DISCUSSION AND CORRESPONDENCE

BABYLONIAN DISCOVERY OF THE PRECESSION OF THE EQUINOXES

RECENTLY it has been shown[1] that the slow motion of the equinoctial points on the ecliptic, called the precession of the equinoxes, was first discovered before the time of Hipparchus, by a Babylonian astronomer *Kidinnu* (sometimes written *Kidenas* or *Cidenas*), who directed an astronomical school at Sippra, on the Euphrates, about 343 B. C. This Babylonian achievement had been suspected for some years, but no definite conclusion had been reached, because of uncertainties relating to the interpretation of astronomical records.[2] The final settlement of this question has become possible by the examination of some new Babylonian tables.

The fact that the astronomer *Naburiannu* (about 508 B. C.) fixed the equinoctial point at 10°, and Kidinnu, about a century and a half later, at 8°, the zero point on the ecliptic being interpreted as the same in both cases, shows that Kidinnu had a knowledge of the precession of the equinoxes. A study of tables indicates that from that time on, in the ephemerides following the system of Kidinnu, the zero point on the ecliptic was shifted from time to time, to enable astronomers to retain the same angular value for the beginning of the autumnal equinoctial years. This again implies a knowledge of precession. A table (VAT 7821) prepared not later than 186 B. C., and based on the Kidinnu system, gives solar longitudes from day to day, differing by 59′9″, an amount in excess of the true average value of 59′8″9‴.6 for a sidereal year, which was estimated by Kidinnu to be $365^{d}6^{h}13^{m}43^{s}$. This excess was corrected in the table by taking on a certain day 56′9″ in place of 59′9″. Thus the computer of the table took the average daily velocity of 59′9″ to yield in the course of one year, not exactly 360°, but an additional 3′. Dividing 360°3′ by 59′9″, and allowing liberally for certain possible sources of error, Schnabel concludes that the year considered by the computer could not have exceeded $365^{d}5^{h}30^{m}$. The modern value for the equinoctial solar year is $365°5^{h}48^{m}45^{s}$. Thus the Kidinnu astronomy had two years, the sidereal and the equinoctial. Kidinnu deserves to be ranked among the greatest astronomers of ancient times.

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[1] Paul Schnabel, "Kidenas, Hipparch und die Entdeckung der Präzession," *Zeitschrift für Assyriologie*, N.S., Vol. 3, April, 1926, p. 1–60.

[2] F. X. Kugler, "Sternkunde und Sterndienst in Babel," II Buch, II Teil, 2 Heft, 1924, Anhang II.

PUBLICATION BY PHOTOGRAPHY

IN connection with Professor Albrecht's article in SCIENCE for December 31, 1926, on "Publication by Photographic Reproduction of Typewriting," it should be noted that the Coast and Geodetic Survey has been using a similar method for some of its publications since 1923.

Attention was called to the possibility of using such a method by a publication of the Topographic Surveys Branch of the Department of the Interior of Canada, "Magnetic Observations in Western Canada," which appeared in 1921. In it the tabular matter, about 270 pages, was all reproduced photographically from typewritten sheets.

The advantages of such a method were recognized at once, not only the great saving in cost, but also the elimination of the tedious operation of proofreading a mass of figures and the inherent danger of errors being overlooked even by experienced readers, and steps were taken to make use of it where possible. The publications giving the results of observations at the magnetic observatories of the bureau consist largely of tables of uniform size and are, therefore, well adapted to photographic reproduction, and the method was given its first trial with them.

The principal tables give for each hour of each day of the year the values of declination, horizontal intensity and vertical intensity, as well as daily maximum and minimum values and daily and monthly means. These quantities are tabulated by months on suitable forms by means of a specially designed cross tabulating machine, the tabulation being made as the quantities are computed. A carbon copy is made at the same time, and this serves as the copy for photographic reproduction, after such changes have been made as result from the revision of the computation. With care in using fresh carbon paper there is no difficulty in securing a good reproduction even when the reduction in size is considerable.

The method is being used successfully in the publication of the quarterly Seismological Reports of the bureau, the issue of which began in 1926. In this case the copy for reproduction is prepared by typewriter, either with or without carbon paper backing.

