

THE
NUMERATION, CALENDAR SYSTEMS
AND
ASTRONOMICAL KNOWLEDGE
OF
THE MAYAS

BY
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P R E F A C E

THIS volume is issued with the intention of offering to the student of Maya life and customs a statement of the knowledge which we possess of the numeration, calendar, and astronomical attainments of this wonderful people, of the method which has been used in obtaining this knowledge, of the probability — and in most cases the certainty — that our opinions are correct, and of the problems which offer themselves to the student for solution; but with no purpose of writing a history of the Maya people or of their customs, their monuments, or their hieroglyphics, and with no purpose of furnishing a bibliography of sources from which such a history can be gleaned. There are, without doubt, many parts of the codices and inscriptions which refer to other matters than those connected with numeration, the calendar, and astronomy, but I make no attempt to decipher them. Others have made their guesses as to the meaning of these passages, — generally on insufficient evidence, — and, though some of these guesses may be correct, I have not thought it wise to enter into this branch of the subject, especially as it is seldom that two commentators agree in their judgment.

I have not thought it necessary, in writing this volume, to award to this or that modern writer credit for individual discoveries. Students in Maya research, however, will always regard Dr. Ernst Förstemann as the leader who blazed out the path which they are glad to follow, recognizing his clear insight and remarkable advances in the study of the meaning of the hieroglyphs and in the elucidation of the Maya system of numeration, their calendar, and their astronomical knowledge. I wish also to add my testimony to the scientific accuracy of Dr. Schellhas's researches, the stimulus to studies in Maya literature which Dr. Brinton has given

by his publications, the brilliancy and marvellous fecundity of Dr. Seler in his various works on Mexican and Maya subjects, the admirable comparisons and astute deductions of Cyrus Thomas, and the most helpful suggestions and tables of J. T. Goodman. To all of these learned writers I tender my most sincere thanks for their assistance. I claim for myself but little else than a close following in the footsteps of these eminent leaders, and a wish to do all that I can to excite the attention of young men to the attractive paths of Maya studies.

Although this volume contains many illustrations of the Maya signs, it will be necessary for the student to have ready access to the reproductions of the codices and to the drawings and photographs of the inscriptions contained in *Biologia Centrali-Americana*, *Archaeology*, by Alfred P. Maudslay¹ and J. T. Goodman, and in the *Memoirs of the Peabody Museum of Harvard University*.

In publishing this volume I have received invaluable aid from Dr. Alfred M. Tozzer, Instructor in Harvard College. He has taken great interest in my work and has given me the benefit of his advice both in the method and phraseology of the book, — knowing well, from his position as a teacher, what points especially need elucidation, so that they may be clear to the mind of the student who approaches the subject for the first time.

I am also greatly indebted to Mrs. Alberta M. Trethewey for the skill which she has shown in drawing the Maya glyphs and for superintending the making of the blocks for the illustrations, which are nearly all from her hand.

¹ Maudslay, in addition to his photographs, publishes also drawings of the inscriptions. These drawings can, in almost every instance, be relied upon as correct, on account of the care exercised in their reproduction and of the great experience which he and Miss Hunter, who executed the drawings, have had in their investigation of the Maya glyphs.

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CHAPTER I

INTRODUCTORY

THE two main sources from which we can gain a knowledge of the progress of the Maya people¹ in numeration, astronomy, and in the use of the calendar are :

1. The records of the Mayas themselves.
2. The writings of Spaniards and others about the Mayas.

The first of these sources may be divided into three parts, viz. :

I. The Books of Chilan Balam.

II. The Codices.

III. The Inscriptions in stone or on wood or stucco, — those on stucco being few in number and of but little importance.²

The Books of Chilan Balam. — These books are written in the Maya language, but in Spanish script. The actual writing therefore was done after the Conquest (placed by Dr. Brinton in

¹ The term "Maya people" is intended to include the Mayas, properly so called, who at the present time occupy practically the whole of Yucatan, together with all the tribes which were closely allied to the Mayas in language, numeration, calendar, astronomical knowledge, and religious customs. This classification, roughly stated, includes the tribes between the upper Cordilleras and the sea, taking in the states of Chiapas and Tabasco in Mexico on the north, and the northern part of Honduras on the south, thus including a large part of Guatemala and corresponding in a general way with the localities in which, as will be seen hereafter, the hieroglyphic inscriptions on stone are found. There are one or two sporadic groups of the Maya kindred outside of the localities here mentioned, but, as far as I know, we possess no knowledge of their attainments either from their writings, pictures, or inscriptions.

² In addition to these sources, many characters are found upon vases and sherds, but none of these have as yet added to the knowledge of the subjects of which this volume treats.

A. D. 1541), but the records contained in them very often ante-date the Conquest by many years. Dr. Brinton, who possessed copies of many of these books, refers to them thus:

"There were at one time a large number of these records. They are referred to by Cogolludo, Sanchez Aguilar, and other early historians. Probably nearly every village had one, which in time became to be regarded with superstitious veneration.

"Wherever written, each of these books bore the same name; it was always referred to as 'The Book of Chilan Balam.' To distinguish them apart, the name of the village where one was composed was added. Thus we still have preserved to us, in whole or in fragments, the Book of Chilan Balam of Chumayel, of Kaua, of Nabula, etc.; in all, it is said, about sixteen.

