ing up hills, or working bicycles or pedals, or standing on tip-toe, or dancing, tires out the calf, produces pain in the hamstring muscle and a weakness in the back. These conditions are not rarely ascribed to ingrowing toe-nails, corns, or a tender foot, while in fact they are the legitimate outgrowths of slowly developing anatomical deformities. Added to the improper shape of the shoe and its

FIGS. 4 and 5.—Adults' feet, showing the advanced stages of deformity. Scale, one-eigth of an inch to one inch.

poor construction, we have the element of bad leather with stiff inflexible joining, all going as important factors of the development of the deformity. The question of the arrest of these changes, the prevention of deformity, lies, of course, entirely in properly made shoes. The shoe should certainly be the same width from the metatarso-phalangeal articulation to the tip of the toe. Crowding should be prevented. The soles should be flat, no heels to jab the foot forward upon the toes. The weight should be transmitted directly to the plantar arch, and not to the ball of the foot. Stockings should be wide and not taper at the toes, having a uniform width as in the shoe from the ball to the tip of the toe; they should be seamless in the area coming in contact with the toes and soles, The texture of both the stocking and the shoe should be pliable, and neither should be worn long enough to become saturated with moisture.

PHONETIC VALUE OF THE *CH'I* GLYPH IN THE MAYA GRAPHIC SYSTEM.

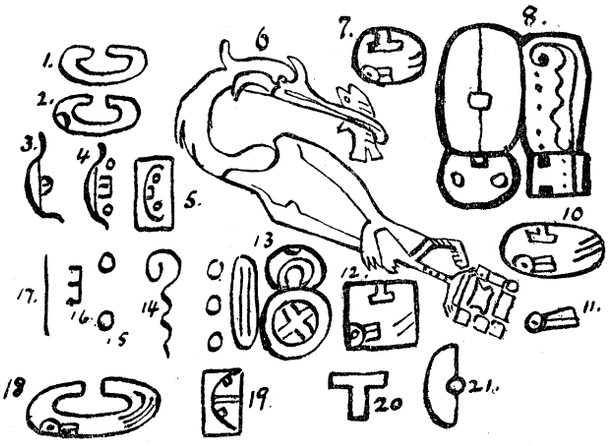
BY HILBORNE T. CRESSON, A.M., M.D.

THE *Ch'i* glyph, which figures so extensively both in the hieratic and demotic script of the Mayas, seems to have been used in the most archaic forms of their graphic system, as it appears in their altar tablets of Copan (see Fig. 3 of the illustration accompanying this article), and it is also to be remarked among the ikonomatic decorations of various ancient Maya cities.

Ch'i, in Maya, means "to seize" or "hold" with pins, thorns, or claws, or other sharp-pointed objects; this would be clearly ikonomatic for *Ch'ic* or *Ch'i*. In 1876, while in Paris, it was my good fortune to examine, at the library of the École des Beaux Arts, an excellent photograph of the tablet to the left-hand side of the doorway of Casa, No. 3, Palenque, which, in a previous article published in *Science*, I have suggested is probably a bas-relief of *Kukuitz*. The design and technique of this masterpiece of the Maya scribe-sculptor's art is especially fine, particularly the ikonomatic decorations which ornament the figure of the god. The head-dress of the figure represents feathers, maize leaves, the quetzal head, and other decorations, notably that of a heron (*Baac-há*) in the act of pinching a fish (*cay*) in its powerful bill. The suggestion of *Baac-há* in the act of pinching *cay* in its bill (Fig. 6), although it recalled by means of the various phonetic components of the crane's head, neck, and eye, that the scribe intended to suggest to one's mind *ha-ca-ba*, or *hach kabah*, or it may be *ah kaba*, also suggested that *ch'i*, "to pinch," "bite," was implied by the action of the heron's bill. It would make the sentence more complete, for the fish, *cay*, is, in fact, but a determinative, showing that *ch'á* is intended rather than *ch'i*, thus giving us "Ba-haá-chá" or "haá-chá-bá," an excellent rebus-like suggestion of *ah kaba*, which in Maya = "he who has a name." I notice that in the Casa, No. 2, tablet, Palenque, that the *main clouée* of Brasseur calls attention to "ah kaba," and a sculptured vase recently discovered in Yucatan, now in the Peabody Museum, has this same hieroglyph incised upon it in connection with other components which suggest *xma-kaba-kin* = "days without names." The so-called "nail-head" component of this glyph seems to have the phonetic value of *á*. It is absent, however, on the vase just referred to. In order to find out whether the *ch'i* glyph was used in other localities, a reference to Catherwood's drawing of the glyphs on the top of an altar at Copan, and various other sculptured tablets, indicates that it was used repeatedly by the Maya scribes. In one instance, at Copan, it recalls *Chikin*, the "west" or "sun-bitten." (Fig. 13).

