that even the most common fertilizing materials will have varying effects on the different soil types.

Much of the work of the past has been carried out with a complete disregard of the particular soil conditions; the results of field experiments, greenhouse tests and laboratory investigations have been quite generally interpreted as applicable to all soils. While extreme differences in soils, such as occur between sands and clays, were recognized, there was a decided tendency to look upon "any soil as soil." An examination of the voluminous soils literature of the past will bear out this statement. For example, the results secured by one investigator may not be checked by another, and each, then, may privately suspect the other of inaccurate work, even if they do not go as far as to engage in a polemical dispute in some scientific journal. The Bureau of Soils' toxic theory of soil fertility, the acid phosphate-rock phosphate dispute, the character of soil acidity, the cause of soil infertility, the protozoal theory of the Rothamsted investigators, the plant disease theory of Bolley and a host of other interesting and important questions have not been settled because it has been attempted to dispose of them without regard to the soil types involved.

There are, of course, certain principles which may be found to be applicable to all soil types, to all soil series, to all soil families or to all soil orders, but they can not be accepted as applicable by mere assumption. Investigations must be carried out on each type. Obviously, such principles can not be enunciated, therefore, for many years to come. Not even for a limited area will it be possible to lay down laws until investigations have been continued over a long period of time. There are over two hundred soil types now mapped in Iowa, and before the survey of the state is completed there will be many more. In the United States there will undoubtedly be many thousands of types.

But soil investigators are not at all alarmed by the amount of work which is thus indicated to be ahead of them. Rather are they enthusiastically accepting the "new soil science" and planning and carrying out their work on the modern basis, knowing that their results will not be misinterpreted, will not be discarded because of being inapplicable to all soils and will not be merely an evidence of wasted effort. They can be confident that they are adding to the sum total of human knowledge and eventually in the distant future they will have played their part, contributed their quota toward the establishment of the principles and laws of soil science.

While the investigations of the past have added much to the present-day knowledge of soils, the studies of the present are accumulating facts upon which laws can be formulated. The modern concept of soil science has literally brought all soils work "down to earth," and the future can be faced with confidence. No more will there be any question of whether or not soil science is a real science. No more will investigations be criticized on the basis of being inapplicable to all soils. Work on one soil type will be recognized as of value. The "new soil science" is scientific; it is distinct; it is permanent, and, finally, it is definitely and undisputably agriculturally practical.

RECENT PROGRESS IN THE HISTORY OF ANCIENT MATHEMATICS[1]

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NOT much more than one hundred years ago the united efforts of a large group of European scholars unraveled the mysteries of the Egyptian hieroglyphics and hieratic characters, and only a little while thereafter in a somewhat analogous manner the mysteries of the Babylonian cuneiform writing were revealed. By these efforts two absolutely dead languages were placed among the living languages of the world of scholarship. These achievements must always be accounted among the greatest accomplishments of the human intellect, restoring Egypt and Babylon to participation in the telling of the history of by-gone ages.

In the early days of Egyptology the Rhind mathematical papyrus was discovered and translated, based upon the recently deciphered hieratic writing. In Babylon the tablets of Senkereh, with tables of squares and cubes, gave a significant bit of material about Babylonian mathematics. In both instances these were accidental documents whose preservation and discovery were somewhat a matter of chance.

Concerning certain developments of Greek mathematics particularly with respect to the development of arithmetic and algebraic ideas the information available has long been fragmentary and to some ex-

[1] Address delivered before the Michigan Education Association Institute, Ninth District, Mathematics Section, October 28, 1929.

tent unsatisfactory, largely, doubtless, because the histories of mathematical subjects written about the time of Aristotle are lost.

Since the dawn of the twentieth century an amazing amount of new material has come to light to increase our knowledge of Egyptian, Babylonian and Greek mathematics. Doubtless the discovery of the lost work of Archimedes, "The Method Treating of Mechanical Problems," is the most significant addition of the period. On the one hand, this discovery indicates that the work of the superlative genius, far in advance of his contemporaries, to a large extent fails because of lack of appreciation and of continuation; on the other hand, the fact that a noteworthy work of a popular genius like Archimedes could vanish indicates that hundreds of documents of men less famous in their own day have absolutely disappeared. The studies of the late Karl Schoy and the studies of Dr. Julius Ruska and others have also added new Greek material through Arabic sources.

