

correlation charts, and 2 maps showing the distribution of the Mesozoic and Cenozoic igneous rocks of Eastern China.

Unfortunately the promising research of these Chinese geologists came to a halt in 1966 because of the "proletarian cultural revolution." This halt does provide an opportunity for Western geologists to catch up with the progress in tectonic thought that Chinese geologists made in the ten years prior to 1966.

POW-FOONG FAN

Hawaii Institute of Geophysics,
University of Hawaii, Honolulu

Nitrogen Source

Urea as a Protein Supplement. MICHAEL H. BRIGGS, Ed. Pergamon, New York, 1967. xii + 466 pp., illus. \$18.

This book includes 23 chapters written by authors from 11 countries, including such notable nutritionists as J. Brüggemann from Munich and A. I. Virtanen from Helsinki. The book is divided rather arbitrarily into four sections entitled History, Manufacture and Role of Urea in World Food Problems; The Effect of Urea on Ruminant Physiology; Urea as a Supplement for Ruminants; and Urea in Diets for Non-ruminants.

The first chapter, on the history of the use of urea in ruminant feeds, by H. J. Stangel of Allied Chemical Corporation, gives an excellent review of the literature reflecting the thorough knowledge its author gained from editing, initially with D. F. Green, the book *Urea and Non-protein Nitrogen in Ruminant Nutrition*.

H. K. Hendrickx compares by in vitro methods the effectiveness of urea with that of other non-protein nitrogen (NPN) compounds and reports the findings from his laboratories and others that urea is second only to certain ammonium compounds and acetamide in utilization in the rumen.

Chapter 4 states that the most serious nutritional lack in the world is protein (although it is probably energy) and implies that urea will provide alleviation of this world protein shortage. The author seems unnecessarily and unrealistically intrigued with the practical usefulness of leaf-protein foods and the supplementation of the residues by urea for ruminant feed. Workers in Africa and elsewhere have suggested, much

more practically, that supplementation of tropical forages with urea is productive of more animal protein for human consumption, an observation not mentioned in this chapter. The statement that there is no way of measuring the adequacy of diets for the adult is in disagreement with many years of research in quantitative nutrition.

The second section of the book is devoted primarily to the subject of urea and protein synthesis via rumen microbial fermentation. The excellent initial chapter by H. M. Schwartz points out that under non-urea dietary conditions there are a number of natural NPN sources, including urea from saliva and the bloodstream, which are converted to protein in the rumen. Ammonia is perhaps one of the most important NPN compounds discussed because it is the principal source of nitrogen utilized by the rumen flora and arises from both dietary protein and NPN sources. The retention by the ruminant of blood urea under low protein intakes as investigated by Livingston *et al.* and by Schmidt-Nielsen is discussed in the chapter on ureolytic rumen bacteria. This is a very important factor in tropical nutrition. The chapter by Brüggemann on the effect of urea on rumen microbiology and metabolism is one of the most thorough chapters, with an extensive bibliography. A chapter on the endogenous urea cycle in the ruminant by H. Le Bars follows logically. Nobel laureate A. I. Virtanen discusses experiments from his own laboratory on the production of milk by cattle on protein-free rations containing urea.

Part 3 covers some of the more applied aspects of urea as a feed supplement for ruminants. It contains a chapter by Rys from Krakow presenting a thorough review of urea utilization by dairy cows, a matter over which there has been a great deal of controversy because of the high protein needs for milk production. There is a short chapter on the feeding of urea to buffalo and zebu cattle, and a long chapter on urea in rations for fattening lambs, plus chapters on beef cattle. One of the best and most interesting chapters is one by E. C. Owen dealing with relationships among urea and other dietary constituents. Of particular importance and significance is the relationship between nitrogen source and cellulose digestion. A chapter on additives includes a discussion of much-advertised ethanol, which apparently has no useful effect. The important idea of the addition of

urea to silage is discussed by J. W. Ryley. The final chapter in this section establishes, with certainty, the lack of any relationship between dietary urea and vitamin A nutrition, laying to rest another in the multitude of dietary interrelationships, almost all of which turn out to be indirect or nonexistent, leaving some few, like protein-energy and thiamine-carbohydrate as realities firmly based on biochemistry.

The last section, devoted to urea in diets for non-ruminants, discusses the demonstrated ability of urea to provide the nitrogen required for biosynthesis of nonessential amino acids when added to a diet low in protein but adequate with regard to all the essential amino acids. This experiment was discussed at the University of Wisconsin as early as 1939 and was reported by Lardy and Feldott in 1949.

While unevenness and considerable overlapping among chapters are evident, many chapters are very thorough, well-written, critical reviews. I believe the book will prove of real value to all people working in the field of ruminant nutrition, particularly those in countries that are just developing an active animal agriculture and wherever protein sources for ruminant feeding are scarce or costly.

B. CONNOR JOHNSON

Department of Biochemistry,
University of Oklahoma Medical
Center, Oklahoma City

Improving Farm Animals

Genetics and Animal Breeding. IVAR JOHANSSON and JAN RENDEL. Translated from the Swedish edition (Stockholm, 1963) by Michael Taylor. Freeman, San Francisco, 1968. xii + 489 pp., illus. \$17.50.

After World War II new books and journals appeared in almost every field of science. In the field of animal breeding, however, comparatively little has been published. The texts of Winters and Rice are far out of date, and though the works of Lush, Lerner, Falconer, Hutt, and Lerner and Donald offer good reference material in their specialized fields, there has been a great need for a textbook on animal breeding. Johansson and Rendel's new text therefore is most welcome, since it summarizes the development of animal breeding over the past 40 years and supplements it with new theories and concepts. Now that