The *ch'i* glyph has numerous variants, and seems to be accompanied by determinatives so as to indicate the vowel combinations, such as *chá*, *chā*, *ch'i*, *cho*, *chu*. We have called attention to a supposed determinative in a previous article published in *Science*, and one has already been referred to in this article. Where the glyph has no determinative whatever, as in Fig. 1, I accept it as *ch'*. If accompanied by the small circle, as in Fig. 2, I use it as *ch'i*. The sign of May orientation (Fig. 13), *Chikin*, the "west" or "sun-bitten," is an instance where this phonetic value has worked successfully. Where the *ch'i* glyph accompanied by two small circles (Fig. 15) placed on either of the tooth-like attachments (Fig. 16) which generally accompanies it, the phonetic value *ch'u* is suggested (see Figs. 4 and 5). Fig. 19 gives an admirable example of where two of the count-numerals are attached to the glyph; and, accepting it as a determinative, we obtain the phonetic value *ch'á*.

The *ch'i* glyph sometimes appears as shown in Fig. 18, and the resemblance of it to that of the day-sign, *manik* (Fig. 10), is striking. *Manik* has the same components,



only the outer line of the glyph encloses it completely, while in the *ch'i* glyyh the two ends of the pinching claw, or hand, are left open. Where it is closed we have a glyph formed, as in Fig. 20, which is not unlike the draughtsman's T-square, and seems to have the phonetic value *ma*. The T-square glyph (Fig. 20) is used at Palenque, small ventilators in the walls of one of the houses being shaped like it. At *Ch'i Ch'een-Itza* it appears as an ikonomatic decoration on the walls of a temple, and the small component (Fig. 11), so often used in the Maya glyphs, also appears as an ikonomatic decoration at *Ch'i, Ch'een, Itza*. Its phonetic

value seems to be *ich*, as an affix, and *chi* as a suffix. In Fig. 18 it is a prefix and reads *ich*, suggesting that *ch'i* is the proper phonetic value to be used. The determinatives that we have referred to in this and other articles seem to be phonetic.

Fig. 3 is the *U* of Landa, and there is reason to think that it is correct, for the *o* or *u* attached to it is divided in half by a line which I believe, from results obtained in other directions, is the vowel *o* with the cut-line through it. In the various *Ch'u* (or *Ch'o*) glyphs (Figs. 4 and 5) that we have given this component of the glyph is square (Fig. 16). It has the cut-sign in the middle, or is divided by it, and gives a fair representation of teeth. Co = tooth in Maya (pronounced Coo), and, as in Figs. 3, 4, 5, the cut-sign runs to the perpendicular line (Fig. 17), whose phonetic value in my alphabet = *H*, either end of the *h* glyph touching the *ch* glyph, which envelops it externally, as in Figs. 3, 4, I accept it as a suggestion of *h'* or *ch'u*