Here at the University of Michigan we are able to record the discovery of a notable addition to our information concerning the algebra of Greece.[2] Among the papyri acquired by that indefatigable friend of learning, Professor Francis W. Kelsey, was one of the second century of the Christian era which gives a series of algebraic problems. These form the logical continuation of problems found in Egypt and problems analogous to those of the so-called Greek Anthology, and the problems of Diophantos. This document was translated by Professor Frank E. Robbins, who permitted me to collaborate in a popular exposition of the papyrus appearing in SCIENCE. Another document[3] which has been published from the Michigan collections is in a way of minor importance and yet indicates both the continued Greek use of the unit fractions of the Egyptians and the method of that use.

A new translation and study of the Rhind papyrus has been made by the distinguished Egyptologist, T. Eric Peet,[4] of Liverpool. This work throws much new light on the ancient document. We are even to-day eagerly awaiting the facsimile and translation of this document being published under the sponsorship of the Mathematical Association of America by Chancellor A. B. Chace, of Brown University, with the scholarly assistance of Dr. Ludlow Bull, of the Metropolitan Museum, and Professor H. P. Manning, of Brown University. And even with more impatience we await the complete translation of the Moscow papyrus, by Struve, of Leningrad, which will doubtless throw a wealth of light upon Egyptian mathematics as indicated by the few fragments already published.[5] Touraeff in 1917 gave from this Moscow papyrus the volume of the truncated pyramid as $1/3\ h(a^2+ab+b^2)$, and Struve adds an equally amazing formulation for the surface of a hemisphere as $2\pi r^2$. Heretofore no historian has suspected that the empirical knowledge of these formulas was not the undisputed achievement of Greece. Indeed, concerning the volume of the pyramid Archimedes, himself the reputed discoverer of the second of these theorems, ascribes the first statement of the first theorem to Democritus and its proof to Eudoxus. It is quite probable, also, as I pointed out in my translation of Touraeff's article, that the Moscow papyrus may show that the Greek work given in Euclid's Data on construction of rectangles and application of areas is logically connected with early Egyptian mathematics. Notably the well-known Egyptian problem on the distribution of a square of 100 square units into two equivalent squares whose sides have a given ratio is a beginning along this line, and the Moscow papyrus evidently refers to other similar material.

Only a few months ago the historians of science were delighted to receive the first issue of a new journal in the field of the history of mathematics, *Quellen und Studien zur Geschichte der Mathematik*, edited by O. Neugebauer, of Göttingen, J. Stenge, of Kiel, and O. Toeplitz, of Bonn. The publisher is Julius Springer in Berlin. The amazing nature of the contents of the first issue of this journal has been indicated in SCIENCE by R. C. Archibald.[6] Some time ago I called attention to the notable additions to our knowledge of Babylonian mathematics which were summarized in the work of Bruno Meissner.[7]

In the article of 1929 in the above-mentioned journal and in an article "Über vorgriechische Mathematik"[8] Dr. Neugebauer adds to the available material on the mensuration of circles, of triangles and of trapezoids. However, the most significant and almost revolutionary announcement is the discovery among the early Babylonians of the numerical solu-

[2] L. C. Karpinski and Frank E. Robbins, "Michigan Papyrus 620; The Introduction of Algebraic Equations in Greece," SCIENCE, September 27, 1929, 70: 311–314.

[3] L. C. Karpinski, "Michigan Papyrus No. 621," *Isis*, 5 (1923): 20–25, with plate.

[4] "The Rhind Mathematical Papyrus," Liverpool, 1923.

[5] B. Touraeff, "The Volume of the Truncated Pyramid in Egyptian Mathematics," "Ancient Egypt," 1917, pp. 100–102; L. C. Karpinski, "An Egyptian Mathematical Papyrus in Moscow," SCIENCE, 57 (1923): 528–529. In the article in SCIENCE I pointed out the importance of the other problems to which Touraeff refers. There is a further article on this work, in Russian, by D. Zinserling, "Geometry of Ancient Egypt," *Bulletin* de l'Académie des Sciences de l'U. R. S. S., 19 (1925): 541–568.

[6] *Babylonian Mathematics*, July 19, 1929, 70: 66–67.

[7] "New Light on Babylonian Mathematics," *American Mathematical Monthly*, 33 (1926): 325–326.

[8] Abhandlungen aus dem mathematischen Seminar der Hamburger Universität, Vol. VII, 1929, pp. 107–124.

tion of a type of complete quadratic equation. The more detailed explanation to appear in a later issue of the *Quellen* is awaited with great interest. With this material is also found new material on arithmetical series and on linear and quadratic equations in two unknowns.

