

# EGYPTIAN ASTRONOMY, ASTROLOGY AND CALENDRIAL RECKONING

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## INTRODUCTION

More than any other ancient people, the Egyptians seem to have occupied themselves with the reckoning of time. They were the first to come to an approximation of the true length of the natural year and to devise a calendar based on it. They were the first to divide the night and the day into twelve hours each, and they were the first to make these hours equal. The story of these developments is at the same time the story of the Egyptians' astronomical knowledge, because to a very high degree Egyptian astronomy was the severely practical servant of Egyptian time-reckoning. This was true over the long span of Egyptian written history, the three millennia before the Christian era.

Although during this time there were many references to the sun, moon, and stars in texts, and the planets were known and named, there is nothing approaching an astronomical treatise, such as those known from Babylonia, where the movements of the celestial bodies were studied and recorded. Before the Ptolemaic period, in fact, there is but one text, the *Cosmology* of Seti I and Ramses IV, that exhibits some thinking about astronomical matters; but these too are concerned mainly with time-reckoning. It was only with the Persian conquest in the middle of the first millennium B.C. and, two centuries later, with the advent of the Ptolemies, that Egypt became a fertile field for the transplant of foreign speculation and the study of the cosmos and its activities. Theoretical astronomical treatises appeared then, as did the zodiac and astrology. But this was long after the early splendid achievements of the Egyptians in calendar development and time-reckoning, and it is to these that we must first direct our attention.

## THE FIRST CALENDAR

The Egyptians, no more than any other primitive people, did not suddenly, one day, invent a calendar. It must have been the result of a long, slow

process of accretion and experiment. Before the desiccation of the Sahara plain of North Africa drove primitive man into the valley of the Nile, he was a hunter and food-gatherer. As such he would have come to some terms with the rhythm of the seasons. From the simple concept of the presence of the sun in the sky as day and its absence as night, he would surely have begun to notice the other large heavenly body, the moon, which had a regularity in its change from its reappearance as a thin crescent to its growth as full moon and then its gradual change back to crescent and final disappearance from the sky for two or three days. When he began to count, he would discover that from one disappearance to the next, or from one new crescent to the next, or from one full moon to the next, twenty-nine or thirty days would elapse. This concept of month might then be carried to the realization that usually twelve or thirteen of these larger units would cover the time from one natural event, such as the reappearance of a certain edible fruit, to its next occurrence after a period of time; this would be a year.

When the lack of rainfall in North Africa forced primitive man to abandon his nomadic life as a hunter and settle down near water, he had perforce to become mainly an agriculturist. In eastern North Africa the Nile valley proved to be an admirable haven. Some hunting was still possible in the marshes along the river, and the valley itself proved most fertile. Very quickly the primitive Egyptian discovered that the river was the dominant force in his new activity as a food producer. This mighty waterway had a life of its own. At a certain time it would begin to rise until it overran its banks and covered all the valley between the eastern and western cliffs except the higher ground of habitation. Slowly the water would retreat, the river would return to its bed, and planting could be done. As the river dropped, growth would take place and finally crops could be harvested. After a period of low water, the cycle would repeat itself. Through long experience the valley dweller came to divide his years into three seasons of four

months each, although he noticed that at times one season would appear to be five months long.

Through the years he came to notice that a remarkable celestial event took place just about the time that the Nile, after its long period of low water, began to rise again. The brightest star in the sky, Sirius (named Sothis by the Egyptians), would reappear on the eastern horizon just before sunrise, after a lengthy period of invisibility. This event is now called its heliacal rising, and in the Julian calendar (the predecessor of our Gregorian calendar) it fell around July 17/19 throughout Egyptian history.

The heliacal rising of Sirius-Sothis was thus recognized as heralding the coming inundation, and the first calendrical genius in Egypt used it as a peg on which to construct and keep in place a formal calendar year. The first season, *Akhet* (since the Egyptians wrote only consonants, the vocalizations are makeshifts), "Flood" or "Inundation," coincided with the rise and overflow of the river; the second was *Peret*, "Emergence"; and the third was *Shomu*, "Low Water" or "Harvest." Each season had four months, and each month was named after a special festival that took place in it. Thus, for example, the first month was named from the *Tekhy* feast; the third, from the feast of the goddess Hathor; the eighth (the fourth month of the second season), from the festival of the goddess of the coming harvest, Ernutet; and so on for all except the fourth month of the third season. Whereas all the other month names came from festivals that took place on days determined by the moon (such as the first day, the day of the first quarter or last quarter, the day of full moon), the twelfth month was named *Wep-renpet*, "Opener of the Year." This was taken from the name the Egyptians gave to the heliacal rising of Sirius-Sothis and was, of course, a stellar event. To keep this festival always within its proper month was a problem, since twelve months of varying length, either twenty-nine or thirty days, would average but 354 days, shorter than the natural or solar year by some eleven days.

The problem was solved by applying a simple rule. Whenever Sirius-Sothis rose heliacally (*Wep-renpet*) in the last eleven days of the twelfth month, an intercalary month was added to the year, lest in the next year the festival fall out of its month. Fittingly, the intercalary month was named *Thoth*, from a god associated with the moon. To illustrate this rule, if Sirius-Sothis rose heliacally on the third day of the month *Wep-renpet* in one year, in the following year it would rise on the

fourteenth day, and in the year after that on the twenty-fifth day. The intercalary month of *Thoth* would then be added to keep the feast of *Wep-renpet* from falling in *Tekhy*, the first month of the next year. Such a procedure would need to be utilized every three or, more rarely, two years.

Parenthetically, it should be noted that the Egyptians began a lunar month not with the reappearance of the crescent in the western sky, as did most ancient peoples using a lunar calendar, but with the day on which the old crescent was no longer visible in the eastern sky just before sunrise. Their calendar day, then, ran from sunrise to sunrise and not from sunset to sunset nor, like ours, from midnight to midnight.

How early this lunistellar calendar was systematized and adopted, we do not know. Written proof of it is lacking before the Fourth Dynasty, the middle of the third millennium B.C.; but there can be little doubt that it was employed for centuries before.<sup>1</sup>

## LATER CALENDARS

While other countries, such as Babylonia, that employed a lunar calendar with an intercalary month to keep it in harmony with the natural year, continued using such a calendar year exclusively throughout their history, Egypt took a different course. During the Predynastic Period and early into the Dynastic Period (the First Dynasty began about 3110 B.C.), the oscillation of the lunar year about the heliacal rising of Sirius-Sothis and its irregular length—now twelve, now thirteen months—were relatively minor inconveniences. With the advent of the dynasties, however, Egypt became a highly organized and efficient state. Such a year of irregular months, with the months themselves of irregular length, must have come to be regarded by officialdom as a great nuisance.

At this point the second unknown calendrical genius in Egypt made his contribution. He determined the length of the natural year to be 365 days. There are two ways he could have done this. He might have averaged the lengths of several lunar calendar years in succession (the average of eleven years would come very close to 365) or, more probably, he counted the days from one heliacal rising of Sirius to the next, since this event was the lunar calendar's control. Only very few years would be necessary to establish the figure of 365 days from one *Wep-renpet* to the next. With this figure firmly established, he organized the new

calendar as follows: The three seasons remained, but the four months in each were given a constant length of thirty days. Unlike the lunar month, which divides more or less evenly into four "weeks" based on "first day" to "first quarter" (seven days), "first quarter" to "full moon" (eight days), "full moon" to "last quarter" (seven days), and "last quarter" to "last day" (seven or eight days); the new thirty-day month was given ten-day "weeks" termed "first," "middle," and "last." In the entire year, then, there were thirty-six such ten-day weeks, or decades. The five remaining days were taken as a small intercalary month and were termed "the days upon the year" (later the Greeks called them the "epagomenal days"). This calendar with its constant length of 365 days has been acclaimed as "the only intelligent calendar which ever existed in human history."<sup>2</sup> The fact that it was constant made it the ideal calendar year for astronomy. Hellenistic astronomers and their successors until Copernicus used this Egyptian calendar for their planetary and lunar tables.

The introduction of the new "civil" year, as we may term it, did not mean the abandonment of the lunar year. Quite the contrary. Almost all important festivals continued to be determined by the moon—in this respect much like Easter Sunday, still set by the moon. The new civil year was an artificial creation, useful for accounting and administrative purposes but devoid of religious significance.

We do not know exactly when the new calendar was introduced, but we can set probable limits for this act. On the plausible assumption that when its use was inaugurated, the first days of both the lunar and the civil calendars coincided, this event must have fallen between *ca.* 2937 and *ca.* 2821 B.C. If the first day of the lunar year was only twelve days after *Wep-renpet*, the year would be *ca.* 2821 B.C.; if as much as forty-one days after (eleven plus an intercalary month of thirty days), the year would be *ca.* 2937 B.C.

The reason for this latitude of over a century lies in the fact that the true length of the natural year is, of course, not 365 days but almost exactly 365.25 days. The practical result of this was that the beginning of the new civil year, since its calendar did not have a leap year every four years, as ours has, began imperceptibly to move forward in the natural year. The civil year was, to be sure, planned to run concurrently with the lunar year. But since the latter was so variable, it would be a long time before the progress forward of the civil year became apparent. After fifty years—an ordi-

nary lifetime—the two years would still seem to be in good general agreement. After two centuries, however, there could be no doubt that the two calendars were in difficulty. Never, now, would the first month of the civil year and the first month of the lunar year coincide for even one day.

Superficially, it would have been easy to adjust this situation simply by adding some fifty days onto one civil year and thus bringing it back to the pattern of concurrency at its inauguration. For whatever reason—we may suppose that Egyptian bureaucracy would not have it—this solution was rejected. Instead, since this was apparently regarded as a religious problem, a new lunar year was created, one designed specifically to run in partnership with the civil year and so give substance to the latter's artificiality. Like the original lunar year, the new lunar calendar had an intercalary month when it was necessary to keep the lunar calendar in place. A very simple rule of intercalation was used. Whenever the first day of the lunar year would fall before the first day of the civil year, an intercalary month was added.

From this time on (about 2500 B.C.), Egypt had three calendar years, all of which remained in use until the end of pagan Egypt. As the centuries passed, certain festivals were given fixed dates in the civil year, while the new lunar calendar determined the lunar festivals that were not dependent on the natural year, such as the monthly full-moon feasts. The original lunar year, kept in place by the heliacal rising of Sirius-Sothis in its twelfth month, maintained its general agreement with the natural year and gave dates to all agricultural and seasonal events.

The civil calendar is the one most familiar to students, and the most important for historians, because all records were dated in it. A typical date would give the regnal year of the king who happened to be on the throne, followed by the month (I to IIII) of *Akhet*, *Peret*, or *Shomu* and the day of the month (1 to 30). Throughout most of Egyptian history, regnal and calendar years coincided, with the last fractional year of one king and the first fractional year of his successor together making one civil year. For a while, however, beginning in the Eighteenth Dynasty, a pharaoh began his reign with a full first regnal year that began on the day of his accession to the throne and ran for 365 days, thus encompassing parts of two civil years and at times creating dating problems for historians.

