Studies on individual factors in the CSF—such as electromagnetic force, ion exchange, and change of constituents from its source to the surface of the brain cell —are needed for the basic understanding of the CSF; perhaps it is more truly the *milieu interieur* than ever before understood. I was surprised to learn that most authors now believe ion exchange from blood to brain or CSF and vice versa is more rapid than was previously believed.

This volume is of great importance to all respiratory physiologists and also a much needed text for those interested in the basic roles of the CSF.

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Market Economics of Maize in Tropical Africa

Maize ranks after cassava and the millets (*Sorghum* and *Pennisetum*) as a food source in tropical Africa, but owing to its palatability and the ease with which it may be transported, its commercial ramifications are more widespread than those of either of its rivals. A book on the subject therefore needs no apology, but the choice of title for this one, **Maize in Tropical Africa** (University of Wisconsin Press, Madison, 1966. 345 pp., $7.50), by Marvin P. Miracle, is most unfortunate. It is a surprise to find that agricultural and ecological matters are dealt with in the most superficial manner, and a more explicitly worded title would have indicated that the book is in fact a treatise on market economics. Indeed maize is barely mentioned in the first 80 pages, which are devoted to a miscellany of introductory topics concerned with farming, marketing, and levels of living in Africa necessary to set the economic scene for the newcomer to the continent. This is followed by detailed quantitative studies of maize production. The pan-African scope of this survey renders it rather indigestible fare for the agricultural reader, for the discussion lacks the depth necessary to expose the agronomic problems of the different territories. Among these are the ability to maintain soil fertility under increased production of a demanding crop like maize, and the economic consequences of extending production into climatic regions where statistical studies of rainfall reliability can predict a proportion of crop failures due to drought.

The last three chapters—on economic determinants of production, efficiency of production, and marketing—are of more interest to the agriculturalist, for they suggest future trends in the production and consumption of maize, and how they are likely to be influenced by innovations. An increasing preference for maize as a food has led to a striking rise in consumption during the last few decades, but a nascent taste for wheaten bread may raise an uncomfortable question mark over the future of all indigenous staples. It is perhaps worth remembering that under the British colonial policy of concentrating on export crops, maize was usually the only staple given serious attention by agricultural departments. With independence has come a belated awareness of the importance of subsistence crops, and the consequent improvement programs may well restore the balance in favor of millets and other indigenous staples.

To sum up: an interesting sourcebook of statistics, but heavy going and flying false colors.

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Ecological and Behavioral Studies of Social Insects

Social Insect Populations (Academic Press, New York, 1966. 143 pp., $6), by M. V. Brian, is an attempt to synthesize and review the abundant recent literature pertaining to ecological and behavioral studies of bees, ants, wasps, and, to a lesser extent, termites and the honeybee. It is the first such review published since 1937, and it covers the literature since that time. The author's intentions are to " . . . bring together a large number of disconnected observations on populations of social insects and to encourage a comparative approach in the future." The extensive literature survey accomplishes his first goal. More than 425 papers are cited in the 18-page reference list and are referred to extensively throughout the text. The comparative approach is evidenced by the arrangement of the book. Each topic is discussed in relation to each social insect group.

Emphasis is placed on those factors that are peculiar to social insects, and these are reviewed in the manner by which they may affect the population of the colony. The chapters are "Numbers and density," "Reproduction," "Brood periodicity," "Age structure," "Dynamics: Worker turnover," "Geometric growth," "Intrinsic limits," "Maturation," "Dynamics: Queen turnover," "Structural limitations," "Food supply," "Intraspecific competition," "Interspecific competition," "Intergeneric competition," "Predators and parasites," and "Population regulation." Foraging, feeding behavior, and caste determination have been omitted since they have been the subject of other, more recent reviews. A numerical approach is used in many cases,