When the Rhind papyrus was issued in 1877 by Eisenlohr the announcement was made that an ancient leather roll of mathematical content was also in the possession of the British Museum. Recently, in the *Journal of Egyptian Archaeology,*[9] S. R. K. Glanville has been able to publish the contents, as improved chemical methods made it possible to unroll the document. The material adds definitely to our knowledge of the Egyptian treatment of fractions. A long series of articles on the Egyptian fractions and other phases of the Egyptian mathematics, notably the beginnings of algebra, has appeared within recent times by Wieleitner, Abel Rey, Kurt Vogel, Loria, Neugebauer and others, as well as more detailed discussion in the books by Peet, by Gillain,[10] and in the work of D'Ooge, Robbins and Karpinski.[11] Doubtless in the new edition of the Rhind papyrus by Chancellor Chace, Dr. Archibald will give a somewhat comprehensive summary of the literature to date.

Any summary, however brief, of recent activities in the field of ancient mathematics and science must include a large group of serious comprehensive treatises which contribute largely to the modern view of the ancient learning. First and most important is George Sarton's "Introduction to the History of Science," a veritable mine of information. Then there are the histories by Gino Loria, Aldo Mieli, Sir Thomas L. Heath and J. L. Heiberg which from varying points of view give a survey of the present state of our knowledge and a background for appreciation of the most recent discoveries.

The writer may be pardoned if in closing reference is made to an article "Algebraical Developments among the Egyptians and Babylonians" which appeared in the *American Mathematical Monthly*[12] more than twelve years ago. In this the writer stated that the material then available indicated a high state of development of mathematical thought in Egypt and Babylon before the golden age of Greece. To-day even more than then, when the assertion represented a somewhat new point of view, it is certain that the indebtedness to Babylon and Egypt often explicitly affirmed by Greek writers is no figure of speech, no rhetorical gesture, but rather an assured fact.

OBITUARY

VICTOR CLARENCE VAUGHAN

THE death of Victor Clarence Vaughan on November 21, 1929, has deprived American medicine and public health of a great leader. He was born on October 27, 1851, at Mount Airy, Missouri. From 1874 until his retirement in 1921 he was connected with the University of Michigan, first as student, then as teacher and dean, during which long period he achieved for himself a rare reputation as a teacher, scientist and epidemiologist.

Dr. Vaughan went to the University of Michigan in 1874, after having taught Latin for two years at Mount Pleasant College, Missouri, where he graduated in 1872. At Michigan he received four degrees: M.S. in 1875; Ph.D. in 1876; M.D. in 1878, and the honorary degree of LL.D. in 1900. Later, other institutions honored themselves by conferring upon him the honorary degrees of LL.D., Sc.D. and M.D.

Dr. Vaughan was president of the Association of American Physicians in 1908 and of the American Medical Association in 1914. He was a member of the National Academy of Sciences, the American Philosophical Society, the French and Hungarian Societies of Hygiene. He also served as member of the House of Delegates of the American Medical Association in 1902, 1903, 1904 and 1906, and of the Council on Medical Education from 1904 to 1913. He was chairman of the section on pathology and physiology in 1902, of the reference committee on medical education in 1904 and of the Council on Health and Public Instruction from 1919 to 1923.

Dr. Vaughan began his teaching connection with the University of Michigan in 1875, as assistant in the chemical laboratory. In 1879 he became lecturer and in 1880 assistant professor of medical chemistry, and in 1883 he was advanced to the professorship. In 1887 he became professor of hygiene and physiological chemistry and director of the newly established hygienic laboratory. To these duties he added, in 1891, that of dean of the medical school. He held this chair and the deanship until 1921 when he retired as emeritus professor.

Retirement from the university did not close his activities. For several years, as chairman of the Medical Division of the National Research Council, he resided in Washington. It was there he wrote his splendid work, in two volumes, on "Epidemiology and Public Health," and in 1926 he produced his living

[9] 13, 1927: 232–239.

[10] "La Science Egyptienne," "L'arithmétique au moyen empire," Brussels, 1927. xvi and 326.

[11] "Nicomachus of Gerasa, Introduction to Arithmetic," Michigan Humanistic Series, Vol. XVI, Chapter I. New York, 1926.

[12] L. C. Karpinski, *American Mathematical Monthly*, 24: 257–265.