three stages of the Wilton stone tool industry. The fourth of these is historic, from the time of the Bantu invasions of the period between A.D. 1450 and A.D. 1650; they show battle scenes. The fifth style, which is decadent, dates from about 1820 until the present and consists of clumsy copies, mostly by Bantu herdsmen, of earlier works.

For the rock art of South Africa itself we return to Frobenius in his *Madsimu Dzangara* (Pictures of the Forgotten Ones). Working without chronology and disregarding artifacts, Frobenius concentrated on styles. He finds two, the so-called Wedge style of the Transvaal and adjacent parts of Southern Rhodesia and the South African style proper, which extends to the Cape.

The Wedge style, also noted by Goodall and Cooke, is an elegant and delicate one reminiscent of some of the finer work of the Domestic Animal period of the Sahara. The name *wedge* is used because the torsos of the human figures are triangular. The artist filled in the wedge by applying thin stripes of red next to each other, working from right to left, adding the outline last. In some cases white dots or stipples were added over the stripes, and such dots were also used separately, apparently to indicate rain. The torso is shown front on, the heads and faces in profile, as in Ancient Egypt. Features are conventional, limbs spindly. Human heads show wigs, animal masks, or headdresses, or they are only dots, and sometimes limbs are missing. Animals are few and lifeless; most animals shown in these pictures were painted over them later. These wedge-style pictures are mostly landscapes, with granite boulders, plants, trees, and lakes.

The principal theme of these compositions is death and funeral rites. Bodies are wrapped in skins, with masks, ornaments, funeral gifts, sacrificial animals, rocks of the burial place, and a tree from which embalming oil is drawn. According to Frobenius' interpretation, which is based on local mythology, some show the holy lake, the source of all life and of the afterworld. Others show the brother and sister who married and became the first rulers, and the brother walking in the holy lake. In a rain ceremony a princess is buried under a tree in time of drought, the tree grows to the sky, and a weather snake comes out of the leaves to transform himself into clouds and rain.

Frobenius traces the origin of these pictures to the Monomotapa Empire of the 16th century, and beyond it to the legendary and greater empire of the Moon Kings, through the legends of the Mwutesi, their supposed descendants. He traces their culture back to Egyptian and Western Asiatic influences by way of the "Southern Erythryote" culture first seen by the Portugese.

The South African style resembles the Domestic Animal style without the domestic animals. It employs many techniques from simple silhouettes to shaded, foreshortened polychromes. The animals are lively and realistic, the people engaged in hunting and in processions. Some of the human figures are painted in stripes, like those of the Wedge style, but the stripes go from left to right. This is proper Bushman art, which was abandoned when the Bushmen were forced onto the rockless desert.

In "The rock art of South Africa" (in the Bandi volume, pp. 153 to 203), Erik Holm supplies the mythological interpretation of the South African art which Frobenius did not. He sees in the paintings the Bushman's creator, Mantis, depicted either as an insect or an eland; the sky; and the stars which are dead animals and people awaiting reincarnation. Short legs on an animal show the waxing moon, and when the moon is full the legs are long. He sees the representation of a legend in which the rhinoceros bursts the spleen of another animal with his horn and scatters the bile. This same scene he also identifies in a Lascaux painting. Foreshortening, he says, is done not as an art effect but to illustrate a myth. Rain myths are shown in the form of an elephant, who becomes a great black cloud, and water falls from him, just as he squirts it from his trunk.

These pictures, says Holm, are not totems for the Bushmen have none. Nor were they painted for the material purpose of getting game (comparable to commercial art), at least in a conscious sense, but they show instead the essential unity of man and animals in the universe and their interchangeability. They were drawn to express the artist's emotion in terms of myths as vehicles. The Bushmen painted them over and over, "killed" them, and renewed them. The animal headed figures are neither shamans nor sorcerers, they are gods. Plump women were not drawn for fertility but through sheer exuberance at the blessings of life, for fat means food. "Idyllic animal scenes," he remarks, "suggest an Elysian existence in the midst of nature . . . ," and in this Holm makes wonderful sense.

Andreas Lommel's "Rock art of Australia" (in the Bandi volume, pp. 235 to 301) deserves a review of itself apart from this African symposium. In it he supports Erik Holm's interpretations through the knowledge of what actually happens when a hunting people create rock paintings. They represent their ideas of creation; of man's relationship to the landscape, to other animals, and to the endlessness of time and the permanence of timeless events. They paint over their rock faces again and again, seeking to reestablish and renew man's wholeness with the universe and stand as monuments to the lost wisdom of the ancient hunters.

Biostratigraphy

Principles of Zoological Micropalaeontology. vol. 1. Vladimír Porkorný. Translated from the German edition (Berlin, 1958) by K. A. Allen. John W. Neale, Ed. Pergamon, London; Macmillan, New York, 1963. xvi + 652 pp. Illus. $17.50.

The translation of the 1954 edition of *Základy Zoologické Mikropaleontologie* into an expanded two-volume German edition in 1958 was acclaimed the world over as a major contribution to the field of biostratigraphy. Now comes the English version of the first volume of the Pokorný texts, but unfortunately only minor alterations were made in translating the German revision into English.