The civil year of course continued its slow progression through the natural year, until after some 1,460 years ( $4 \times 365$ ) it regained its original place

vis-à-vis the natural year. This period is known as the Sothic cycle, since the important chronological event of the heliacal rising of Sirius-Sothis (besides *Wep-renpet*, now also called *Peret-Sepdet*, "the Coming Forth of Sothis") would, generally speaking, fall for four years on I *Akhet* 1, for example, then for four years on I *Akhet* 2, and so on through the whole civil year. Occasional dates of *Peret-Sepdet* are of signal importance for chronology, since it is firmly established on the authority of Censorinus that there was a coincidence of *Peret-Sepdet* with I *Akhet* 1 in A.D. 139. Reckoning backward, we would expect a similar coincidence in 1322 B.C. and, before that, in 2782 B.C. In fact, since the star Sirius has a movement of its own, the coincidences must be computed from astronomical tables, and come out as more likely in ca. 1317 and ca. 2773 B.C. For example, there is a temple record dating one occasion of *Peret-Sepdet* to IIII *Peret* 16 of the seventh year of Sesostri III of the Twelfth Dynasty. Other historical data place this dynasty in the early second millennium B.C. The Sothic date narrows the seventh year of Sesostri III to 1870 B.C.  $\pm$  about six years. Some lunar dates of the same king enable us to pin the year down to 1872 B.C.; and since we know how long the kings of this dynasty reigned, we can fix them all chronologically.<sup>3</sup>

By the New Kingdom, and from then on, the months of the civil year were at times referred to by names, some of which are the same as those of the original lunar calendar months, while others witness the introduction of new and important feasts. As written later by the Greeks, the names are shown below.

| FIRST<br>SEASON | SECOND<br>SEASON | THIRD<br>SEASON |
|-----------------|------------------|-----------------|
| <i>Akhet</i>    | <i>Peret</i>     | <i>Shomu</i>    |
| 1. Thoth        | 5. Tybi          | 9. Pachons      |
| 2. Phaophi      | 6. Mechir        | 10. Payni       |
| 3. Athyr        | 7. Phamenoth     | 11. Epiphi      |
| 4. Choiak       | 8. Pharmuthi     | 12. Mesore      |

In these names it is possible to recognize the goddess Hathor in the name of the third month and, in the eighth month (with slight change), the harvest goddess Ernutet (*Pha* or *Pa* means "The One of").

There is no evidence whatever to suggest that after the civil calendar was installed, it was adjusted to arrest its forward movement in the natural year prior to 239 B.C., when Ptolemy III Euergetes issued the Decree of Canopus, which made every

fourth year a leap year with a sixth epagomenal day. No attention, however, was paid to this decree and the civil year continued exactly as before.<sup>4</sup> It was not until the time of Augustus, over two centuries later, in 30 or possibly 26 B.C., that a leap year was firmly established. From that time on, the reformed civil calendar was known as the Alexandrian calendar.

Nevertheless, the old civil calendar remained in use—and not only by astronomers. One of these, however, whose name is still unknown, wrote a papyrus (Papyrus Carlsberg 9) that represents the one astronomical and mathematical text we now have from the last centuries B.C. that is certainly Egyptian in origin. Although it was written no earlier than A.D. 144, it surely goes back for its material to the fourth century B.C.<sup>5</sup> The text itself is a cyclical scheme over twenty-five years for beginning the months of the later lunar year without the necessity of observing the moon. While the papyrus gives only dates in alternate months of the civil calendar, it is possible to deduce, from other sources, the rules governing the dates in the intervening months and thus to reconstruct the entire cycle.<sup>6</sup> Table 1 gives the completed cycle.

Underlying the cycle are the astronomical facts that twenty-five years have 9,125 days and 309 lunar months have 9,124.95231 days. Over twenty-five civil years, nine intercalary months are necessary to prevent the first day of the lunar year from falling before the first day of the civil year; they occur in cycle years 1, 3, 6, 9, 12, 14, 17, 20, and 23. As we should expect, the first lunar month begins on I *Akhet* 1. For 357 B.C., when it is possible that the cycle was installed (plus or minus some fifty years) and the morning of crescent invisibility remained the first day of the new month, a test by calculation for the twenty-five dates in cycle years 1 and 2 shows that eighteen of them are in agreement with observation. It is likely that the figure of 72 percent correctness would hold for the entire cycle; and given the simplicity of the scheme, this is no mean achievement. In time, however, since the lunar months were .04769 of a day short over twenty-five years, this deficiency would accumulate. In five hundred years the cycle would be about one day off and would no longer agree with the mornings of crescent invisibility but, rather, with the evenings of first crescent visibility, normally one day later and the basis for the month's beginning in the Macedonian, Hebrew, and Babylonian calendars. We know that this result was anticipated by the Ptolemies using the Macedonian calendar, since they took over the

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| Months<br>Year | AKHET |    |      |      | PERET |    |      |      | SHOMU |    |     |      | Ep. |
|----------------|-------|----|------|------|-------|----|------|------|-------|----|-----|------|-----|
|                | I     | II | III  | IIII | I     | II | III  | IIII | I     | II | III | IIII |     |
| 1              | 1     | 1  | 1-30 | 30   | 29    | 29 | 29   | 28   | 27    | 27 | 27  | 26   | Ep. |
| 2              | 20    | 20 | 19   | 19   | 18    | 18 | 18   | 17   | 16    | 16 | 16  | 15   | 1   |
| 3              | 9     | 9  | 8    | 8    | 7     | 7  | 7    | 6    | 5     | 5  | 5   | 4    | 2   |
| 4              | 28    | 28 | 27   | 27   | 26    | 26 | 26   | 25   | 24    | 24 | 24  | 23   | 3   |
| 5              | 18    | 18 | 17   | 17   | 16    | 16 | 16   | 15   | 14    | 14 | 14  | 13   | 4   |
| 6              | 7     | 7  | 6    | 6    | 5     | 5  | 5    | 4    | 3     | 3  | 3   | 2    | 5   |
| 7              | 26    | 26 | 25   | 25   | 24    | 24 | 24   | 23   | 22    | 22 | 22  | 21   | 6   |
| 8              | 15    | 15 | 14   | 14   | 13    | 13 | 13   | 12   | 11    | 11 | 11  | 10   | 7   |
| 9              | 4     | 4  | 3    | 3    | 2     | 2  | 2    | 1    | 1-30  | 30 | 30  | 29   | 8   |
| 10             | 24    | 24 | 23   | 23   | 22    | 22 | 22   | 21   | 20    | 20 | 20  | 19   | 9   |
| 11             | 13    | 13 | 12   | 12   | 11    | 11 | 11   | 10   | 9     | 9  | 9   | 8    | 10  |
| 12             | 2     | 2  | 1    | 1    | 1-30  | 30 | 30   | 29   | 28    | 28 | 28  | 27   | 11  |
| 13             | 21    | 21 | 20   | 20   | 19    | 19 | 19   | 18   | 17    | 17 | 17  | 16   | 12  |
| 14             | 10    | 10 | 9    | 9    | 8     | 8  | 8    | 7    | 6     | 6  | 6   | 5    | 13  |
| 15             | 30    | 30 | 29   | 29   | 28    | 28 | 28   | 27   | 26    | 26 | 26  | 25   | 14  |
| 16             | 19    | 19 | 18   | 18   | 17    | 17 | 17   | 16   | 15    | 15 | 15  | 14   | 15  |
| 17             | 8     | 8  | 7    | 7    | 6     | 6  | 6    | 5    | 4     | 4  | 4   | 3    | 16  |
| 18             | 27    | 27 | 26   | 26   | 25    | 25 | 25   | 24   | 23    | 23 | 23  | 22   | 17  |
| 19             | 16    | 16 | 15   | 15   | 14    | 14 | 14   | 13   | 12    | 12 | 12  | 11   | 18  |
| 20             | 6     | 6  | 5    | 5    | 4     | 4  | 4    | 3    | 2     | 2  | 2   | 1    | 19  |
| 21             | 25    | 25 | 24   | 24   | 23    | 23 | 23   | 22   | 21    | 21 | 21  | 20   | 20  |
| 22             | 14    | 14 | 13   | 13   | 12    | 12 | 12   | 11   | 10    | 10 | 10  | 9    | 21  |
| 23             | 3     | 3  | 2    | 2    | 1     | 1  | 1-30 | 30   | 29    | 29 | 29  | 28   | 22  |
| 24             | 22    | 22 | 21   | 21   | 20    | 20 | 20   | 19   | 18    | 18 | 18  | 17   | 23  |
| 25             | 12    | 12 | 11   | 11   | 10    | 10 | 10   | 9    | 8     | 8  | 8   | 7    | 24  |

TABLE 1. The Lunar Calendar Cycle (R. A. Parker, *The Calendars of Ancient Egypt*, 25).

Egyptian twenty-five-year cycle in the third century B.C. and added one day to every date in it, thus effectively converting the cycle to suit their own requirements.<sup>7</sup>

## THE HOURS OF THE NIGHT AND DAY

Thus far we have been concerned with time measurement as determined by natural events—the day, the month, and the year—and have seen that no smaller unit goes evenly into the larger one. The lunar month has no exact number of days, and the natural or solar year has neither an exact number of days nor an exact number of lunar months. These elements of time measurement have to be fitted to one another by some calendrical scheme that, while arbitrary, attempts to preserve the essential relationship of the units. Thus our own calendar still keeps to twelve months in the year and twenty-eight to thirty-one days to a month, although the result is an awkward instrument.

There are, however, no natural subdivisions of

the day beyond light and darkness. A minute of sixty seconds, an hour of sixty minutes, and a day of twenty-four hours have completely arbitrary subdivisions. Nothing in nature requires that the day should be divided into twenty-four parts. That it is so divided is a by-product of the established civil calendar and the ancient Egyptians' desire to break the night into smaller units.

Why the Egyptians desired to do this is a matter of inference, since there is nothing in the written records that have come down to us to explain their action. From late temple calendars of feasts, we do know that some feasts were celebrated at night; and occasionally we are told that certain rites must be performed at a specific hour of the night. There can be little doubt that what was the late custom also obtained in much earlier times. Over and above such individual feasts, however, was the obsession of the Egyptians with the passage of the sun god Re through the Other World, or Duat, from sunset until sunrise of the next day. There are a number of religious treatises, such as the "Book of Him Who Is in the Underworld," the "Book of

[illegible]

FIGURE 1. Schematic star clock.

Gates," and the "Book of Day and Night," that trace his passage in his night bark, with his crew of gods and goddesses, through dangers and difficulties until once again he rises triumphantly in his day bark and illuminates the Two Lands, Upper and Lower Egypt. In all of these the Other World is divided into twelve regions, and in each of these regions the sun god spends one hour of the night. We do not have such books written earlier than the New Kingdom (ca. 1500 B.C.); but in one of the pyramid texts of the last king of the Fifth Dynasty, Unas (twenty-fourth century B.C.), he "clears the night and dispatches the hours." In Egyptian the word for "hour" is written with a star.

At some time before Unas, then, but after the civil calendar was adopted, another unknown Egyptian astronomer devised a scheme to divide the night into parts by using the apparent movement of the stars. We know that this apparent movement is due to the rotation of the earth on its axis and its travel about the sun. He did not. For him the stars did rise, traverse the sky, and set, like the other heavenly bodies. He had studied the stars and had grouped many of them into constellations to which he gave names such as *Nakht* ("Giant"), *Reret* ("[female] Hippopotamus"), *Sah* (our Orion), *Meskhethiu* ("Foreleg" or "Adze," our Big Dipper). He knew that certain stars, which we call "circumpolar," never set. These he called the "indestructible stars." He had studied Sirius-Sothis, the most important star; and he knew that when it disappeared from the sky, it was some seventy days before it reappeared in its heliacal rising. He knew that other stars followed the pattern of Sirius, with a similar period of invisibility and then a heliacal rising. His concentration was on the eastern horizon, more than the western. It was

there that Sirius reappeared to announce the coming inundation. It was there that the last crescent was no longer to be seen and the new lunar month began. It was there that the morning star appeared, to which there are so many references in the earliest religious texts in the pyramids and with which the king sought identification. These texts never mention an evening star.