"'Chilan Balam' was the designation of a class of priests. 'Chilan,' says Bishop Landa, 'was the name of their priests, whose duty it was to teach the sciences, to appoint holy days, to treat the sick, to offer sacrifices, and especially to utter the oracles of the gods. They were so highly honored by the people that usually they were carried on litters on the shoulders of the devotees.'¹ Strictly speaking, in Maya, **Chilan** means 'interpreter,' 'mouth-piece,' from **Chij**, 'the mouth,' and in this ordinary sense frequently occurs in other writings. The word **Balam** — literally 'tiger' — was also applied to a class of priests, and is still in use among the natives of Yucatan as the designation of the protective spirits of fields and towns, as I have shown in a study of the word as it occurs in the native myths of Guatemala.² '**Chilan Balam**' therefore is not a proper name, but a title, and in ancient times designated the priest who announced the will of the gods and explained the sacred oracles. This accounts for the universality of the name and the sacredness of its associations.

"The dates of the books which have come down to us are various. One of them, 'The Book of Chilan Balam of Mani,' was undoubtedly composed not later than 1595, as is proved by internal evidence. Various passages in the works of Landa, Lizana, Sanchez Aguilar, and Cogolludo — all early historians of Yucatan — prove that many of these native manu-

¹ Relacion de las cosas de Yucatan, p. 160.

² The names of the Gods in the Kiche Myths of Central America. Proceedings of the American Philosophical Society, Vol. XIX, 1881. The terminal letter in both these words — **Chilan**, **Balam** — may be either "n" or "m," the change being one of dialect and local pronunciation. I have followed the older authorities in writing "Chilan Balam," the modern preferring "Chilam Balam."

scripts existed in the sixteenth century. Several rescripts date from the seventeenth century, — most from the latter half of the eighteenth.

“The names of the writers are generally not given, probably because the books, as we have them, are all copies of older manuscripts, with merely the occasional addition of current items of note by the copyist; as, for instance, a malignant epidemic which prevailed in the peninsula in 1673 is mentioned as a present occurrence by the copyist of ‘The Book of Chilan Balam of Nabula.’

“These ‘Books of Chilan Balam’ are the principal sources from which Señor Pio Perez derived his knowledge of the ancient Maya system of computing time, and also drew what he published concerning the history of the Mayas before the Conquest, and from them also are taken the various chronicles which I present in the present volume.

“That I am enabled to do so is due to the untiring researches of Dr. Carl Hermann Berendt, who visited Yucatan four times, in order to study the native language, to examine the antiquities of the peninsula, and to take accurate copies, often in facsimile, of as many ancient manuscripts as he could discover. After his death, his collection came into my hands.”¹

Dr. Brinton also states that the contents consist of astrological and prophetic matters, including prophecies which probably antedate the coming of Christianity to America, ancient chronology and history, medical recipes and directions, later history and Christian teachings.² To these should be added astronomical matters.

The Codices. — Ponce tells us that the Mayas had characters or letters with which they wrote their histories and ceremonies, the order of their sacrifices, and their calendar, in books made of the bark of a tree. These books were made in long strips folded so that they appeared like a quarto volume. They were only understood by the priests (*Ah-kines*) and by chiefs. Afterwards some of the Spanish priests came to understand them and to write them.³

¹ Brinton, 1882, pp. 68 *et seq.* In this volume Dr. Brinton has printed the original and translation of several of the Books of Chilan Balam. The translation is not always accurate.

² Brinton, 1882 a, p. 8. Also Brinton, 1890, pp. 255 *et seq.*

³ “Son alabadas de tres cosas entre todos los demas de la Nueva España, la una de que en su antigüedad tenían caracteres y letras, con que escribían sus historias y las ceremonias y orden de los sacrificios de sus ídolos y su calendario, en libros hechos de corteza de cierto árbol, los quales eran unas tiras muy largas de quarta o tercia en ancho, que se doblaban y recogían, y venía á quedar á manera de un libro encuadernada en cuar-

Landa says that the Mayas wrote their books on a long sheet doubled in folds, all of which was enclosed between two decorated slabs of wood; that they wrote on both sides of this sheet, in columns on the folded leaves, and that they made their paper from the roots of a tree and gave it a white coating on which they could write easily.¹

Other Spanish authors have also described these books. The description is such that it is easy to recognize them when we examine the only three codices which are known. Brinton has also described them as follows:

"These books consisted of one long sheet of a kind of paper made by macerating and beating together the leaves of the maguey, and afterwards sizing the surface with a durable white varnish. The sheet was folded like a screen, forming pages about 9 by 5 inches. Both sides were covered with figures and characters painted in various brilliant colors. On the outer pages boards were fastened, for protection, so that the completed volume had the appearance of a bound book of large octavo size.

"Instead of this paper, parchment was sometimes used. This was made from deerskins, thoroughly cured and also smoked, so that they should be less liable to the attacks of insects. A very durable substance was thus obtained, which would resist most agents of destruction, even in a tropical climate. Twenty-seven rolls of such parchment, covered with hieroglyphics, were among the articles burned by Bishop Landa, at Mani, in 1562, in a general destruction of everything which related to the ancient life of the nation. He himself says that he burned all that he could lay his hands upon, to the great distress of the natives." (*Relacion de las cosas de Yucatan*, p. 316.)²

tilla, poco mas ó menos. Estas letras y caracteres no las entendian, sino los sacerdotes de los idolos, (que en aquella lengua se llaman 'ah-kines'), y algun indio principal. Despues las entendieron y supieron léer algunos frailes nuestros y aun las escribien." (*Relacion Breve y Verdadera de Algunas Cosas de las Muchas que Suciedieron al Padre Fray Alonso Ponce, Comisario-General en las Provincias de la Nueva España*, p. 392.) Brinton, 1882, p. 63. This quotation is found in Vol. II, p. 392, of Ponce.