What we have designated as the cut-line, or sign, appears in other places. A good example is shown in Fig. 8. It is the well-known honey-sign, but in this case is combined with other glyphs. I act on a principle of analysis which so far has given good results, that the glyphs and Maya decorations are composed of ikonomatic components, and that the Maya scribe-sculptor and his more demotic brethren do not seem to have used any meaningless decorations, either in their hieroglyphs or the ornamentation of their palaces, all these being in keeping with the words which they intended to convey to the reader's mind by the sound of the name of the thing represented. Fig. 8 is a glyph in the second row of the outer page of the Codex Troano. It is placed in front of Plate 35 of Brasseur's work. We will begin our analysis as follows: (*a*) The upper, left-hand glyph and the determinative sign below it on the lower, left-hand side; (*b*) the upper, right-hand glyph and the honey-sign below it at the lower, right-hand side. The *o* or *u* glyph is composed of the eye glyph, *ich*, or *uich*, placed on either side below the tooth-like appendage, *Co*. Just above it, in the elongated, oval glyph, is the *há* or *h* glyph, a line running through *o* or *u*, these two glyphs giving us an admirable suggestion of *ch'u* or *ch'o*. By taking half of this upper glyph it can easily be seen that the *u* of Landa (Fig. 3) is but a variant of this glyph (Fig. 21). The upper right-hand glyph (Fig. 8) has the dotted *sh* aspirate, together with the *i* loop and *l* curve. Descending from the *i* loop is the twisted glyph (or line), whose phonetic value I have so far used with success as *ba* (from *ba*, twisted, tortuous, bent). By trying every combination that can be obtained from this glyph and the preceding glyphs, I find that the following word was probably that intended by the Maya scribe, viz., "ch'u-h-oo-sh-il," or "ch'hucil." Turning to the vocabulary of Brasseur, which seems to suit this kind of work better than the dictionary of Perez, I find that the word in Maya means "sweets." This placed over the honey-sign, at the lower right-hand corner, indicates that we are not far astray in our analysis. The honey-sign has the two small, square, black, count glyphs attached to its left upper and lower corners = *ca*, or "two;" next comes our dotted aspirate line, which has the phonetic value *sh* or *x;* beyond this aspirate, to the left, is the *há* or *h*, a perpendicular line, giving us in connection with the other components and the aspirate "ca-há" (*b* is understood) = *cab*, or "honey." "Sweets-honey" is, I think, a fair interpretation of this glyph, which anyone who has studied the "Bee-Keeper's Narrative" of the Troano will recall as intimately associated with honey and the honey-comb. Its component, *il*, is the antennæ of the bee, with the *i* loop attached.

This antennæ glyph I have shown in a previous article to be intimately associated with the honey-sign *Cab*.

The second *u* of Landa's alphabet (Fig. 14) is expressed by the *o* and *u* and the *l* curve to which the twisted glyph, *ba*, is attached. This gives us "Ho-ba;" and the aspirate of Landa, marked by the indented curve between the *il* and *ba* components of this sign, changes the *bá* into *há* or *yá*, giving us "Ho-ya" = "to water," "sprinkle." The *u* of Landa is often seen placed below the hieroglyph of the firmament, and is intimately connected with *há*, or "water which refreshes the earth with rain," "dew and moisture." *Ca*, *há*, *o*, *u* have an interesting relation with the *ch'i* glyph, and, from what we have related, seem to be determinatives.

The *ch'i* glyph is represented in many different parts of the Troano either as the claw-like appendage of the shell-fish, as in Plate 24 (*b*), Codex Troano, the centipede or tarantula claw, as in Plate 13, Troano (*b.c.*), Plate 18 (*b*), Plate 9 (*c*), or as the "pinching hand," with its crustacean-like thumb on Plate 25 (*b*), Troano.

DEATH OF PROFESSOR W. P. TROWBRIDGE.

PROFESSOR WILLIAM P. TROWBRIDGE, the head of the engineering department of the Columbia College School of Mines, died of heart-failure at his home in New Haven last Friday. He was born in Troy, Oakland County, Mich., May 25, 1828, and entered the West Point Military Academy in 1844, where he graduated four years later, receiving an appointment as second-lieutenant in the corps of engineers. He had served as Assistant Professor of Chemistry during the last year of his course at the academy, and after his graduation he was occupied for some time with astronomical work at the West Point Observatory. In 1851 he was appointed to a position on the Coast Survey under Superintendent Bache, which he held till 1856, and at a later time he took part in the survey of the James and Appomattox Rivers and in a series of surveys on the Pacific coast.

In 1854 he had received a commission as first-lieutenant in the U. S. Army, which he resigned two years later to accept the professorship of mathematics in the University of Michigan; but after a year of service, he resigned his professorship also, and was appointed scientific secretary to the superintendent of the Coast Survey. During the Civil War he again served in the army, and rose to the rank of brigadier-general; his work in the army being largely in connection with fortifications in New York harbor and elsewhere.

After the war was over he resigned his commission again, and entered the Sheffield Scientific School of Yale College as Professor of Dynamic Engineering, but resigned in 1877 to take the professorship of engineering at Columbia, which, as we have stated, he held up to the time of his death.

Professor Trowbridge was the author of a treatise on "Heat as a Source of Power" and several other works on engineering subjects. He was the chief agent of the tenth census for collecting statistics relating to power and machinery employed in manufactures. He was for four years Adjutant-General of Connecticut, was Vice-President of the New York Academy of Sciences and of the American Association for the Advancement of Science, and was a fellow of the National Academy of Sciences. For several years Professor Trowbridge was a director of the Science Company.