Discussion of the Foraminifera, those protozoans so helpful in dating and correlating sedimentary formations, still comprises a considerable portion (308 pages) of the new publication; however, it is regrettable that the author failed to include references to several important large and small genera and an up-to-date bibliography of the order. As in previous editions, it is puzzling to note that no mention is made of the classifications of Cushman, Galloway, and Glaessner, whose arrangements have been compared and contrasted by most systematists. Likewise, inclusion of recent studies on other groups of fossils which are described in the Czechoslovakian and German editions, particularly the Radiolaria, Thecamoebea, Tintinnina, Chitinozoa, and Hystrichospheres, would have enhanced immensely the

value of the English language translation since their remains are significant in delineating stratal sequences in some geologic provinces.

Notwithstanding these deficiencies, as well as several glaring typographical errors, a few upside down photomicrographs, and an inferior binding, all of which make this weighty volume less attractive than the more compact German edition, a clear presentation of the principles of micropaleontology and microstratigraphy is provided in the introductory chapters on basic terminology and the historical development, collection, preparation, and examination of fossils and their intra- and interregional value in correlation.

It is hoped that volume 2, on the Ostracoda and other well-known microfossils, soon will be available in English, for the wealth of material in its 453 pages is indispensable to the academic and commercial microscopist.

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Classic Papers on Genetics

Papers on Human Genetics. Samuel H. Boyer, IV, Ed. Prentice-Hall, Englewood Cliffs, N.J., 1963. x + 305 pp. Illus. $9.

In line with the current fashion of collecting, for ready reference and study, classic papers in a discipline, Boyer, a member of the very active Johns Hopkins group, has put together his selection of the contributions to human genetics which have oriented and stimulated the science. Those of us who have had the privilege of reading most of these papers when they first appeared find it a real pleasure to have them available under one cover. For the relative newcomer in the field, the collection should be of great value in developing an understanding of the origins, intuitions, inferences, pitfalls, deductions, and rigid investigations which have combined to bring human genetics to the outstanding position that it holds today.

Part 1 contains Weinberg's demonstration of equilibrium and Lenz's exact treatment of the role of consanguinity, classic papers indeed.

Part 2 deals with human blood groups and presents Landsteiner's original contribution (1901) as well as the Hirschfelds' historic paper on racial distribution. The Rh factors are represented by the works of Levine and Stetson and by that of Landsteiner and Wiener. A paper by Watkins and Morgan considers group-specific substances. I wish Bernstein's very basic and important contribution had been included.

Part 3 is concerned with studies of biochemical genetics: the original papers on alcaptonuria, phenylketonuria, and galactosemia; a series of papers on the hemoglobinopathies; and a selection of contributions on the serum proteins. Although population genetics is not given a specific part in the volume, some of the papers in part 3 deal with this phase of human genetics.

Part 4 is devoted to recent papers on human chromosomes and the anomalies that result from their aberrations. Mary Lyon's excellent contribution to the problem of sex chromatin and gene action is included here.

Part 5 deals with mutation and contains papers by Penrose and by Schull and Neel.

Part 6 is a reprint of Leslie Dunn's provocative presidential address made to the American Society of Human Genetics (1961).

An interesting vignette by the editor precedes each selection and adds immeasurably to the value of the collection.

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Analytical Chemistry

Ionic Equilibria in Analytical Chemistry. Henry Freiser and Quintus Fernando. Wiley, New York, 1963. xiv + 334 pp. Illus. $4.95.

Everyone who teaches analytical chemistry knows the feeling of resignation with which he approaches the topic of equilibrium calculations. He struggles with freshmen and sophomores, again with seniors, yet again with graduate students. The difficulty arises because ionic equilibria cannot be reduced to one simple all-purpose formula, nor are they amenable to rigid mathematical treatment. Even simple acid-base problems include hydrogen-ion concentrations to the third or fourth power, and to describe the titration of zinc ions with EDTA in an ammonia buffer, for example, requires 10 equilibrium constants. That most practical situations can be described quite adequately by simple approximate equations saves a chemist from going crazy, but it is the art of making these approximations that baffles the student.

For a very long time there has been a need for a book devoted exclusively to the calculations of ionic equilibria, and now that this book has been written, the authors, Henry Freiser and Quintus Fernando, deserve the heartfelt thanks of all teachers of analytical chemistry. The book is written for students who know a little physical chemistry but who have no special knowledge of electrolytic solutions. Activity coefficients and the calculation of "concentration quotients" from thermodynamic equilibrium constants are considered in chapter 3, and the problem of approximations to solve high-order equations in chapter 4. Here an error of ±5 percent is arbitrarily selected as that to be allowed in calculations in this book.

To judge the validity of approximations one must know the orders of magnitude of the various ionic and molecular concentrations. To show these concentrations the authors have made generous use of logarithmic graphs, including potential-*p*H diagrams. Acid-base, oxidation-reduction, and complexation equilibria, as well as separations by precipitation, solvent extraction, and ion exchange are discussed. Each chapter has a very fine set of problems, including some that are worked out in the text, and the tables of equilibrium constants and standard potentials at the end of the book are unusually extensive.

There is one strange omission from the literature citations: "Hydrogen Ion Concentration" by J. E. Ricci (1952), which is surely the definitive work on acid-base equilibria in aqueous solutions. The problems of liquid-junction potentials and activities in mixed electrolytes are not mentioned, and these will make the allowed error of 5 percent unduly optimistic for many practical cases. Hydrogen-ion concentrations, rather than activities, are calculated. Of course the calculation of single-ion activities requires extra-thermodynamic assumptions, but these are implicit in the whole concept of *p*H.

My main criticism is that the book might have been more clearly written. Complicated equations are used where simple ones would suffice; there seems