Our unknown astronomer also knew that a star rising heliacally, which might then for a time be called the morning star, did not stay on the horizon but every day was a little higher in the sky at sunrise. After some days another bright star might rise heliacally, and this in turn might be named the morning star. His brilliant scheme to divide the night was simply to go through one year of the civil calendar and pick a star or group of stars, which we now conventionally term "decans," that rose heliacally on the first day of each of the thirty-six decades or ten-day weeks of the year. During the night, then, he called the interval between the rising on the eastern horizon of one such decanal star and the rising of its immediate follower an "hour."

It is not, however, until the middle of the twenty-second century B.C. that we know with certainty that these "hours" totaled only twelve. The proof comes from diagrams on the underside of the lids of some coffins, buried during the Eleventh Dynasty, that were first known as "diagonal calendars" but are now correctly termed "star clocks." Figure 1 is a schematic version of such a clock, and all the examples we have follow it to some degree of completeness. It is to be read from right to left. The upper horizontal line T is the date line, beginning with the first decade of the first month of *Akhet* in the first column and running to the thirty-sixth column with the last decade of the last month

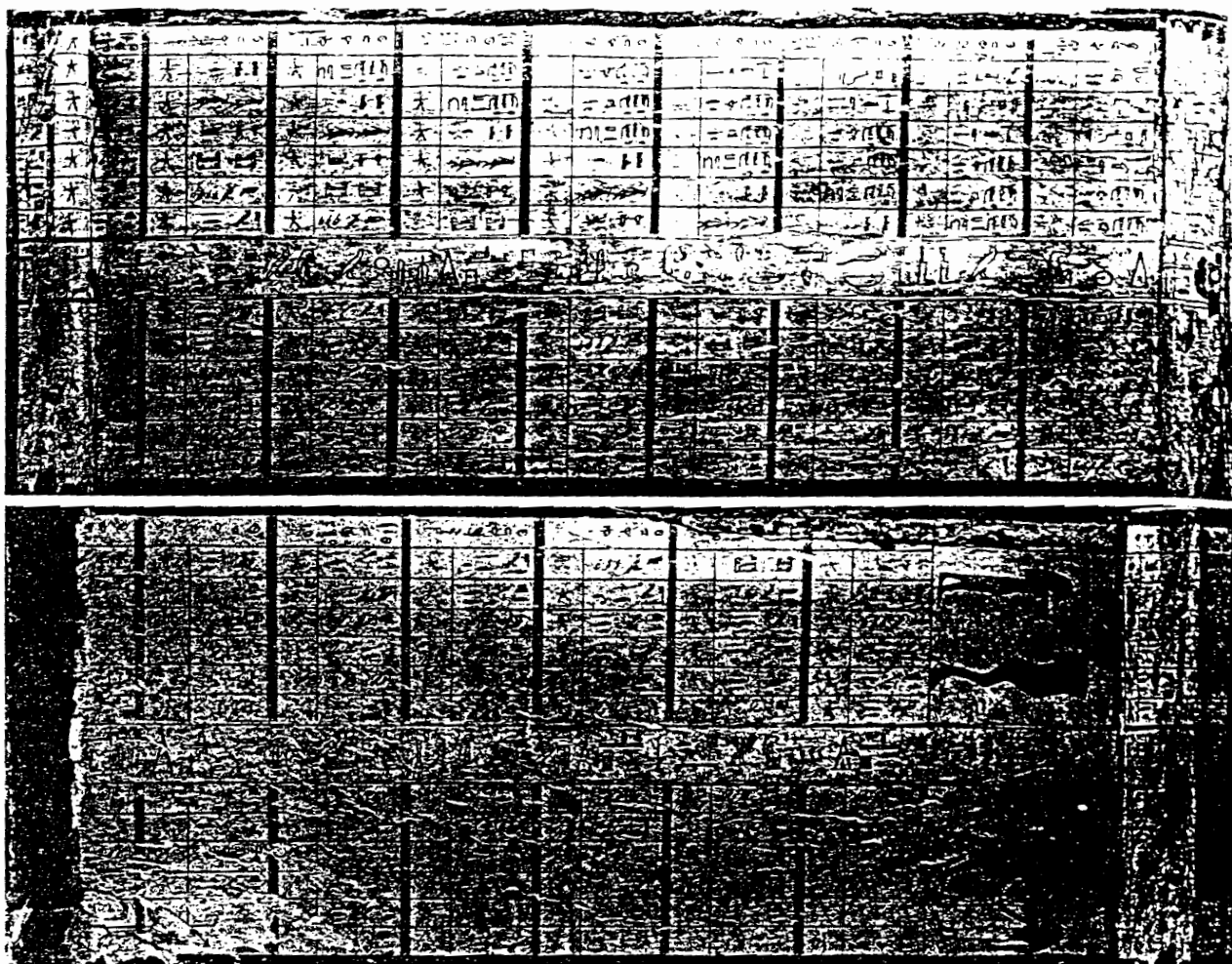


PLATE 1. Star clock of Idy (Sammlung des Ägyptologischen Instituts der Universität Tübingen, no. 6)

of *Shomu*. In the decade numbered 26 there begins a triangle of alternate decans to tell the hours of the five epagomenal days. Intruding before the epagomenal days column (40) are three columns that merely list the thirty-six decans of the preceding columns. Each column lists twelve hours. Between the sixth and seventh hours is a horizontal inscription (R) that is a funerary prayer that the sun god Re and other celestial deities will provide the dead person with offerings. Separating the eighteenth and nineteenth columns is a space (V) wherein are depicted Nut, the goddess of the sky, the Foreleg of an Ox (the Big Dipper), the constellation *Sah* (Orion) as a god, and Sothis as a goddess.

The actual star clock for a man named Idy is shown on Plate 1. It is not complete, since it has only eighteen decade columns; but it well illustrates the features just discussed and provides

graphic evidence of the progress of a decanal star from the twelfth hour to the first hour, after which it drops from the clock. The probability is that the rising of a decanal star showed the end, not the beginning, of its hour. From still later texts in the cenotaph of Seti I at Abydos,<sup>8</sup> we learn that there was a conscious effort by the early astronomer to choose decanal stars invisible for seventy days, just like Sirius. Such stars would all fall in a band south of and parallel to the ecliptic. Figure 2 shows Sirius and Orion, a constellation that provided several decanal stars, in the decanal band.<sup>9</sup>

It is obvious that hours determined in this fashion were not all of equal length. As the night grew longer, the last hour before dawn would be longer; and this process would go on until the night began to shorten, at which time dawn would begin to come earlier and the last hour before it would shorten. Such hours of varying length may be called "sea-

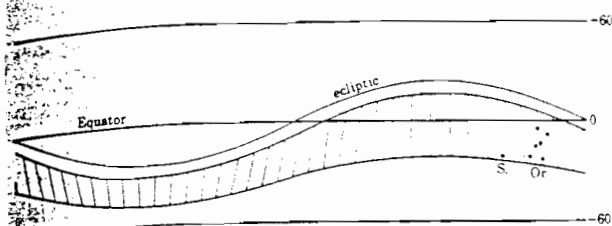


FIGURE 2. The decanal band, with Orion and Sirius-Sothis as hour stars.

sonal" hours, since twelve winter night hours are individually much longer than twelve summer night hours, although, strictly speaking, "seasonal" hours are one-twelfth the time from sunrise to sunset or from sunset to sunrise.

That there were but twelve hours reckoned, when at any one time there were always eighteen decanal stars visible from horizon to horizon, is explained by the necessity to take into account morning and evening twilight. The length of time it takes for the brightest stars to appear is termed "civil" twilight, and it averages about half an hour. From sunset until all stars are visible ("astronomical" twilight) takes longer, and may be well over an hour. The decans measured only the time of total darkness. Moreover, in any one night only the interior hours (two to eleven) would be of the same length throughout a decade. One may well assume that the first hour would begin with darkness and run until the rising of a certain decanal star. This first hour would be longest at the beginning of a decade, since on each night thereafter the star ending the hour would rise a little earlier. The twelfth hour, however, would gradually lengthen if, as is probable, it would be taken as ending with morning twilight, even though the decanal star that rose heliacally on the first day of the decade would be visible a little earlier in darkness on each succeeding day of the decade.

It is important to observe that the twelve-hour division of total darkness, with two to three "hours" of twilight after sunset and before dawn, is the direct result of the division of the civil calendar into thirty-six decades. We have only to assume that the year had been divided not into ten-day but five-day "weeks." There would then have been thirty-six pentades of stars from horizon to horizon, and the division of total darkness would have been into some twenty-six "hours."

There appears to be no other explanation for the hours of the day being taken as twelve except analogy with those of the night.<sup>10</sup> Presumably the earliest information we have on the day hours is from a

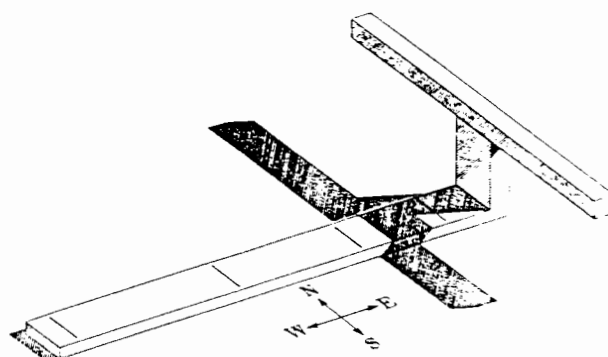


FIGURE 3. Shadow clock.

funerary text—and so a text of some antiquity—in the cenotaph of Seti I (1303–1290 B.C.) that gives directions for constructing a shadow clock. This has a base with four divisions marked on it and with a raised crossbar at its head (Figure 3). The text informs us that, with the head to the east, four hours are indicated by shadows that grow shorter and shorter. The instrument is then reversed with head to the west, and four more hours are marked off. More importantly, the text ends with the statement that two hours pass before the shadow clock tells the first hour and two more pass after the clock itself has finished. It is a reasonable conclusion that these two hours, before and after the eight hours determined by the shadow clock, are divided by the phenomena of sunrise and sunset; and the first and last hour of the whole period of daylight were morning and evening twilight, respectively.

From the division of total darkness into twelve hours and of daylight, including the two twilights flanking it, into twelve hours, the next step for which we have evidence was the division of daylight, from sunrise to sunset, into twelve hours. A shadow clock from the time of Thutmose III (1490–1436 B.C.) has five divisions on its base, so that the first and twelfth hours must have been those before and after the sun shone on it. The corresponding division of the period from sunset to sunrise into twelve parts could not have been effected by the stars and must have been done by a water clock. The earliest water clock we have, however, dating from Amenhotep III (1397–1360 B.C.) but reflecting the calendar situation about 1540 B.C., still divided only total darkness and was used, as a later text informs us, only when the stars could not be seen.