¹ "Que escrivian sus libros en una hoja larga doblada con pliegues que se venia a cerrar toda entre dos tablas que hazian muy galanas y que escrivian de una parte y de otra a colonas segun eran los pliegues, y que esta papel hazian de raizes de un arbol, y que le davan un lustre blanco en que se podia bien escribir." (Landa, 1864, p. 44.)

² Brinton, 1882, pp. 64, 65. In this volume parts of several Books of Chilán Balam are published, with a translation.

With such a disposition on the part of the Spaniards to destroy the native records, it is fortunate indeed that we have preserved to us three Maya codices. These are —

- A. The Codex Dresdensis, or Dresden Codex, in the Royal Library in Dresden. This is the best preserved of the codices and is very carefully and delicately drawn. The subjects of which it treats are broader in scope than are found in the others, since not only the offerings to the gods, the ceremonies, sacrifices, and domestic avocations are set forth, but many of its pages are devoted to astronomical and numerical computations.¹
- B. The Codex Tro-Cortesianus. This is now in the Museo Arqueologico Nacional of Madrid. It was found in two parts, — one in the Library, and the other in the possession of Don Juan de Tro y Ortolano, of Madrid, Spain. The two pieces were found to be complements of each other. This codex is much coarser in its style than either of the others, and treats chiefly of offerings, ceremonies, sacrifices, and domestic avocations, — usually set forth as occurring in or regulated by the familiar period of 260 days.²
- C. The Codex Peresianus, in the Librairie National in Paris. This is more imperfect than either of the others, but its workmanship is of a very fine character. Less has been accomplished in deciphering the meaning of this codex than in the case of the Dresden or the Tro-Cortesianus.³

The subjects treated of in the pages of these codices at times occupy the whole of the page, while in other cases the pages are divided into two, three, or four sections. The hieroglyphs are usually placed in vertical columns and in horizontal rows. When

¹ This Codex was reproduced in colors by Lord Kingsborough in Vol. III of his great work, "Antiquities of Mexico," and again by Dr. Ernst Förstemann in 1880. A second edition was issued by Dr. Förstemann in 1892.

² The part of this Codex which belonged to Señor Tro (called the Codex Troano) was reproduced in colors by Brasseur de Bourbourg under the title "Manuscrit Troano, Étude sur le système graphique et la langue des Mayas," 2 vols., Paris, 1869, 1870. The other part (called the Codex Cortesianus) was reproduced by Léon de Rosny in black and white, Paris, 1883, and by Rada y Delgado in colors, Madrid, 1892. The two parts forming one Codex are known under the name "Tro-Cortesianus," and the pages are numbered consecutively.

³ This Codex was reproduced in colors by Léon de Rosny, Paris, 1887, and a second edition in black and white was issued in 1888.

it is desired to refer to a particular glyph,¹ it will be designated as occurring on a particular page, in a section marked "a," "b," "c," or "d," running from the top downward, and in a column marked 1, 2, 3, etc. from left to right, and numbered in the column from top to bottom. Thus Dr. 30b, col. 4. 1, and Tro-Cor. 36a, col. 4. 2, both refer to the glyph, Fig. 1.

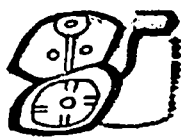


FIG. 1.

The Inscriptions. — Scattered all over the northerly and easterly slopes of the Cordilleras, as they run through the State of Chiapas in Mexico and through the Republic of Guatemala into Honduras, in the fertile valleys of the rivers which take their rise in this great chain of mountains, and in the whole extent of the peninsula of Yucatan, are the remains of great buildings with ornamental façades, and of large monoliths of various shapes and sizes. Within the buildings carvings are often found, representing human figures either by themselves or in connection with hieroglyphs, while there are many tablets, lintels, and other parts of the buildings on which hieroglyphs appear in columns and rows without figures. The monoliths may be roughly divided into two kinds, according to their shape. One kind (called *stela*, plural *stelae*) is tall, measuring in one case twenty-eight feet in height, while they are not over four feet in width or depth. The others are low and take various forms, being square, oblong, or round as a rule, though some are carved in the shape of an uncouth animal. These have been called altars, though without deciding whether sacrifices were ever offered upon them or not. These altars often stand in close proximity to the stelae.

The stelae usually have a human form carved upon the front or back, or upon both, while two or more sides are covered with hieroglyphs arranged in rows and columns. The altars are often adorned with figures and hieroglyphs in rows and columns, but are sometimes without hieroglyphs or figures.

¹ A liberty has been taken in the use of the word "glyph," which in its strict sense means a carved figure or character. I use it with this meaning in the inscriptions, but I also give this name to the characters which, drawn in square or roundish forms, are found in the codices, usually arranged in a regular order. These characters have been called by various authors "katounic," "calculiform," etc.

