DISCUSSION

LARGE NUMBERS USED BEFORE THE CHRISTIAN ERA

FOREIGN missionaries and others have frequently called attention to the very limited number developments among some of the uncivilized tribes of recent times. In many cases it has been reported that such tribes could not count as far as ten, and that members thereof frequently referred to even very small numbers by means of such general terms as many or infinite. As people advance in civilization they naturally use the latter of these terms for larger and larger numbers. Hence it may be of interest to note here a few instances where very large numbers were used before the Christian era, especially since some statements in recent American histories of mathematics convey decidedly incorrect impressions along this line.

Even in our day we meet with expressions which imply that the grains of sand on the seashore can not be numbered. It is therefore of interest to recall that Archimedes, who is commonly regarded as the greatest mathematician of antiquity, wrote a work called "The Sand-reckoner" in which he developed a system of numeration which is not only amply extensive to provide different numbers for every pair of grains of sand on earth, but which provides such a vast number of numbers that those required for the enumeration of these grains of sand is a comparatively insignificant part of the available total. The multitude represented by "the sand of the sea" is therefore insignificant in comparison with the multitude of numbers described in a work of Archimedes written more than two centuries before the beginning of the Christian era.

It may be of interest to observe that each of the two Greek mathematicians who are commonly regarded as most eminent in the remarkable period of early mathematical development has associated with his name an extensive system of numeration. The second of these is Apollonius who was a contemporary of Archimedes and used 10^4 as the base of a system of numeration while Archimedes used 10^8 for this purpose. These arithmetic developments are the more worthy of note here in view of the fact that the Greeks are especially noted for their contributions towards the development of geometry. Their contributions towards the development of arithmetic and algebra have perhaps received too little attention in the past as a result of undue credit to the Hindus and Chinese who have made many claims for discoveries which have proved to be unreliable.

In the favorably known "Vorlesungen über Geschichte der Mathematik" by M. Cantor the statement appears that it is probable that the cuneiform notation for numbers used by the Babylonians did not extend as far as one million—at least no such large numbers had then been found. A similar statement has naturally been introduced into many other works on the history of mathematics. Much larger numbers have, however, been found later in this notation, and it is very interesting to note that these extend to $60^8 + 10.60^7$, and thus suggest a connection between this system and that of Archimedes based upon 10^8. At any rate, we have here an instance of the use of a very large number by the ancient Babylonians even if it is much smaller than those used later by the ancient Greeks. In fact, the ancient Hindus and Chinese are also said to have developed a system of enumeration based on as large a number as 10^{53}, but many of the dates relating to early mathematical developments in these countries seem to be uncertain.

The main object of the present note is to direct attention to the early efforts to exhibit linear order in this world by means of large numbers and thus to extend the field to which the considerations relating to finite multitudes apply. The use of large numbers represents an intellectual emancipation from the narrow channels of experience, for if all the human beings that have ever lived on this earth had assisted each other in counting consecutive numbers, each one confining himself to the numbers not counted by any of the others, they would not yet have reached the enormous totality which the system of Archimedes made available. While the contemplation of systems of numeration relating to large numbers is inspiring it has not been as rich in fruition as regards the later development of number theory as some other very early theoretic considerations relating to numbers, for instance, the contemplation of what are known as Pythagorean triads, which seem to have attracted attention at least as early as 4000 B. C.

G. A. MILLER

UNIVERSITY OF ILLINOIS

SOYBEAN CHEESE

IT is probable that the Chinese are the best empirical dieticians in the world. In the course of their thousands of years of civilization the Chinese have accumulated an amazing knowledge of the preparation of foods. This knowledge they have handed down from generation to generation with the greatest fidelity, in recorded and printed form in their cyclopedias and in actual practice from master to apprentice.

The interpretation of these dietary practices in terms of modern science is now under way, with the prospect that the Chinese people themselves will learn how to carry out their established dietary

practices more effectively and more profitably and that after the soundness of these practices has been demonstrated by scientific experiment the rest of the world will receive from China important contributions to knowledge.