With the water clock, however, came the means for developing the concept of "equal" as opposed

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to "seasonal" hours. This is hinted at in a sadly mutilated inscription in the tomb of one Amenemhet (time of Amenhotep I, 1545–1525 B.C.), who is thus the first astronomer we can name in ancient Egypt.<sup>11</sup> The change in length of the nights is discussed with a presumable ratio of the longest to the shortest as fourteen to twelve. That this is a very poor approximation is obvious, but it paved the way for a text on papyrus that clearly proves the existence of equal hours. Again, although the papyrus itself is from the Ramesside period (twelfth century B.C.), it reflects an earlier calendrical situation, about 1300 B.C., since the shortest night falls in the last month of the third season, the last month of the year. For every month the text gives the hours of day and night, with the extremes of eighteen to the day and six to the night, and vice versa six months later. Such figures can be explained only on the basis that the six night hours were those of total darkness on the shortest night of the year, and then the astronomical scribe simply employed a linear increase and decrease of two hours to each month.<sup>12</sup> The correct ratio for Egypt of longest to shortest day or night is more correctly fourteen to ten.

Egypt's contribution to our time-reckoning did not go beyond the concept of twenty-four equal hours to the day. It is to the Babylonians, with their sexagesimal system, that we owe the division of the hour into sixty minutes and the minute into sixty seconds. We have not, however, exhausted the Egyptian efforts to make easier the telling of the hours of the night.

### THE DECANS IN TRANSIT

We have seen that the star clocks of the Eleventh Dynasty determined the hours by the risings of the decanal stars. With adjustments from time to time, necessitated by the forward movement of the civil calendar in the natural year, such clocks continued in use into the Twelfth Dynasty (1991–1786 B.C.). At that time, however, it would appear that decanal risings were abandoned in favor of the transits of the decans. We learn this from later texts that have already been mentioned, the Cosmology of Seti I and Ramses IV.<sup>13</sup> Although there is much mythology in the content of the texts that surround a ceiling depiction of the goddess of the sky, Nut, bending over the earth, Geb, and supported by Shu, god of the air, there are a few texts that embody the first astronomical thinking of the ancient Egyptians so far known to us.

Most important is the concept that the stars and sun are linked as heavenly bodies that disappear and reappear in the sky. At sunset the sun goes to the Duat, where he spends the twelve night hours journeying from west to east. The decanal stars also disappear, for the lengthy period of seven days that they spend in the Duat. When a star leaves the Duat, it is born again at its heliacal rising. It then spends eighty days in the eastern sky before embarking upon 120 days of work in telling the hours (ten days for each hour) with its transit of the meridian. When the star finishes work, having indicated the first hour of the night, it spends ninety days in the western sky and then dies again. One text says:

As for (what is) between the star which makes the first hour and the star which will be enclosed by the Duat, it is 9 (stars). Now as for (what is) between the star of birth to the star which makes the first hour, it is 20 stars; which gives 29, being those which live and work in the sky. One dies and another lives every decade (of days). Now as for (what is) between the star of birth and the star which will be enclosed by the Duat, it is 29 through that breadth of the sky as stars.<sup>14</sup>

[In this, as in the following extracts, the symbols ( ) indicate additions by the translator, [ ] restorations, and < > emendations.] Thus at any one time there were seven stars in the Duat, eight in the east, twelve in the middle of the sky working, and nine in the west. It is clear that we have here a simplified scheme of stellar activity, based on a year of only 360 days. As such, corrective factors would need to be continuously applied, but there is no evidence for them.

A further consequence of a shift from rising to transiting decans was an extensive rearrangement of the decans themselves. While successive rising stars on the horizon might mark off an hour nicely, the same stars, in transit, might be too close or too far from one another. In the list of thirty-six rising decans of the star clock nearest in time to the transit list, only twenty-three remain in the same relative positions. The remaining thirteen stars are either newly selected ones or have changed their places.

After the Twelfth Dynasty there is no contemporary evidence for any decanal star clocks. One from the time of Merneptah (1223–1211 B.C.), while the latest we have, is purely funerary in purpose; and its antiquity is such that its arrangement of stars in the civil year could suit only a time some six centuries earlier.

We do have many lists of decans from later monuments extending well into the Roman period, but these are never in the form of a star clock. One can surmise, of course, that any observer had only to memorize a list of thirty-six decans, rising or transiting, watch to see which one was rising or transiting, just after evening twilight, and then use the risings or transits of the next twelve decans to mark the night hours. This could have been done, but again there is no evidence for it.

### THE RAMESSIDE STAR CLOCKS

Following the discovery of the water clock, alluded to above, a new type of star clock was invented no later than the middle of the second millennium B.C.<sup>15</sup> Three centuries later the ceilings of three royal Ramesside tombs were adorned with the twenty-four tables (two to a month) of a new clock (Plate 2). The basis for telling the hours remained transits, but these were not always of the meridian. Short distances before or after the meridian were indicated by such phrases as "on the right eye" or "on the left eye," "on the right ear" or "on the left ear," "on the right shoulder" or "on the left shoulder," while the meridian itself was known as "opposite the heart." "Right" and "left" are from the viewpoint of a seated observer facing a seated man, the target figure, to his exact south. In Plate 2 the target figure is shown below a chart of seven inner vertical lines crossed by thirteen lines of text and with thirteen stars entered on it. The first line gives the position of the star that begins the night; and the following twelve lines detail the stars that end the twelve hours, with their positions. In the example shown, six stars are "opposite the heart" and so on the meridian, the central vertical. The first of these begins the night. Two stars are "on the right eye" and five "on the right shoulder," although three of these are to one side of the vertical.

Such relatively fine distinctions in transit clearly imply that a water clock was utilized to construct the tables. There are, as well, other differences from the decanal star clocks based on risings. In the latter the list of stars remains constant from one decade to the next, as do the lengths of the hours. In the new clock, stars change position from table to table and at times drop out entirely, replaced by new stars, with the lengths of hours varying accordingly. Very few decanal stars appear in the new clocks, but these include Sirius-Sothis and Orion, so it is a safe conclusion that the new



PLATE 2. Hour table, tomb of Ramses VII.

set of hour stars is in the southern sky and in a band that parallels and probably slightly overlaps the decanal belt. This would be a convenient arrangement for an observer sitting due north of and facing the target figure, perhaps on a temple roof, and using a plumb bob (in Egyptian, a *merkhet*) to determine the hours.

### ASTRONOMICAL MONUMENTS

In our discussion of the development of the hours, we have become acquainted with some of the sources for our knowledge of the astronomy of the ancient Egyptians. The earliest monuments we have are the star clocks on the insides of coffin lids. These number twelve, ranging from the Ninth to the Twelfth dynasties (between ca. 2150 and ca. 1800 B.C.). The Cosmology of Seti I and Ramses IV, together with the Ramesside star clocks (ca. 1300-1100 B.C.), introduced us to astronomical monuments on the ceilings of royal tombs. In all, more than eighty monuments are now known.

apart from the early coffin lids, that are concerned to some degree with astronomy. Most of these are on ceilings of royal or private tombs or of temples. The insides of some coffin lids from the Greco-Roman period bear zodiacs. Very few of the monuments are nonfunerary: these are several water clocks that have astronomical depictions on the outside.

Many of the monuments incorporate lists of decans, although they are not arranged so as to serve as star clocks. When all these lists are compared with one another, the variants in them permit a grouping into five families, three of rising decans, one of decans in transit, and one that cannot be assigned with certainty to either. Named from the first example of each, we have the Senmut, Seti I A, and Seti I C families of rising decans. The Seti I B family, made up of the decans associated with the cosmologies we have already discussed, is one of transiting decans. Tanis names the family of uncertain application. It is late in origin, and seems to be of artificial construction and unusable as a true star clock.

Many other elements can enter into the composition of an astronomical monument. The decans are given individual figures, and various deities are associated with them. The planets are shown in characteristic images. Various constellations, particularly a group called "northern," appear. In the Greco-Roman period zodiacs are incorporated. A monument also may have cosmic deities, such as those of the sky, air, and earth; calendar elements; figures of the hours of day and night; the goddesses of the cardinal points; and mythological figures of the four winds, although these are all less frequent.

As an illustration of an astronomical ceiling we may analyze the earliest one presently known. It is from the unfinished tomb of Senmut, an official of Queen Hatshepsut (*ca.* 1473 B.C.). Plate 3 is oriented so that the top is south and the bottom north. Correctly, then, since we have seen that the decanal belt is south of the ecliptic, the list of rising decans is above. It begins on the right, or east, and the first six columns list eleven decans, after which a horizontal line separates single decans from their associated deities below the line. What this means is that the decanal arrangement of the Senmut ceiling is based on the first column and the twelfth hour line of a diagonal star clock (see Figure 1). While some decans are reversed and there is confusion in the Orion decans, the model is perfectly clear. The last decan is that of Sirius-Sothis, in the first large column, portrayed as the goddess Isis in a bark. Her position as decan 36 means that the star clock

that served as the model for this arrangement can be dated four centuries earlier, at the end of the Twelfth Dynasty—another example of functional antiquarianism. Before Isis-Sothis is the figure of Orion, also in a bark, with body facing the goddess but with head turned away. Among the other figures shown before Orion are those of a bark with sheep (not to be confused with the zodiacal Aries), both of which have several decans associated with them.

After the thirty-sixth decan of a star clock one expects to find the twelve "triangle" decans for epagomenal days. Six of these do appear after Sothis (one is shown as two turtles), but the others have been replaced by four of the five planets: Jupiter and Saturn, both in the image of the sky god Horus in barks, precede the decans. Mercury and Venus follow them, with Venus shown as a cat in the last column. Mars is omitted, whether intentionally, because it was invisible in the sky at the time this arrangement was first drawn, or through oversight. On other, later ceilings Mars follows Saturn and is usually depicted as a form of Horus, like Sothis and Jupiter, standing in a bark.

Below a central section of five lines of text, the largest of which lists the titles of Senmut, is an interesting combination of astronomical and calendrical elements. Roughly in the center is a group of constellations called "northern" because they are always found in that part of an astronomical monument that exhibits orientation. These include twelve circles with twenty-four segments (that presumably represent the twenty-four hours of the day) into three groups of four. From the names at the top of the circles we know that they represent the months of the lunar calendar, beginning with the month of *Tekhy* in the upper right, running around and returning to the twelfth month of *Wep-re* below *Tekhy*. The three groups are thus the three seasons. Flanking the northern constellations are two rows of deities, whom we know from other sources to be those of days of the lunar month,<sup>16</sup> except for Isis, who heads the right-hand file. It became conventional on later ceilings to retain the lunar day deities with the northern constellations while omitting the lunar month circles, thus establishing an apparent association of deities and constellations that had no basis in fact.