The inscriptions are usually carved upon the solid stone, though in a few cases, as at Palenque, there are some which are moulded in stucco. In Tikal many of the inscriptions are carved on wood.

When it is desired to designate a particular glyph on any of the inscriptions, it is stated as occurring in a column marked "A," "B," "C," "D," etc., from left to right, and in a row marked 1, 2, 3, etc., from top to bottom. In some places a glyph extends over two columns or over two rows, while in others a glyph is subdivided into two or more parts. In the first case the glyph will be designated by two letters or by two numbers, or by both two letters and two numbers; in the last case the part of the glyph will be designated by the small letters "a," "b," "c," "d," placed after the number. As a rule the glyphs are read from top to bottom across two columns at a time.

The Writings of Spaniards and others about the Mayas. — Under this second head there are but few writers whose observations and writings are based on personal knowledge. The greater number of Spanish authors wrote from hearsay, or copied, more or less accurately, the statements of earlier writers. The following authors, however, are of great value to Maya students:

- I. Bishop Diego de Landa was born in Spain in 1524, became a Franciscan friar in 1541, and was appointed Bishop of Yucatan in 1573. He died in 1579. He wrote the "Relacion de las cosas de Yucatan."¹

Three editions of Landa have been published, as follows:

1. By the Abbé Brasseur de Bourbourg, with a French translation, Paris, 1864, to which all references will hereafter be made.
2. By Juan de Dios de la Rada y Delgado, Madrid, 1881, as an Appendix to his "Ensayo sobre la interpretacion de la escritura hieratica," — a translation into Spanish of the work of Léon de Rosny.
3. In "Colección de Documentos Inéditos relativos al descubrimiento, conquista y organización de las antiguas posesiones Españolas de Ultramar." Segunda serie, publicada por la Real Academia de la Historia, Tomo Num. 13, Relaciones de Yucatan, II. Madrid, 1900.

- II. Fray Alonso Ponce came to Mexico as Chief Commissioner in 1584. The account of his journey of over two thousand miles through the provinces of New Spain, entitled "*Relacion breve y verdadera de algunas cosas de las muchas que sucedieron al padre Fray Alonso Ponce en las provincias de la Nueva España, siendo Comisario General de aquellas partes*,"¹ was written, not by himself, but by two secretaries, one of whom came with him from Spain, and the other went with him on his journey in the provinces.
- III. Fray Bernardo de Lizana was born in Spain, went to Yucatan in 1606, became Provincial of Yucatan, and died in Mexico in 1631. He wrote "*Historia de la Provincia de Yucatan y su conquista espiritual*," which was published in Valladolid in 1633.²
- IV. Doctor Don Pedro Sanchez de Aguilar was born in Valladolid in Yucatan, and received the degree of Doctor in 1588. In 1613 he wrote "*Informe contra Idolorum cultores*," which was published in Madrid in 1639.³
- V. Fray Diego Cogolludo was born in Spain, joined the Franciscans in 1629, and became Provincial of Yucatan. He wrote the "*Historia de Yucatan*," which was published in Madrid in 1688.⁴
- VI. Reports sent to Spain by order of the King, giving an account of all matters concerning the natives which might be of interest.⁵

It may be proper to select from the modern writers four who have had access to Maya writings which are not now known or which are not readily accessible, either from their being deposited in distant libraries or from their not having been translated from the Maya or Spanish languages. These are —

¹ Published in "*Colección de Documentos Ineditos para la Historia de España*," Madrid, 1872, vols. 57, 58.

² An edition was published in Mexico in 1893 by the Museo Nacional under the title of "*Historia de Yucatan*."

³ A new edition was published in 1892 in the "*Anales del Museo Nacional de Mexico*," Tomo VI, pp. 13 *et seq.*

⁴ An edition was published in Merida, in 1842, and another in 1867-1868.

⁵ These reports are found in "*Colección de Documentos Inéditos relativos al descubrimiento, conquista y organización de las antiguas posesiones Españolas de Ultramar*." Segunda serie, publicada por la Real Academia de la Historia, Tomos 11 and 13, *Relaciones de Yucatan*. Madrid, 1900.

- VII. Don Juan Pio Perez.
- VIII. Don Crescencio Carrillo y Ancona.
- IX. Dr. Carl H. Berendt.
- X. Dr. Daniel G. Brinton.

Though several of the Spanish authors are of assistance to the student of Maya culture by giving information on the customs, habits, modes of life, and in some cases on the calendar, of the Mayas, none of them has described the Mayas in such detail as has Bishop Landa. It is to him above all others that we are indebted for our knowledge of this intelligent people.