At any Chinese restaurant in America one may obtain, by asking for it with sufficient diligence, a cheese made not from the animal protein of milk but from the vegetable protein of the soybean. Persistence in the asking is usually required, because the Chinese manager of the restaurant keeps this food on hand for his own use. It is only in rare instances that his American customers know of it or ask for it.

Soybean cheese is highly salted and its use by the Chinese corresponds very closely to our use of Roquefort cheese. The Chinese do not serve salt on their own tables, but they salt and at the same time season their food by the addition of one of two substances, soybean cheese and soybean sauce. The latter is a brown, salty liquid, also prepared from the soybean. Soybean cheese is excellent when served with salad, meats, vegetables or bread.

Protein is extracted from the soybean in the form of a milky liquid by a process of grinding, boiling and straining. From the soybean milk prepared in this manner the protein is coagulated or precipitated in the form of a white curd by the addition of brine made from impure salt containing as impurities magnesium chloride and calcium chloride, just as cheese curd is precipitated from cow's milk by the addition of rennet. From the soybean curd soybean cheese is made through the process of fermentation described in a forthcoming paper on "A New Species of Mono-Mucor, *Mucor sufu,* on Chinese Soybean Cheese." The author of the paper, Mr. Nganshou Wai, chief chemist of the National Hygienic Laboratory, Shanghai, is a native of Chekiang Province, China, and was graduated in 1924 from the Japanese Imperial University, Kyoto, where he became specially interested in biochemistry. He then worked for two years in the laboratory of Professor Genitzu Kita, at Kyoto, whose studies of fermentation are well known.

Mr. Wai has isolated from soybean cheese a mold which uniformly accompanies the proper fermentation of this cheese, has grown the mold in pure culture, and by inoculating fresh soybean curd with it has produced soybean cheese of characteristic flavor and texture. The original account of the experiments was published in Chinese, with illustrations, in December, 1928, in the Agricultural Journal of the Agricultural College, National Central University, Nanking. Mr. Wai's present paper, an abstract of the original, is the first presentation in English.

FREDERICK V. COVILLE

MANGANESE TOXICITY IN TOBACCO

DURING the season of 1928 peculiar abnormal physiological symptoms appeared on tobacco plants grown in soil in the greenhouse at the Connecticut Agricultural Experiment Station at New Haven. The symptoms were compared with similar symptoms occurring on tobacco plants grown in water and sand cultures at the Tobacco Substation in Windsor, Connecticut. At this latter station a study was made on the effect of manganese on the growth of tobacco. It was found that injury to the plants occurred in water cultures at a concentration of 1 p.p.m. of manganous sulphate, while in sand cultures the injury first occurred at 80 p.p.m. In comparing the symptoms of the injury on plants from the two stations they appeared to be fully identical. Complete analyses were made of the soils used in the New Haven experiment and they were found to be normal except for a high content of soluble manganese and also a high acidity. Later analyses were made of the soils under different fertilizer treatments and also of respective plant material grown on them. A definite correlation was established between reaction of the soil and manganese content of the plant material, *viz.,* the higher the acidity, the greater the percentage of manganese found in the plant material.

In order to determine more definitely that manganese was causing the toxicity a soil of very low content of soluble manganese was placed in a greenhouse flat and planted to tobacco. The plants were watered with a weak (0.5 per cent.) solution of manganous sulphate. The resulting growth was fairly normal and showed only slight evidences of the peculiar symptoms previously noted on plants in the greenhouse pots. Analyses of the soil and the plant material showed considerable amounts of manganese in both cases. The acidity of the soil, however, was not high. More plants were set in the same soil and watering with weak manganous sulphate solution was continued. In this case the growth was identical to that observed on the plants in the greenhouse pots. On analysis both the soil and the plant material contained very high amounts of manganese and the acidity of the soil was higher than in previous tests.

The manganese injury in tobacco may be described as follows: The leaves are sometimes normal in shape and size but are often distorted and dwarfed. The top leaves at first have a yellow-green color. When the leaves are fully developed the yellowish color is minutely distributed in the interspaces of the finest ramifications of the leaf veins, which long remain green. The color grows paler toward the tip. In later stages the entire leaves take on a more yellow color, but the "pattern" remains the same. In still