### THE NORTHERN CONSTELLATIONS

On the Senmut ceiling, at the top of the column of constellations and, by comparison with other monuments,

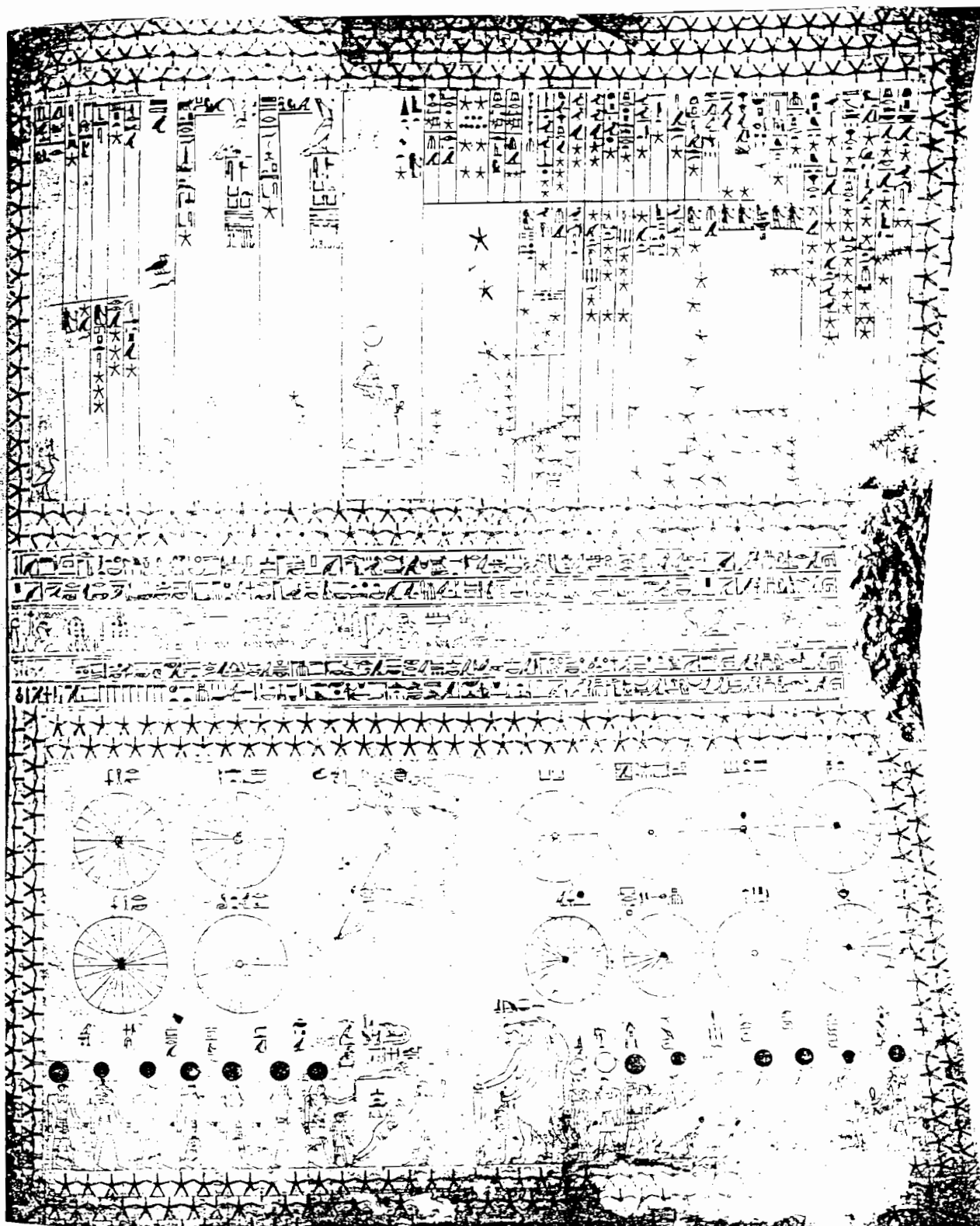


PLATE 3 Ceiling, tomb of Senmut.

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rather out of place through the necessity of separating the month circles into seasons, is a group including the figure of a bull with tiny legs on an oval body. A ceiling in the tomb of Seti I (Plate 4) has a much more realistic bull. Both are portrayals of the constellation we call the Big Dipper—the one certain identification that can be made in all the northern group. Called *Meskhietiu* by the Egyptians, it may be depicted merely as the foreleg of a bull, such as on the coffin lid of Idy (Plate 1) and on certain later monuments. To the bull's right stands a female hippopotamus with a crocodile on her back and her hands on a mooring post (Seti I) or on a mooring post and a smaller crocodile (Senmut). This is the other constellation always shown with the Foreleg or Bull, from Senmut's time on. The other elements may or may not be present, but these two were essential. Their relationship is mentioned in a number of mythological texts, such as this from the Book of Day and Night (time of Ramses VI): "As to this Foreleg of Seth, it is in the northern sky, tied to two mooring-posts of flint by a chain of gold. It is entrusted to Isis as a Hippopotamus guarding it."<sup>17</sup> Isis, as the wife of Osiris, thus protects him from his inimical brother Seth. The chain is visible on Seti I's ceiling but not on that of Senmut.

Like the decan lists, the monumental depictions of the northern constellations fall into groups with

variations in details although the main elements are commonly present. Thus on Senmut a falcon-headed god An is apparently spearing the Bull, while on Seti I he supports it. The constellation of the goddess Serket is above and behind the Bull on Senmut, while on Seti I she is to its left. On Seti I the constellation Lion has a Falcon over its head that is replaced in Senmut by a small Crocodile (*Sak*). In both an unnamed Man is apparently spearing a second crocodile constellation under Lion, although the spear is lacking. Lion's name in full is "Divine Lion, Who Is Between Them"—that is, between the two Crocodiles. On Seti I another unnamed Man holds the chains between the Hippopotamus and the Bull, but on Senmut he is not present.

Moreover, on Senmut there are traces of an earlier and different arrangement of Lion and Crocodile, with the spearing Man omitted. It is just such variations as these, in inclusion or omission of constellations or in their positions relative to one another, that make any attempt at identification of the constellations other than the Big Dipper a hazardous one. We can be reasonably sure that they all belong in the northern sky in opposition to the decanal belt, but we cannot be sure that they were all circumpolar and never-setting (and thus called in Egypt the "indestructible stars"), although no doubt some of them were.

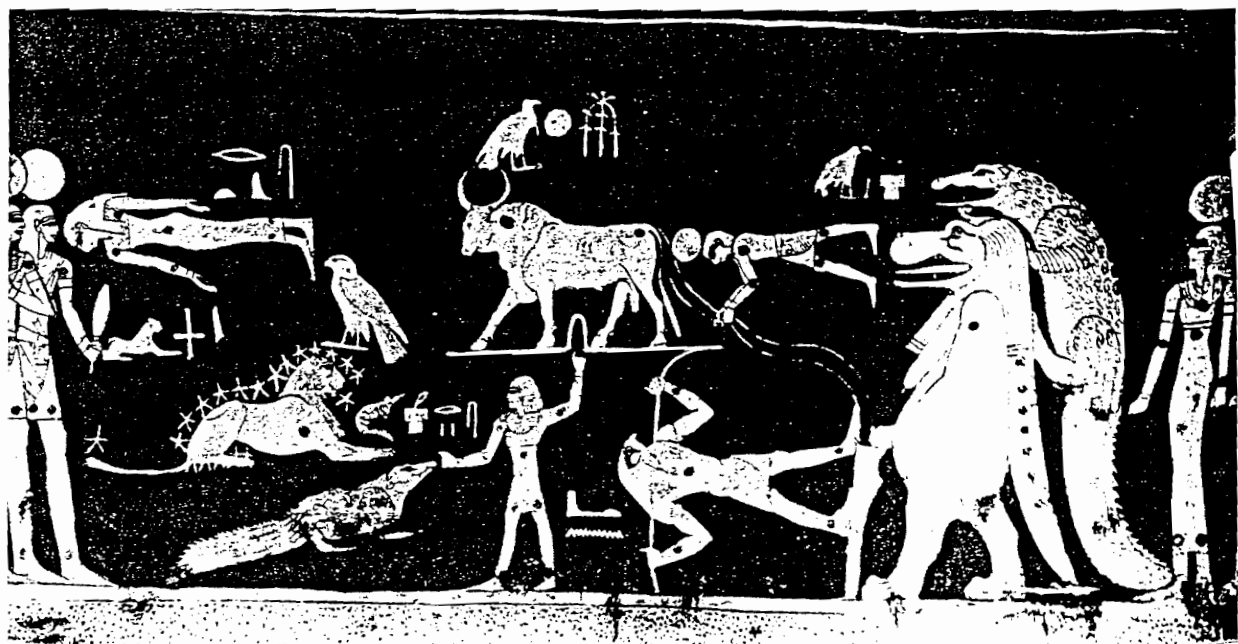


PLATE 4. Northern constellations, tomb of Seti I.

## THE PLANETS

All the planets were surely recognized and named long before we have textual evidence to support such a statement. Anyone using a star clock could not fail to notice the five bright stars changing their positions among the fixed ones. But it is not until the ceiling of Senmut that we have the planets depicted, with only Mars absent. Mars is present with the others, less than two centuries later, on the tomb ceilings of Seti I and Ramses II; and they are all frequently found on later ceilings. The usual order on the earlier monuments is Jupiter, Saturn, Mars, Mercury, and Venus—but this order, rather surprisingly, has no demonstrable factual basis. When the planets are separated, as by the triangle decans, the first three, the outer planets, are usually grouped together, with the second group made up of the inner planets. Mercury and Venus, Jupiter, Saturn, and Mars were all considered to be aspects of Horus, the falcon god of the sky. Jupiter was "Horus Who Bounds the Two Lands" or "Horus Who Illuminates the Two Lands" at first, and later "Horus Who Illuminates the Land" or "Horus Who Opens Mystery." Saturn was "Horus Bull of the Sky" or "Horus the Bull," with no later change. Mars was "Horus of the Horizon" or "Horus the Red." When depicted, the planets were usually shown as falcon-headed gods with human bodies, a star above the head, standing in barks. On the latest monuments Jupiter may be human-headed or be only a falcon; Saturn may be bull-headed with human or falcon body; and Mars may be human-headed or a falcon with a serpent tail. Still other variations were possible.<sup>18</sup>

Mercury had the name *Sebeg(u)*, but its meaning is not known. The god associated with Mercury was Seth, an enemy of Horus and his father, Osiris. Shown with human body and characteristic animal head, Seth's figure was frequently mutilated or replaced on early monuments by reason of his hostile nature. Venus was early pictured as a heron, with the name "Crosser" or "Star Which Crosses." Later she was known as "Morning Star" and was frequently given human form, either falcon-headed or, occasionally, two-headed or two-faced.

The names of the planets and the bits of text with them tell us little about the outer planets except that "Horus the Red" can only be Mars. We are better off with the inner ones. Venus' name "Crosser," together with two faces or two heads, should mean that it was recognized as both morning and evening star as early as the Senmut ceiling,

where it bears the name although it is shown as a heron. The other inner planet, Mercury, was certainly known to be both evening and morning star at an early date, since we have a text from the tomb of Ramses VI (1148–1138 B.C.) stating that Mercury is "Seth in the evening twilight, a god in the morning twilight." The suggestion is that as evening star and Seth, Mercury was malevolent, while as morning star he may have been quite different. It seems probable, then, that by the middle of the second millennium B.C. the Egyptians were aware that the morning and evening stars were but one star, crossing the sun, and that this was either one of the two inner planets.

Identification of the planets from their names only was speculated about by early scholars; but it was not until the Stobart Tablets, written in Demotic of the Roman period, were successfully read by Heinrich Brugsch as giving the dates of entry of the planets into the zodiacal signs for years in the reigns of Vespasian, Trajan, and Hadrian that certain identification was made.<sup>19</sup> The identifications have all been amply confirmed by other late texts, in particular the horoscopes of the Greco-Roman period.

With the introduction of the zodiac to Egypt, the planets are frequently found on monuments in their special astrological signs, such as their exaltations (among others, the Esna temple ceiling and the Dendera B ceiling). On the Dendera E ceiling they are found in their day and night houses.

## THE DECANS IN THE ZODIAC

Zodiacs on astronomical monuments do not occur in Egypt until the Greek period. The first one we know of, now entirely destroyed but fortunately copied by the French expedition under Napoleon, was a ceiling in the temple of Esna (Ptolemy III–V, 246–180 B.C.). The latest, from the Roman period, is from a private tomb at al-Salāmūni (about A.D. 150). In all there are twenty-five known and published zodiacs, all but two either on ceilings in temples or tombs or on the inside of coffin lids. Unpublished, and possibly as late as the fourth century A.D., are three zodiacs in tombs found recently by Ahmed Fakhry at Qaret al-Muzawwaqa in the oasis of al-Dakhla.