Brasseur de Bourbourg informs us that Landa was of noble race, that he was born in Cifuentes de l'Alcarria in Spain in 1524, and that he took the habit of St. Francis in 1541 at the convent of San Juan de los Reyes in Toledo. He was one of the earliest and most zealous of the Franciscans who entered Yucatan, — so zealous, indeed, that he was charged with usurping higher functions than belonged to him in conducting an *auto-da-fê*, in which, though no human life was sacrificed, he burned many of the books and idols of the natives. He was, however, absolved from this charge, and in 1573 was appointed the second bishop of Merida. He died there in 1579 at the age of fifty-four.¹

Brasseur de Bourbourg also expresses his views of Bishop Landa's character, and in such well-chosen words that I cannot do better than to reproduce them here. He says :

“Landa has in turn been considered a saint and an odious persecutor. According to Cogolludo, his first biographer, he died in the odor of sanctity, and according to another biography, inserted as an appendix to the second edition of the work of Cogolludo, published at Campêche in 1842, he is stigmatized as a fanatical, extravagant, and cruel man. But if circumstances and the times make men, it is often the circumstances and the times which also make their reputation. Of the two biographers of Landa, one exaggerates the virtues which belonged to his times and to a Spanish bishop ; while the other exaggerates his faults, which shock us of this age and especially the liberal writers of Yucatan, but which, nevertheless, were virtues in the eyes of Spaniards of earlier times. In order to appreciate

¹ Landa, 1864, preface, p. vii.

Landa's true character, it is only necessary to run through what he accomplished. His was a strenuous character, but an investigating one, wiser than one would think, and sincerely friendly to the natives, whom he protected constantly from the violent acts of the conquerors. From the point of view in which he placed himself, he may well be excused for having delivered to the flames so many statues and valuable documents, a fact which he acknowledges most ingenuously (p. 316). In doing this he was no more culpable than Zumarraga in Mexico and Las Casas in Guatemala. But in the midst of this excess of zeal, which we deplore so much to-day, Landa rendered an immense service to historical science in compiling the precious information which we publish here, and in preserving the characters of the Maya alphabet. His book wipes out over and over again his faults, which were those of his century; for it is the key of American inscriptions; without it they would have remained an enigma, perhaps forever, like the hieroglyphs of Egypt before the discovery of the Rosetta stone and the splendid work of Champollion."¹

Of the four men whom I have mentioned as having had access to Maya documents which have not been at the service of others, Pio Perez is perhaps the most important. He has given a very full account of the Maya days, months, years, and other divisions

¹ "Landa a passé tour à tour pour un saint et pour un odieux persécuteur. Suivant Cogolludo, son premier biographe, il mourut en odeur de sainteté, et, d'après une autre biographie, insérée comme appendice à la seconde édition de l'ouvrage de Cogolludo, publiée à Campêche, en 1842, il est stigmatisé comme un homme fanatique, extravagant et cruel. Mais si les circonstances et les temps font les hommes, les circonstances et le temps sont bien souvent aussi ce qui fait leur réputation. Les deux biographes de Landa exagérèrent, le premier, des vertus qui étaient de son époque et d'un évêque espagnol; le second, ses défauts, choquants, surtout, pour les écrivains libéraux du Yucatan, dans notre siècle, défauts qui étaient encore eux-mêmes des vertus aux yeux des Espagnols d'autrefois. Il suffit de parcourir l'ouvrage de Landa, pour apprécier son véritable caractère. C'était un esprit violent, mais curieux, plus sage qu'on ne pourrait le croire, et sincèrement ami des indigènes qu'il protégea constamment contre les violences des conquérants. Au le point de vue où il se plaçait, il peut paraître excusable d'avoir livré aux flammes tant de statues et de documents précieux, ce qu'il avoue lui-même ingénument (p. 316) : en cela, il ne fut pas plus coupable que Zumarraga à Mexico, que Las Casas au Guatemala. Mais, au milieu de ces excès de zèle, que nous déplorons si vivement aujourd'hui, Landa rendit un immense service aux sciences historiques, en compilant les renseignements précieux qui suivent, et en nous conservant les caractères de l'alphabet maya. Son livre efface outre mesure ses fautes qui furent celles de son siècle; car, il est la clef des inscriptions américaines; sans lui, elles fussent demeurées une énigme peut-être pour toujours, comme les hiéroglyphes égyptiens, avant la découverte de la pierre de Rosette et les magnifiques travaux de Champollion." (Landa, 1864, Avant-propos, pp. vii and viii.)

of time. But as he does not give any authorities in support of his views except that they were founded on "*varios documentos antiguos*," and as some of his statements are apparently at variance with the codices and with the books of Chilan Balam (the latter being probably the chief source of his information), we need not give, as I think, to the views of Perez any greater force than belongs to the opinions of any intelligent, honest searcher who has had original documents before him to which he has given hard study. A similar view must be taken of the opinions of the three others whom I have named. Perez also wrote a valuable Maya-Spanish dictionary, which has been printed.

Dr. Brinton is the only one of the four who has published the results of his studies to any great extent. He was fortunate in being the possessor of the collection of Dr. Berendt, who had travelled for many years in Yucatan, Mexico, and Central America, studying the native languages, examining the antiquities of the country, and taking accurate copies, often in facsimile, of as many ancient manuscripts as he could discover. This collection now forms part of the Library of the Free Museum of Science and Art of the University of Pennsylvania.

In treating of the subject of Maya calculations I shall follow the order of the successive steps which have led us to our present knowledge, gaining a secure foothold on one step before moving to the next. This course will prevent my finishing the discussion of each point by itself, but is the only course consistent with setting forth clearly the means which have been made use of in gaining our knowledge and with establishing a confidence in the results of our inquiries.