D. L. HAZARD
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REFERRING to the letter by Dr. Albrecht regarding the advantages of photographic reproduction in publishing, I should like to add my testimony to the excellence of the method for all uses, but especially for tabular matter. The American Jersey Cattle Club has for several years been publishing its tables of production by the animals of the breed it records by this method, and the results are really not inferior to

the ordinary type, though having some of the imperfections that Dr. Albrecht notes. I can easily understand the cheapening in cost he suggests.

Recently I have received a book on this breed, containing considerable tabular matter, but mostly straight reading, made by this process, double spaced between the lines, type of the normal size of the typewriter, printed on one side of the sheet only, which is really easier on the eyes than the ordinary print, excelling even the admirable type used in SCIENCE in that respect.

I thoroughly agree with Dr. Albrecht in thinking that this method, particularly if improved as he suggests, might help to solve the financial problems that often present themselves to the impecunious research man who wants to let other people know what he has been doing.

And while we are about it, why not follow the suggestion of Dr. Metcalf on the same page, and adopt a character to convey the sound of "th"? I would suggest that the adoption of the crossed "h" which he mentions might lead to the same sort of confusion that some of us have experienced in reading the books of the eighteenth century in which the long "s" was used, and the difficulty in separating it from an "f." Why not take one of the letters from other languages, as the Greek θ?

LUCIUS P. BROWN

SPRING HILL, TENNESSEE

IN reference to the suggestions of Mr. Albrecht in regard to photographic reproductions of typewriting, I, some years ago, prepared a special text in physics for freshmen. I was unable to have it published in the usual way because the price of the book to the student would have to be so great that it seemed unreasonable. I then wrote the whole text on the typewriter, attached cuts in their place on the page and arranged with a firm in Cincinnati to photograph each page and make zinc etchings. This they did for $293.00. These were then sent to the Reformatory at Mansfield, Ohio, where the books were printed and bound for $150.00—500 copies. This made a total of $443.00 and the books could then be sold to the students at $1.25, which not only met all expenses but cleared a small margin for the department.

J. A. CULLER

MIAMI UNIVERSITY

EXPLORATION OF THE ETOWAH MOUNDS

THE department of archeology, Phillips Academy, Andover, Mass., has carried on two seasons' exploration at a large village site and mound group in northern Georgia. About one hundred stone graves were discovered which contained some engraved shells, various ornaments, pottery vessels and some engraved copper plates. The eminent authority on Mexican cultures, Mrs. Zelia Nuttall, examined the collection at Andover and suggested several lines of comparison between certain of the human figures and those observed among Toltec and Mayan remains. It is not claimed that any connection exists, but some of the comparisons are exceedingly striking.

Two complete sarcophagi were shipped to the Andover museum, set up, filled with Georgia earth and the skeletons and objects placed in natural position. Five such graves were shipped to other museums and have attracted considerable attention.

Any museum director or curator who wishes one of these graves and its contents can correspond with me at Cartersville, Georgia.

WARREN K. MOOREHEAD

METAPSYCHICS

IN my "Zoology" (1922), page 536, I have given an explanation of the term Metapsychics, which may perhaps later come into more general use. It may be worth while to record the history of this term, before it is forgotten. I published it in *The Dial* (Chicago) of February 1, 1905, page 86, with a definition. In the *Daily Graphic* (London) of February 9, 1905, page 7, I read that quite independently Professor Richet had proposed the same term at a meeting of the Psychical Society. If there is an earlier publication of the word, I have not found it.

T. D. A. COCKERELL

QUOTATIONS

THYROXINE

RECENTLY the Chemical Society resolved to award the Edward Frank Harrison Prize for 1926 to Dr. C. R. Harington, of University College Hospital. The achievement which has earned this tribute from the colleagues of Dr. Harington has been the synthesis in the laboratory of the active principle of the thyroid gland—the substance thyroxine.

It was only in June of the present year that those who follow the literature of chemistry learnt of the progress of his labors, and discovered Dr. Harington on the very threshold of a complete success. Two papers under his name appeared at that time in the *Biochemical Journal*. The first described a greatly improved method for the separation from thyroid tissue of the hormone in a chemically pure state—a method, moreover, which was not found wanting when pursued in an industrial laboratory. The second paper proceeded to the chemical analysis of the pure