The concept of the zodiac was not Greek in origin but Babylonian, as is proved by the forms of the signs. For example, the images of the goat-fish (Capricorn) and the two-headed archer on a winged, scorpion-tailed horse (Sagittarius) are

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found on much earlier Babylonian boundary stones. Egypt enthusiastically received this new concept of ordering the sky and the path of the sun, as transmitted to it by the pervading Hellenistic culture of the time, and proceeded to incorporate into its depiction the traditional Egyptian elements of decans, planets, constellations, sun, and moon. It was the decans that were most affected. Since they were all in a band just south of the ecliptic, and it was the ecliptic that the zodiac di-

vided into twelve signs, the names of three presumably adjacent decans were taken over by each sign and were used to divide that sign into three ten-degree subdivisions.

More than one decanal family was thus introduced into the zodiac. On one ceiling alone, that of the destroyed Esna temple, the decans of the Seti I B family were in a strip above the strip of zodiacal signs, while the decans of the Tanis family were in another strip just below. A comparison of the two

|             | SETI I B                                                     | HEPHAESTION                  | TANIS                                                       |
|-------------|--------------------------------------------------------------|------------------------------|-------------------------------------------------------------|
| Cancer      | <i>spdt</i><br><i>št(w)</i><br><i>knm(t)</i>                 | σωθις<br>σιτ<br>χνουμις      | <i>knmt</i><br><i>hry (hpd) knmt</i><br><i>hšt dšt</i>      |
| Leo         | <i>hry hpd knm(t)</i><br><i>hšt dšt</i><br><i>phwy dšt</i>   | χαρχνουμις<br>ηπη<br>φουπη   | <i>dšt</i><br><i>phwy dšt</i><br><i>tmšt</i>                |
| Virgo       | <i>tm(št)</i><br><i>wššt(i) bkšt(i)</i><br><i>ipsd</i>       | τωμ<br>ουεοτεβκωτ<br>αφοσο   | <i>wššt(i)</i><br><i>bkšt(i)</i><br><i>ipsd</i>             |
| Libra       | <i>sbhs</i><br><i>tpy- hnt</i><br><i>hnt hr(t)</i>           | σουχωε<br>πτηχουτ<br>χονταρε | <i>sbhs</i><br><i>tpy- hnt</i><br><i>hry-ib wš</i>          |
| Scorpio     | <i>hnt hr(t)</i><br><i>tms (n) hnt</i><br><i>spt(y) hnwy</i> |                              | <i>st(prt(i) hnwy</i><br><i>sšmw</i><br><i>sš sšmw</i>      |
| Sagittarius | <i>hry-ib wš</i><br><i>sšmw</i><br><i>knmw</i>               | ρηουω<br>σεσμε<br>κομμε      | <i>knmw</i><br><i>tpy- smd</i><br><i>pš sbš wty</i>         |
| Capricorn   | <i>tpy- smd</i><br><i>smd</i><br><i>srt</i>                  |                              | <i>smd</i><br><i>srt</i><br><i>sš srt</i>                   |
| Aquarius    | <i>sš srt</i><br><i>hry hpd srt</i><br><i>tpy- šhw(y)</i>    |                              | <i>tpy- šhw(y)</i><br><i>šhw(y)</i><br><i>tpy- bšw(y)</i>   |
| Pisces      | <i>šhw(y)</i><br><i>tpy- bšw(y)</i><br><i>bšw(y)</i>         |                              | <i>bšw(y)</i><br><i>hnt(w) hr(w)</i><br><i>hnt(w) hr(w)</i> |
| Aries       | <i>hnt(w) hr(w)</i><br><i>hnt(w) hrw</i><br><i>sš kd</i>     | χονταρε<br>χονταχρε<br>σικετ | <i>kd</i><br><i>sš kd</i><br><i>hšw</i>                     |
| Taurus      | <i>hšw</i><br><i>rt</i><br><i>rmin hry</i>                   | χωου<br>ερω<br>ρομβρομαρε    | <i>rt</i><br><i>rmin hry</i><br><i>tsrk</i>                 |
| Gemini      | <i>tsrk</i><br><i>w'rt</i><br><i>tpy- spdt</i>               | θοσολκ<br>ουαρε<br>φουορι    | <i>rmin hry</i><br><i>w'rt</i><br><i>phwy hry</i>           |

TABLE II. Lists of decans from Seti I B, Hephaestion, and Tanis  
(O. Neugebauer and R. A. Parker, *Egyptian Astronomical Texts*, III, 170-171)

decanal lists reveals that only twelve common decans are in the same position in both lists, sixteen are common to both lists but differ in position, and eight variants are found. This underlines the artificial character of the whole arrangement. It is obvious that such decans can hardly function as hour stars in clocks any longer and are merely lending their names to divisions of the zodiac.

This conclusion can be forcefully substantiated in yet another way. In Hellenistic astrology the Egyptian decanal names were rendered in Greek. So far as is now known, the first complete list of decans in the zodiac is that of Hephaestion of Thebes (fourth century A.D.). A comparison of Hephaestion's list with that of Seti I B or Tanis shows only partial agreement with either. It will be found very instructive, however, to set the three lists together, the Seti I list beginning as usual with *Sepdet* (Sothis) and Tanis with *Kenmett*. Hephaestion, in the center of Table 2, shows agreement with Seti I B in the left column of Greek names and with Tanis in the right column.

This tabular pairing shows twenty-four agreements between Hephaestion and Seti I B and fifteen between Hephaestion and Tanis, with but three in common. Such a result shows convincingly that the list compiled or taken over by Hephaestion was a quite arbitrary and eclectic one. The Tanis list, to be sure, is of suspicious origin; but the list of Seti I B was originally based on transits and must have been established through direct observation. Were there any real desire to have decanal names in the zodiac bear a direct relationship to the location of the decans in the decanal belt, we should certainly have had a much higher agreement between Seti I B and Hephaestion. But many of the decans are off by ten or twenty degrees and one, *Sesme*, is repeated thirty degrees away.

### THE ZODIACS OF DENDERA

The most famous monument, the circular zodiac (Plate 5), now in the Louvre, was once part of the ceiling of the East Osiris Chapel on the roof of the temple of Hathor. To be dated to the years before 30 B.C., it appears to be the most successful of all the known astronomical monuments in Egypt in representing the heavens with some approach to accuracy. Not shown on the plate are the four goddesses of the cardinal points, who are correctly oriented, and four pairs of falcon-headed deities, all of whom support the circular sky. About the

edge of the circle are the thirty-six figures of the decans of the Tanis family (no. 1 is *Kenmett*). In the center are the Hippopotamus (*A*) and the Foreleg (*C*), the sole representatives of the northern constellations. The pole, unmarked, must be between them. In a circle about it, but a circle that, like the ecliptic, is properly askew with respect to the pole, are the twelve zodiacal figures. Between the zodiac-ecliptic circle and the pole are depicted a number of constellations (*A-M*) that must all be considered north of the ecliptic. The planets are placed with the zodiacal signs in which they are considered to be most influential—in astrological terms, in exaltations. Venus is in Pisces, Mercury in Virgo, Mars in Capricorn, Saturn in Libra, and Jupiter in Cancer. The zodiacal belt touches the decans at the top of the plate, but below there is a crescent-shaped area between the two belts that is occupied by other constellations (*N-Y*) that must be regarded as south of the ecliptic. Some of them are surely in the decanal band, since Orion (*P*) and Sothis (*S*) are readily identifiable, the latter as a cow (with a star between the horns) recumbent in a bark. Two goddesses, *Satis* (*T*) and *Anukis* (*U*), may not represent constellations, since they commonly accompany Sirius-Sothis. The other and unidentifiable constellations south of the ecliptic may also be in the decanal belt or may be somewhat south of it.

Another ceiling in the Dendera temple, of the time of Tiberius (A.D. 14-37), and so about a century later than the circular zodiac, has many of the same figures as the latter; but this time they are arranged in long strips on the ceiling of the outer hypostyle hall (Dendera E). The constellations are located in particular signs; and this information, combined with the location north or south of the ecliptic in the circular zodiac (Dendera B), permits the drawing up of a catalog that can at least give a general idea of where a constellation may be sought. Briefly, north of the ecliptic are the following:<sup>20</sup>

- A* (hippopotamus). Dendera E places *A* and *C* with the god An between Sagittarius and Capricorn. Dendera B has *A* above and between them and the pole.
- B* (jackal on hoe). Dendera E, in Scorpio.
- C* (foreleg). Dendera E (bull-headed leg), see *A*. Dendera B, between Gemini and the pole.
- D* (small lion on *C*). Omitted by Dendera E.
- E* (god). Dendera E, in Gemini. Dendera B, near Gemini.
- F* (small seated god). Only in Dendera B, above Leo.

# EGYPTIAN ASTRONOMY, ASTROLOGY, AND CALENDRIAL RECKONING

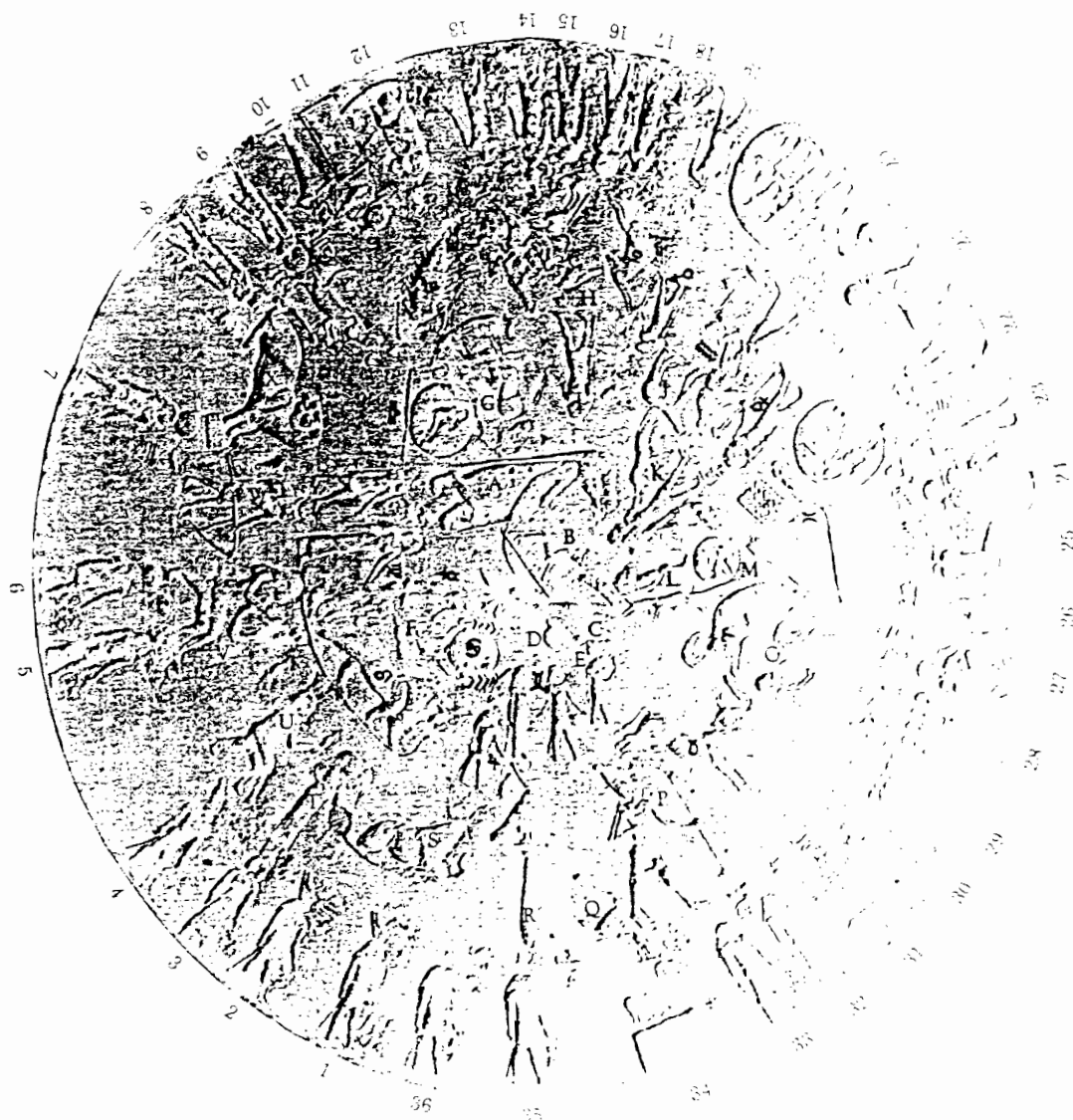


PLATE 5. Zodiac ceiling, Dendera.