Therefore confining our attention at first to the codices, I shall treat of the Maya days, their names and signs. Then I shall take up the numerals (usually red) attached to the days and thus forming the Tonalamatl. Next I shall take up the black numerals in the codices, carrying the numeration through the fourth term (including the katun, tun, uinal, and kin) and showing various signs for certain numbers. I shall then discuss the Maya months, their names, signs, and the numbers attached to them. This will bring

us naturally to the consideration of the Maya year, leading us to the fifty-two-year period or Calendar round and the one-hundred and-four-year period. A chapter will follow on the longer numeration found in the codices, carrying us to the sixth term (including cycle and grand cycle) in connection with the count by days and months.

I shall then take up the inscriptions, showing the similarity of the forms of the days and months with those found in the codices, together with the glyphs representing the different periods, both normal and face glyphs, and the normal forms of numbers used in connection with the days, months, and periods. This will include the "long count," so called, as found in the Initial series (counting from a date far in the past which usually does not appear), and the distance numbers, which express the distance from one given date to another given date. It will also be shown that the codices, as well as the inscriptions, contain glyphs representing some of the periods. Glyphs in the form of heads will then be discussed, representing numbers from 1 to 19, followed by the explanation of two other methods used by the Mayas for fixing a date besides that of the long count. This will be followed by a discussion of other points connected with the codices and inscriptions.

It is very possible that the other systems of numeration and calendar which were adopted by neighboring and cognate people might be of use in studying the Maya system. So little is known however of these related systems, except that employed by the Mexicans, and the native evidence in regard to them is so slight, that I have not thought it wise to extend the limits of this volume in order to enter upon this subject. I give, however, in an Appendix a table showing the names of the days in a number of the related systems. The Mexican system of numeration and calendar is very like that of the Mayas, but it was not carried to the perfection which is found in the latter.

CHAPTER II

THE DAY SIGNS IN THE CODICES AND THEIR IDENTIFICATION

Days as given by Landa. — Landa states that the Mayas had months consisting of 20 days each. These were called **Uinal-hun-ekch**. The year was composed of 18 of these months, and, in addition, 5 days and 6 hours. He states that for the 20 days contained in 18 months, making 360 days in all, they had 20 letters or characters, one for each of the 20 days of the month. He gives a table as follows, the order of reading being in horizontal rows :

Kan	Chiochan	Cimi	Manik	Lamat
Muluc	Oc	Chuen	Eb	Ben
Ix	Men	Cib	Caban	Eznab
Cauac	Ahau	Ymix	Ik	Akbal ¹

Later on² Landa says that the Mayas gave names to the days of the month, and that they formed a kind of calendar from all the months taken together. The first day of their calendar was called

¹ "Tienen su año perfecto como el nuestro de CCC y LXV dias y VI horas. Diviéndolo en dos maneras de meses, los unos de a XXX dias que se llaman U, que quiere dezir luna, la qual contavan desde que salia nueva hasta que no parecia.

"Otra manera de meses tenian de a XX dias, a los quales llaman **Uinal-hun-ekch**: destos tenia el año entero XVIII y mas los cinco dias y seis horas. . . . Para estos CCCLX dias tienen XX letras o carateres con que los nombran, dexando de poner nombre a los demas cinco, porque los tenian por aciagos y malos. Las letras son las que siguen y llevara cada una su nombre en cima . . ." (Landa, 1864, pp. 202 *et seq.*). Then follows the forms of the day signs with the names over them.

² "Ponían a los dias de sus meses nombres, y de todos juntos los meses hazían un modo de calendario, con el qual se reglan assí para sus fiestas como para sus cuentos y tratos y negocios, como nosotros nos regimos con el nuestro, salva que no començavan el primero dia de su calendario en el primero dia de su año, sino muy adelante. . . . las letras y dias para sus meses son XX." (Ibid. p. 234.)

Hun-ymix (see Plate I, **YMIX** 1).¹ This day, however, was not the first day of the month, and consequently of the year, but it occurred much farther along in the year than the first day.

Beginning with **Ymix**, the order of the days runs thus: ²

Ymix
Ik
Akbal
Kan
Chicchan
Cimi
Manik
Lamat
Muluc
Oc
Chuen
Eb
Ben
Ix
Men
Cib
Caban
Eznab
Cauac
Ahau

Landa also gives the names and forms of the twenty days³ extending through the European year, beginning with January 1st, and making the Maya day **Ben** correspond with that day of our month.⁴ In giving this calendar he repeats the Maya day names and forms eighteen times, once for each month. Five of the days, but not the forms, are repeated once more, making the year con-

¹ "el caracter o letra de que comenzava su cuenta de los dias o kalendario se llama **Hun-ymix** y es este." (Landa, 1864, p. 236.) Then follows the day sign **Ymix**. On p. 246, against the date January 29, Landa says, "Aqui comienza la cuenta del Kalendario de los indios, diziendo en su lengua Hun Ymix."

² For the meaning of these names see Appendix I.

³ Ibid. pp. 240-310.

⁴ It will be more convenient in studying the Maya system to arrange the year calendar according to the Maya method, that is, beginning the year with the month **Pop**. All that will be necessary to do will be to place that part of the calendar, as given by Landa, which extends from January 1st through July 15th (pp. 240-276), after the part which ends on page 310. "Pero aunque ellos comienzan su año en Julio, yo no porne aqui su Kalendario sino por la orden del nuestro y junto con el nuestro." (Ibid. p. 236.)

sist of 365 days ($20 \times 18 + 5$). These forms are given on Plates I, II, III, and IV as No. 1 of each day.

Days as given by Perez.—Don Juan Pio Perez¹ says the day was called **Kin**,² and that they were twenty in number, and arranged thus, the reading being downwards in columns:

Primera quinterna	Segunda	Tercera	Quarta
Kan	Muluc	Gix (o Hix)	Cauac
Chicchan	Oc	Men	Ajau (o Ahau)
Qulmij (o Cilmij)	Chuen	Quib (o Cib)	Ymix
Manik	Eb	Caban	Yk
Lamat	Been	Edznab (o Honab)	Akbal³

It will be noted that the names and the order of the twenty days are the same in the last list given by Landa (p. 14) and in that given by Perez, although the lists do not begin with the same day. The first table given by Landa (p. 13) begins with **Kan**, and runs in the same order as that of Perez.

¹ "Codice Perez, p. 92, MS. This is a series of extracts from various ancient Maya manuscripts obtained by the late distinguished Yucatecan antiquary, Don Juan Pio Perez, and named from him by Canon Crescencio Carrillo and other linguists. A copy of it is in my collection. It is in quarto, p. 258." (Brinton, 1882, p. 48.)

² This is the word usually employed among the Mayas at the present time, meaning "day." It also means "sun," as stated by Perez.

³ "Al día llamaban **Kin**, es decir sol, y en esto se parecen à otras naciones que cuentan los días por soles: lo dividían en dos partes naturales, à saber la noche y el tiempo en que aquel astro está sobre el horizonte. En este distinguían la parte que antecede al nacimiento del sol, expresándola con las palabras **hach hatzcab**, muy de mañana, ó con la de **malih-okoc kin**, antes que salga el sol, ó con la de **pot akab** que señala la madrugada. Con la palabra **hatzcab** designaban el tiempo que corre de la salida del sol al medio día, à este lo llamaban **chunkin** que es contracción de **chumuc-kin**, centro del día ó medio día; aunque en la actualidad designan con esta palabra las horas que se acercan al medio día. **Tzelep-kin** llamaban la hora en que el sol declina en el arco diurno aparentemente, esto es, à las tres de la tarde. **Oc-na-kin** es la entrada de la noche ó puesta del sol. Para significar la tarde, dicen que cuando refresca el sol y lo espresan diciendo **cu ziztal kin**. La noche es **akab**: su mitad ó media es **chumuk-akab**, y para señalar el tanto del día ó de la noche intermedio à los puntos dichos, señalan en el arco diurno del sol lo que este había corrido ó correrá, y por la noche la salida ó estado de alguna estrella ó planeta conocida.

"Los días son veinte que por lo regular se dividen de cinco en cinco, . . ." (Perez, 1864, pp. 368 *et seq.*)

Brasseur de Bourbourg adds notes as follows: "**Chumuc**, moitié, milieu, et **kin**, soleil, jour, exactement midi." "Ce partage de cinq en cinq réglait aussi l'ordre des marchés, qui avaient lieu tous les cinq jours et qu'on appelait **tianquiz** ou **tianquiztli**, en langue mexicaine, et **kinic** en maya."

Days as given in Codices.—We are thus furnished with the names of the twenty days and their order, and a type or example of one form at least of each day.

On Tro-Cor. 13-18 we find four rows of hieroglyphs, many of which are the same as the day forms of Landa. Selecting only those which are practically the same as the Landa forms, we can make the following comparison:

Landa	Ymix Ik Akbal Kan Chicchan Cimi Manik Lamat Muluc
T. C. 1st row	Ymix Ik Akbal Cimi Manik
2d "	Ymix Ik Cimi Manik Lamat Muluc
3d "	Ymix Ik Cimi Manik Muluc
Landa	Oc Chuen Eb Ben Ix Men Cib Caban Eznab Cauac Ahau
T. C. 1st row	Oc Chuen Eb Ben Ix Cib Eznab Ahau
2d "	Oc Eb Ix Eznab Ahau
3d "	Oc Ben Ix Eznab Ahau

Looking over the first three rows we see that the only days in the Tro-Cortesianus which we have not recognized by their similarity to the forms as given by Landa, are **Kan**, **Chicchan**, **Men**, **Caban** and **Cauac**. All the rest are either identical with the day forms of Landa, or so closely resembling them that it is impossible to mistake them. These forms, when recognized, all run in the same order as the similar forms given by Landa.

It is therefore a safe inference that Tro-Cor. 13-18 record a full list of the Maya day signs in their regular order, each row repeating the twenty days with twelve additional days at the end, and that all the day signs, including those which cannot be recognized by their resemblance to those given by Landa, can be considered as types from which other day signs resembling them may be recognized. As a further proof of the meaning of this series, it may be noticed that, if we write down the twenty days in four sets of five days each, beginning with **Ymix**, the day given by Landa as the first of the calendar, they will run thus, the reading being downwards in columns:

Ymix	Cimi	Chuen	Cib
Ik	Manik	Eb	Caban
Akbal	Lamat	Ben	Eznab
Kan	Muluc	Ix	Cauac
Chicchan	Oc	Men	Ahau

The columns of five days begin with **Ymix**, **Cimi**, **Chuen** and **Cib**, respectively, these being the days with which the four rows on Tro-Cor. 13-18 also begin.