*G* (group of two gods, one falcon-headed, and jackal). Only in Dendera B, near Libra and Scorpio.

*H* (group of god and goose). In Dendera B, near Scorpio and Sagittarius. Dendera E has them in Aquarius.

*J* (headless body). Near Aquarius in Dendera B and in Aquarius in Dendera E.

*K* (group of god and oryx). In Dendera B, near Aquarius and Pisces. In Aquarius between *H* and *J*, in Dendera E.

*L* (group of oryx and baboon with falcon on head). Nearest to Aries in Dendera B. In Taurus in Dendera E.

*M* (eye in disk). Only in Dendera B, between Pisces and Aries.

For the constellations south of the ecliptic we have the following:

*N* (god in *B*, goddess in *E*, and pig in disk). Near Pisces in Dendera B. In Pisces in Dendera E.

*O* (group of two goddesses, one lion-headed, in *B*; two gods, one lion-headed, in *E*). Near Aries and Taurus in Dendera B. In Taurus in Dendera E.

*P* (Orion). Near Taurus and Gemini in Dendera B. After Gemini and before Cancer in Dendera E.

*Q* (bird). Only in Dendera B. and near Gemini.  
*R* (falcon on column). Under Gemini in Dendera B. After Orion in Dendera E.  
*S* (Sirius-Sothis as cow in bark). Under Cancer in Dendera B. After *R* in Dendera E.  
*T* (Satis). Goddess-companion of Sothis in both Dendera B and E.  
*U* (Anukis). Goddess-companion of Sothis in both Dendera B and E.  
*V* (seated woman holding child). Near Leo in Dendera B. In Leo in Dendera E.  
*W* (bull-headed god, with hoe). Under Virgo in Dendera B. In Virgo in Dendera E.  
*X* (lion with forefeet in water). Only in Dendera B, near Virgo and Libra.  
*Y* (god with human upper body and hippopotamus lower body). In Dendera B near Libra and Scorpio. In Scorpio in Dendera E.  
 Dendera E has two constellations that do not appear in Dendera B (one in Libra and one in Leo), and these might be either north or south of the ecliptic. On both ceilings there are variants in the forms of the constellations; and, as has already been remarked, their locations are at best only approximate.

## EGYPTIAN ASTROLOGY

After the conquest of Egypt by the Persians in 525 B.C. and during their control of it for over a century, there was a constant cultural interchange among all the countries of that empire. Egyptian priests are known to have been in Persia; indeed, we have the personal account of one Udjeharresnet, who was commanded to return to Egypt by Darius I (521-486 B.C.) and there reform the Houses of Life, the centers in the precincts of the temples where medical and religious books were written.<sup>21</sup> It may well have been through him that the first astrological literature reached Egypt from Babylonia. Although the two texts we have<sup>22</sup> are copies made in the Roman period (second or third century), the concordance of Text A between the Egyptian and the Babylonian lunar calendars is such that it must date from six or seven centuries earlier. Moreover, it has no mention of the zodiac, and this places it surely before the fourth century B.C. Text B may be assumed to be of the same antiquity.

Text A is exceedingly fragmentary, with perhaps only one-fifth of it remaining; but it has nevertheless been possible to establish a fairly comprehensive understanding of what it treated. It turns out

to be an example of the earliest type of astrological literature, that of judicial astrology. The concern is with the fate of countries and their rulers (not with that of the individual, whose destiny was the focus of the later, horoscopic astrology), and the text is a compendium of predictions to be drawn from eclipses of the sun and moon. It was important to know in what month of the year (as opposed to what zodiacal sign) the eclipse took place, at what hour of the day or night, and where in the sky. From this information it was possible to tell what country would be affected and what that effect might be. The countries, besides Egypt, are Crete, Syria, Amor, and the land of the Hebrews, those to the north and east of Egypt and those with which Egypt was then more directly involved. It is evident that the text as we have it had been edited and adapted to reflect the special concerns of Egypt.

There were two systems employed to assign the months to countries. In System I, for the sun, IIII *Akhet* to III *Peret* were said to belong to a country of which the name is now missing, IIII *Peret* to III Shomu belonged to Hebrew (land), and IIII *Shomu* to III *Akhet* belonged to Egypt. It is the beginning with IIII *Akhet* that proves a Babylonian origin, since the text states (II, 18-20): "[Nisan (is) the lunar month] IIII *Akhet*; Iyyar [is] the lunar month [I *Peret*; Siwan is the lunar month II *Peret*; Tammuz] is the lunar month III *Peret*; the [se 4 months belong to . . . ]." Nisan to Tammuz are the first four months of the Babylonian year, and it is that year that obviously controls the concordance. For the moon, in System I, the year was divided into four three-month groups, assigned in turn to Hebrew (land), Amor, Egypt, and Syria. Again the concordance began with Nisan being IIII *Akhet*.

In System II the assignments are the same for both sun and moon; but instead of the months being grouped, they were alternated in the order Crete, Amor, Egypt, and Syria, so that to Crete, for example, IIII *Akhet*, IIII *Peret*, and IIII *Shomu* were assigned. Nowhere in either system is there a mention of an intercalary month, although one would have occurred every two or three years.

The hours of the day, like System I for the sun, were divided into three groups of four, to which were assigned Egypt (1-4), Crete (5-8), and Amor (9-12). Again in agreement with System I for the moon, the hours of the night were divided into four groups, assigned to Egypt (1-3), Hebrew (land) (4-6), Amor (7-9), and Syria (10-12).

For solar eclipses the sky was divided into three

## EGYPTIAN ASTRONOMY, ASTROLOGY, AND CALENDRIAL RECKONING

assigned areas, the northern to Hebrew (land), the middle probably to Crete, and the southern to Egypt. In the moon section of Text A there is an unfortunately broken passage that speaks of "the four places of the sky." It may be that for lunar eclipses the sky, in analogy to the four-part divisions of the months and the hours, was also divided into four; but this remains uncertain.

From such assignments it would appear that the effect of an eclipse could vary considerably, being restricted to one country or spread over several. As an example, a solar eclipse in II *Akhet*, in hours one to four of the day and in the southern sky, presumably would concern only Egypt, while one in IIII *Peret*, in hours nine to twelve of the day and in the middle of the sky would involve Crete, Amor, and Hebrew (land) as well as Egypt.

The predictions that are preserved in Text A are only those for the months according to System II. Thus, for example, the most complete passage reads (II, 30-31): "If the sun be eclipsed in [I *Peret*], (since) the month belongs to the Amorite, it means: The chief [of the Amorite shall . . .] occur (in) the entire land." One example of a lunar eclipse reads (IV, 26-27): "If [the moon be eclipsed in II *Shomu*, (since) the month belongs to <Egypt>], it [means]: The chief of the land named shall be captured. The army shall fall to [battle]-weapo[ns]." What may have happened to the other countries involved, determined by the hours and the sky, is nowhere stated. Nor is there any statement about what may happen when the month assignments of Systems I and II conflict.

That such a treatise as Text A was a source of inspiration to Egyptian scholars from the Persian period on may be readily assumed from the second-century B.C. writings of Nechepso and Petosiris, who were the "ancient Egyptians" upon whom Hephaestion of Thebes drew for Chapter 21 of his Book I, in which he discusses eclipses and their omens. It would seem that throughout these later centuries the Egyptians observed eclipses and carefully noted what happened. Nechepso and Petosiris were still concerned with judicial astrology alone, but the sphere of interest was widened to include up to thirty-nine countries, although Egypt predominated. The zodiac was employed and the hour pattern of day and night was by threes, although not consistently. In all, we seem to have in their work a highly complex and developed system of predictions built upon the framework of Text A.

Text B is quite different. It is concerned with happenings in and about the disk of the full moon, such as stars or disks inside or outside, or changes

in coloration. For each case a colored vignette illustrates the text and is accompanied by the specific predictions. These are still judicial, but concern Egypt almost exclusively. If the original text was Babylonian, as seems most likely, it has been thoroughly revised to suit Egypt. Or it may have been that only the idea of such a study of the moon came to Egypt—after which, as with Text A, data were accumulated through the centuries.

It is worth stating here that science as we have it had its origins in just such patient study and accumulation of data. We know that *post hoc, ergo propter hoc* is usually fallacious; but this was by no means so apparent to the peoples of the ancient world, and the hypothesis that celestial events foreshadow earthly events was to them a hypothesis that had been proved correct. Just so have some more recent hypotheses been taken as proved, although later discarded. The activity described was commented upon by Herodotus after he had visited Egypt in 460 B.C.:

I pass to other inventions of the Egyptians. They assign each month and each day to some god; they can tell what fortune and what end and what disposition a man shall have according to the day of his birth. This has given material to Greeks who deal in poetry. They have made themselves more omens than all other nations together; when an ominous thing happens they take note of the outcome and write it down; and if something of a like kind happens again they think it will have a like result.<sup>23</sup>

In passing it should be remarked that predictions from "the day of his birth" are not from the positions of the planets but, rather, according to calendars of lucky and unlucky days, one of which goes back as far as the New Kingdom in the middle of the second millennium B.C.<sup>24</sup>

About twenty vignettes with their predictions are preserved in Text B. For example, the upper half of col. IX has in the vignette a dark yellow disk with plain center and black disks to right and left. The text reads (1-13):

Another. If you see the disk colored completely, its scent(?) red downward in it, there being one black disk on its right and another black disk on its left [you are to] say about it: Enmity shall happen (in) [the entire land]—another version: the land of Egypt—and king shall approach king [. . .] Great fighting shall happen (in) Egypt. Barley and emmer (shall) be plentiful and every harvest likewise with respect to every plowing and every field (in) the entire land. Good things and satisfaction shall occur everywhere, so that they quarrel, they drink . . . and they eat the knife.

Judicial astrology continued in Egypt well into the Roman period, as is witnessed not only by the texts just discussed but also by another of the relatively few astrological texts written in the Egyptian language, *Papyrus Cairo 31222*.<sup>25</sup> This text too is badly preserved, but its structure is clear; it has to do with predictions associated with the heliacal rising of Sirius-Sothis, when the moon and the various planets are in certain zodiacal signs. Thus, in lines 5-8:

If it (Sothis) rises when Jupiter is in Sagittarius: The king of Egypt will rule over his country. An enemy will be [his and] he will escape from them again. Many men will rebel against the king. An inundation which is proper is that which comes to Egypt. Seed (and) grain(?) will be high as to price (in) money, which is . . . . The burial of a god will occur in Egypt. . . . [will come] up to Egypt and they will go away again.

We have already remarked that horoscopic or personal astrology developed later than judicial astrology, and the suggestion has been made that the original impetus for it came in Babylonia as a further development from the older celestial omens.<sup>26</sup> In fact, the first horoscope we now have is dated to 410 B.C. and is Babylonian.<sup>27</sup> Horoscopic astrology probably came to Egypt with the zodiac around the turn from the fourth to the third century B.C. as a developing Hellenistic "science" to which Egypt made little or no contribution that can be specifically identified, except for the decadal divisions of the zodiacal signs.

The earliest Egyptian-language horoscope we now have is on an ostrakon and is datable to 39 B.C.<sup>28</sup> The next oldest horoscopes are from 10 and 4 B.C. and are in Greek, although written in Egypt on papyrus.<sup>29</sup> All others, both Egyptian<sup>30</sup> and Greek, fall into the Roman period, with the vast majority of them in Greek. Less than a dozen horoscopes in Egyptian are presently known. The latest of these are the one of Heter, on the inside of his coffin lid (A.D. 93 but written A.D. 125), and the horoscopes of two brothers (*A*, Ib-pmeny and *B*, Pa-mehit), on the ceiling of their tomb at Athribis (A.D. 141 and 148).<sup>31</sup>

The last two are pictorial rather than written out, and one of them (*A*) may serve to illustrate the zodiac of the time and the individualized figures of the planets (Plate 6). The upper row of the zodiac begins with Scorpio on the left and runs to Aries, with the lower row beginning with Taurus on the right and running to Libra. Between and below the rows are the planets. Jupiter is a falcon with out-

stretched wings and the hieroglyphic sign (thorns) for "open" on its head, in Aquarius. Saturn is a bull-headed falcon with outstretched wings, in Gemini. Mars is a falcon with outstretched wings, three serpents for a head, and a serpent's tail, in Leo. Mercury is a falcon with the head of Seth and a serpent's tail, in Capricorn with the sun. Venus is a standing god, two-faced (human and lion?), in Pisces. The moon, shown both crescent and full, is in Sagittarius. Below the zodiac are Sirius-Sothis, as a cow, and Orion in barks, as well as the *ba* or "soul" birds of the two brothers and the barks of the sun and the moon. About the zodiac are mythological figures and texts.

All these Egyptian horoscopes are concerned primarily with the date of birth and the planetary positions and other data of that day. There are few or no predictions given. These no doubt had to be derived from the abundant literature of the Hellenistic period. In this literature there were a few astronomical treatises written in Egyptian Demotic. Two of these, *Papyrus Carlsberg 1* and *Papyrus Carlsberg 9*, were surely native in origin, since the first of them is a commentary on the Cosmology of Seti I and Ramses IV and the second provides the twenty-five-year lunar cycle. All the others might as well have been written in Greek as Egyptian, since they are purely Hellenistic in content.<sup>32</sup> The more important are *Papyrus Berlin 8279* and the Stobart Tablets, which are tables for some of the years between 16 B.C. and A.D. 133, giving the dates of entry of the planets and the moon into the zodiacal signs and thus useful for the casting of horoscopes.

## SUMMARY

An appropriate summation of the position of Egypt in astronomy, astrology, and calendrical reckoning may be found in the words that an astronomer of the third century B.C., Harkhebi by name, had inscribed on his statue. He describes himself thus:

Hereditary prince and count, sole companion, wise in the sacred writings, who observes everything observable in heaven and earth, clear-eyed in observing the stars, among which there is no erring; who announces rising and setting at their times, with the gods who foretell the future, for which he purified himself in their days when Akh [decan] rose heliacally beside Benu [Venus] from earth and he contented the lands with his utterances; who observes the culmination of every star in the sky, who knows the he-

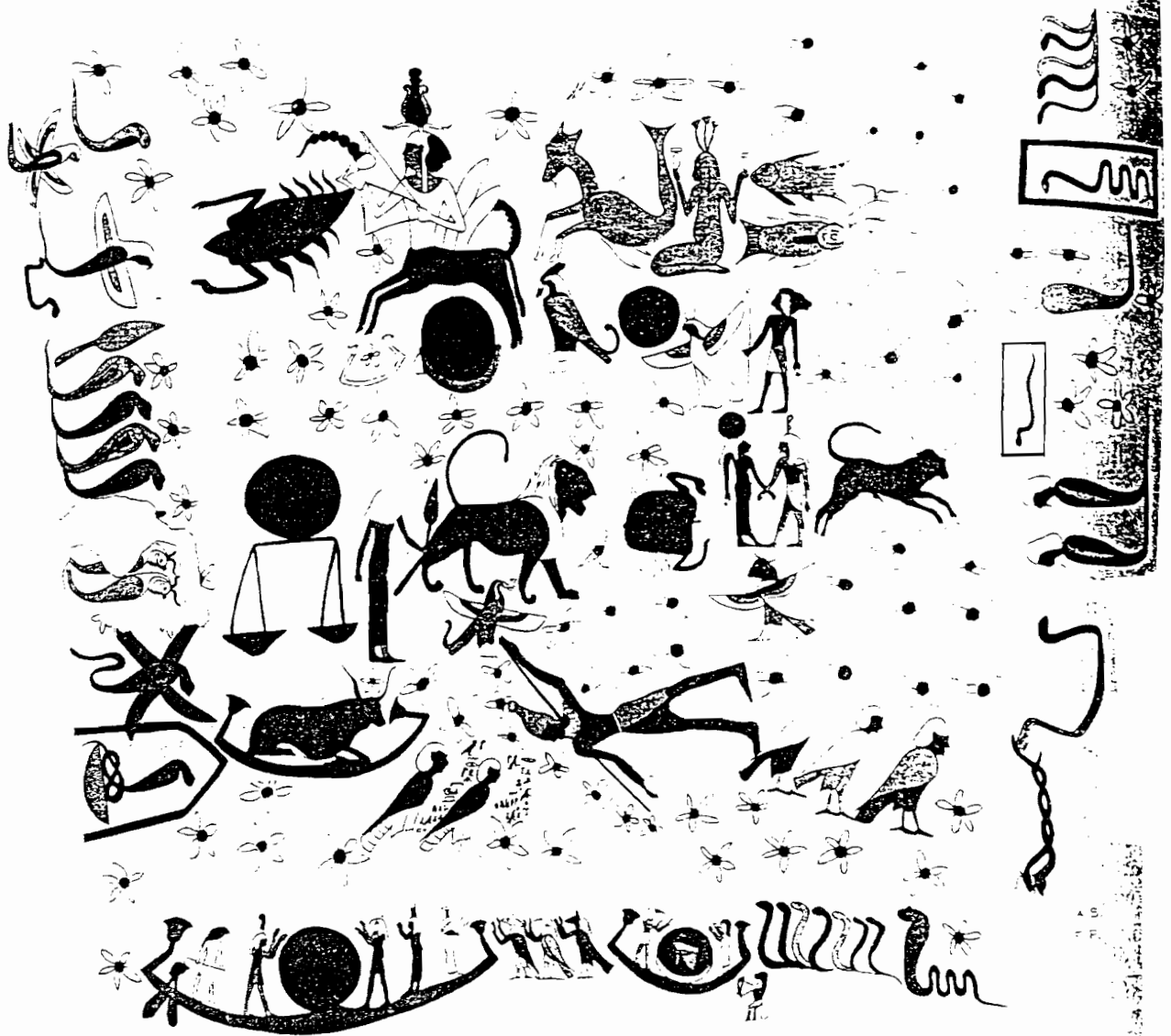


PLATE 6. Zodiac A. Athribis (W. M. F. Petrie, *Athribis*, pl. XXXVII)

liacal risings of every . . . in a good year, and who foretells the heliacal rising of Sothis at the beginning of the year. He observes her [Sothis] on the day of her first festival, knowledgeable in her course at the times of designating therein, observing what she does daily, all she has foretold is in his charge: knowing the northing and southing of the sun, announcing all its wonders [omina?] and appointing for them a time[?], he declares when they have occurred, coming at their times: who divides the hours for the two times [day and night] without going into error at night . . . : knowledgeable in everything which is seen in the sky, for which he has waited, skilled with respect to their conjunction[s] and their regular movement[s]: who does not disclose [anything] at all con-

cerning his report after judgment, discreet with all he has seen.<sup>33</sup>

Harkhebi's text continues with a recital of his skill as a charmer of snakes and scorpions, but with this we need not concern ourselves. We see that as an astronomer he was involved with the regulation of calendar years through his interest in Sothis, with the measurement of the hours of day and night, with the movements of the stars, the sun, and the planets, with predictions to be derived from any sort of celestial omens, and with at least the beginnings of horoscopic astrology in the exaltation of Venus.

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Egypt's greatest achievement was its civil calendar. This, with the observations of the decans, led to our twenty-four-hour day. Otherwise Egyptian astronomy remained at a very elementary level. In the Hellenistic world Egypt was certainly an enthusiastic student of Greek and Babylonian astronomy and astrology, and no doubt there were peculiarly Egyptian contributions to this pervasive learning besides the decans in the zodiac; but at present for the present these remain unknown to us.

## NOTES

- R. A. Parker, *The Calendars of Ancient Egypt*, chs. 1, 3.
- O. Neugebauer, *The Exact Sciences in Antiquity*, 81.
- Parker, *op. cit.*, excursus C.
- R. A. Parker, "Sothic Dates and Calendar 'Adjustment,'" On 239 B.C. as the correct date for the decree, see R. A. Parker's forthcoming article in *Studies in Honor of George R. Hughes*.
- Parker, *The Calendars of Ancient Egypt*, secs. 49-107.
- Ibid.*, secs. 49-119; O. Neugebauer and R. A. Parker, *Egyptian Astronomical Texts*, III, 220-225.
- A. T. Samuel, *Ptolemaic Chronology*, 54-61.
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- Ibid.*, 100.
- Ibid.*, 116-128.
- L. Borchardt, *Altägyptische Zeitmessung*, 60-63.
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- Ibid.*, 58.
- Ibid.*, II.
- Parker, *The Calendars of Ancient Egypt*, sec. 222.
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- Ibid.*, 177-181.
- H. Brugsch, *Nouvelles recherches sur la division de l'année des anciens Égyptiens*, . . . 19-61; Neugebauer and Parker, *op. cit.*, III, 175.
- Neugebauer and Parker, *op. cit.*, III, 200-202.
- A. H. Gardiner, "The House of Life."
- R. A. Parker, *A Vienna Demotic Papyrus on Eclipse- and Lunar-Omina*.
- A. D. Godley, *Herodotus*, bk. II, 82.
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- A. Sachs, "Babylonian Horoscopes."

28. O. Neugebauer and R. A. Parker, "Two Demotic Horoscopes."
29. O. Neugebauer and H. B. Van Hoesen, *Greek Horoscopes*, 16-17.
30. O. Neugebauer, "Demotic Horoscopes."
31. Neugebauer and Parker, *Egyptian Astronomical Texts*, III, 93-98.
32. *Ibid.*, 217-255.
33. *Ibid.*, 214-215.

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