Again, on Tro-Cor. 65-73, we find another long series of day forms. We recognize most of these from their similarity to the Landa forms, while the days **Kan**, **Chicchan**, **Men**, **Caban** and **Cauac**, which we have not so recognized, are practically the same forms which we found in relatively the same places in Tro-Cor. 13-18. In both of these long series we find that the order of days as given by Landa is followed exactly, as far as we can recognize the day forms. It is therefore probable that the forms which we do not recognize (and these are but a small part of the whole) are the day forms of the days which belong in the spaces where they stand, and we can therefore consider these forms to be types from which we can recognize the same or similar forms when we find them elsewhere.

Again, on Tro-Cor. 75, 76, the so-called Tableau des Bacabs, many of the days are given in the regular order, the days not given being indicated by black dots. On Dr. 22a is a regular series of twenty days, beginning with **Cauac** at the left hand of the lowest row and running through that row to the right, then to the left of the row next above, and so on.

In all these cases, then, we are able to recognize the forms of all the days, many of the days showing forms which are radically the same wherever found, such as **Kan**, **Manik**, **Lamat**, **Muluc**, **Ymix**, etc., while others, like **Cimi**, show a great variety of forms, some of which are not at all like the usual form of this day.¹

In addition to the series already described, there are in both the Tro-Cor. and the Dr. very many columns of day forms, of which the days are separated by regular distances² of 4, 5, 6 or 12 days, and sometimes by some other number of days. Thus on

¹ See Plate II, **CIMI**, Nos. 22-24.

² I use the word "distance" as meaning a count between two dates, in which one of the dates and not both are reckoned in; and the word "interval" as meaning a count between two dates, in which neither of the dates is reckoned in. Thus the distance from the 6th of August to the 21st of August is 15 days, the 6th being omitted from the count and the 21st being reckoned in. The interval between these dates is 14 days.

Dr. 13b we find the series of **Ahau**, **Eb**, **Kan**, **Cib**, **Lamat**, and on Dr. 16b there is a series of **Muluc**, **Ymix**, **Ben**, **Chicchan**, **Caban**, each day being distant 12 days from the preceding day and the first day 12 days distant from the last. If then we should find a similar series in which one or two of the day forms are unknown or partially erased, and if we should find that the distance from one day to another in the case of the known days is 12 or a multiple of 12, according to the position of the days, we should be justified in considering that the unknown or partially erased forms are the days which should be reached in the regular course of the series after the proper distance. Such a decision would also be justifiable in the case of a series where the distance from one day to the next is 4 days, 5 days, 6 days, etc.

Thus on Tro-Cor. 51c, where the first column of days runs thus: **Ahau**, **Cimi**, **Eb**, **?**, **Kan**, the distance from the first day to the second, and of the second day from the third, is 6, while the distance from the third day to the fifth is double this, or 12. The natural supposition would be that the regular distance is 6, and that the fourth day is six days after the third and six days before the fifth. The only day which fulfills this requirement is **Eznab**, and we shall be justified in calling the form in the fourth place **Eznab** (see Plate IV, **EZNAB** 8), although the glyph differs from the other forms of this day.

On pages 46-50 of the Dresden Codex there are twenty columns of day signs, which contain the days **Cib**, **Cimi**, **Kan**, **Ahau**, **Oc**, **Lamat**, **Ix**, **Eb**, **Eznab** and **Ik**. Each column contained originally thirteen glyphs of the same day,¹ and in one or more cases these glyphs are enough like those of Landa (except possibly **Ix**) to be easily recognized. These pages show many variations of the same day sign, and also afford an opportunity to see what freedom of design and what carelessness of execution the Maya artist allowed himself when there was no danger of the meaning of his work being misunderstood.

¹ This is apparent by mere inspection in most cases, though many of the glyphs in the upper row are erased. Further proof of the fact by calculation will be given in Chapter III.

Thus there are two ways by which we can identify the day signs: first, by their resemblance to the forms given by Landa; and, second, by their relative position in a sequence, in relation to the signs preceding or following. By this latter method we can restore signs which are partially or wholly illegible, and recognize unknown forms of days.

From these and other sources¹ we get most of the forms given on Plates I to IV, and we have thus made a sure interpretation of practically all the day forms of the codices, provided Bishop Landa can be trusted. And even if we did not have the knowledge given us by Landa, a guess that these forms referred to the Maya days would be confirmed by every part of the codices where they are found. The meaning of the forms given on Plates I to IV can therefore be considered as settled.

Landa also shows us that in reckoning time the day series was a continuous one, the first day following the last when the end of a series was reached. This is an important point to bear in mind throughout the study of the Maya hieroglyphs, — the continuity of the day series. One should keep in mind a circle divided into twenty parts, each part representing a day. The order is always the same, the first day following the last in every case, with no break in the series. Any given day is therefore always a certain distance from another given day. The same continuity is also found to be true when we reach the larger units of time.

I have given a large number of variants of the day forms, so that it may be seen that great differences in form may occur in the day signs without altering their meaning, with a probable corollary that equal differences may occur in other hieroglyphs without their meaning being altered.

¹ The forms from the Books of Chilán Balam are not taken from the original manuscript, but from the pages of *The Books of Chilán Balam*, published by Dr. Daniel G. Brinton, Phil., 1882. These forms often differ greatly from those of the codices, and this difference may well be due to the different periods at which the Books of Chilán Balam and the codices were written.