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Ancient Egyptian astronomy

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[Plates 11–14]

The early astronomy of ancient Egypt is known to us from its practical application to time measurement, in the large sense of a calendar year and in the smaller of the 24 h day. The earliest calendar year was lunar, kept in place in the natural year by the star Sirius. From this lunistellar year evolved the well-known calendar year of 365 days (three seasons of four 30-day months and 5 days added at the end). The division of the 30 day month into three 10-day 'weeks', combined with the observation of stars called decans rising at nightfall, eventually resulted in our 24 h day of fixed length. Constellations, except for decanal stars, and planets figured only in mythology. The zodiac was introduced into Egypt apparently in the Ptolemaic period and the decans finally became merely names for thirds of a zodiacal sign. In this latest period true astronomical texts also appear but they cannot be counted Egyptian in origin.

1. Introduction

When toward the end of Ramesside rule in Egypt, about 1100 B.C., a scribe of sacred books in the House of Life, by name Amenope, composed a catalogue of the Universe to be made up of 'heaven with its affairs, earth and what is in it, what the mountains belch forth, what is watered by the flood, all things upon which Reʿ has shone, all that is grown on the back of earth' he began his list with 'sky', followed by 'sun', 'moon' and 'star'. He then listed five constellations, only two of which can be certainly identified, those of *Sꜣḥ* 'Orion', *Msḫtyw* 'Foreleg', earlier 'Adze', which corresponds to our Big Dipper *ʾIʿn* 'Ape', *Nḫt* 'Giant', and *Rrt* '(female) Hippopotamus'. Surprisingly there is no mention of Sirius which from other texts seems to have been the most important star for the Egyptians. Nor are the planets enumerated. The list goes on to other matters in over 600 entries. Only once again is astronomy mentioned and that is the title *ỉmy-wnwt* 'hour-watcher' or 'astronomer' (Gardiner 1947).

This somewhat casual and rather negative approach to the sky and 'its affairs' suggests that to the ancient Egyptian they were of much less importance than terrestrial matters with which he was intimately involved. This conclusion may be illusory but it is, none the less, a present fact that it is not until the Ptolemaic period, when Egypt was open to and influenced by Hellenistic science, that we have anything approaching a theoretical astronomical treatise. Throughout the three millennia of recorded Egyptian history we have nothing whatever to suggest that the movements of the Moon and planets were systematically observed and recorded as they were in Babylonia. To be sure there are many references in ordinary texts to the Sun, Moon and stars, especially Sirius (the Egyptian Sothis), but except for one cosmological text to which we shall refer later, these convey little or nothing of astronomical import. Moreover, there is a complete absence of technical terms except for the common ones which are found everywhere.

The earliest account we have of what were the concerns of an Egyptian astronomer is as late as the third century B.C. On his statue Harkhebi describes himself as follows (Neugebauer & Parker 1969, pp. 214–15):

'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 heliacal 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 concerning his report after judgment, discreet with all he has seen.'

A few of these accomplishments can go back to early Egypt, as we shall see, but they are of an elementary level. The astrological concept of the exaltation of Venus (see below) is of known Babylonian origin (Neugebauer & Parker 1969, p. 214) and the astrological flavouring of much of the text is obvious.

What then are we to talk about when the subject is ancient Egyptian astronomy? Little enough it may seem, but that little is not devoid of interest since it still endures as a legacy to us in the measurement of time. We begin with the early Egyptian calendars.

2. The early Egyptian calendars

Like all ancient peoples, the protodynastic Egyptians used a lunar calendar, but unlike their neighbours they began their lunar month, not with the first appearance of the new crescent in the west at sunset but rather with the morning when the old crescent of the waning moon could no longer be seen just before sunrise in the east. Their lunar year divided naturally, following their seasons, into some 4 months of inundation, when the Nile overflowed and covered the valley, some 4 months of planting and growth, and some 4 months of harvest and low water. At 2- or 3-year intervals, because 12 lunar months are on the average 11 days short of the natural year, a 13th or intercalary month was introduced so as to keep the seasons in place. Eventually the heliacal rising of the star Sirius, its first appearance just before sunrise in the eastern horizon after a period of invisibility, was used to regulate the intercalary month. Sirius, to the Egyptians the goddess Sopdet or Sothis, rose heliacally just at the time when the Nile itself normally began to rise, and the reappearance of the goddess heralded the inundation for the Egyptians. The 12th lunar month, that is the 4th month of the 3rd season, was named from the rising of Sothis and a simple rule was adopted to keep this event within its month. Whenever it fell in the last 11 days of its month an intercalary month was added to the year, lest in the following year Sothis rise out of its month (Parker 1950, chap. 3).

This luni-stellar year was used for centuries in early Egypt and indeed lasted until the end of pagan Egypt as a liturgical year determining seasonal festivals. Early in the third millennium B.C. however, probably for administrative and fiscal purposes, a new calendar year was invented. Either by averaging a succession of lunar years or by counting the days from one heliacal rising of Sothis to the next, it was determined that the year should have 365 days, and these were divided into three seasons of four 30-day months each, with 5 additional 'days upon the year' or 'epagomenal days'. This secular year which is conventionally termed the 'civil' year remained in use without alteration to the time of Augustus when a 6th epagomenal day every 4 years was introduced. That the natural year was longer than the civil year by a quarter of a day was of course known to the Egyptians fairly soon after the civil year was inaugurated but nothing was ever done about it. Still it is a great achievement of theirs to have invented a calendar year divorced from lunar movement and to have been the first to discover the length of the natural year, which eventually led to the Julian and Gregorian calendars (Parker 1950, chap. 4).

3. Calendar weeks

The first year in Egypt, the lunar one, had divided the month into 4 'weeks' based on 'first quarter', 'full moon', and 'third quarter'. The new month of 30 days was not divisible into 4 even parts but conveniently divided into 3 'weeks' of 10 days each, from later texts called 'first', 'middle' and 'last'. Thus in the entire year there were 36 weeks or decades, plus the 5 days upon the year.

4. Star clocks

We do not know exactly when the stars were first used to tell time at night but it was certainly by the 24th century B.C. and quite possibly soon after the introduction of the civil calendar. One of the texts (P.T. 515) in the pyramid of Unas, last king of the Fifth Dynasty, has the king clearing the night and dispatching the hours and the plural writing of 'hours' is effected by three stars.

It is not until roughly 2150 B.C. that we know for certain that these night hours totalled 12. This we learn from diagrams of stars on the inside of coffin lids, which were earlier termed 'diagonal calendars' but which are better called 'star clocks'. Figure 1 is a schematic version of such a clock, followed in some degree by all our examples. It is to be read from right to left. A horizontal upper line T is the date line, running from the 1st column, the 1st decade of the 1st month of the 1st season, to the thirty-sixth column, the last decade of the 4th month of the 3rd season. With decade 26 there begins in the 12th hour a triangle of alternate decans to tell

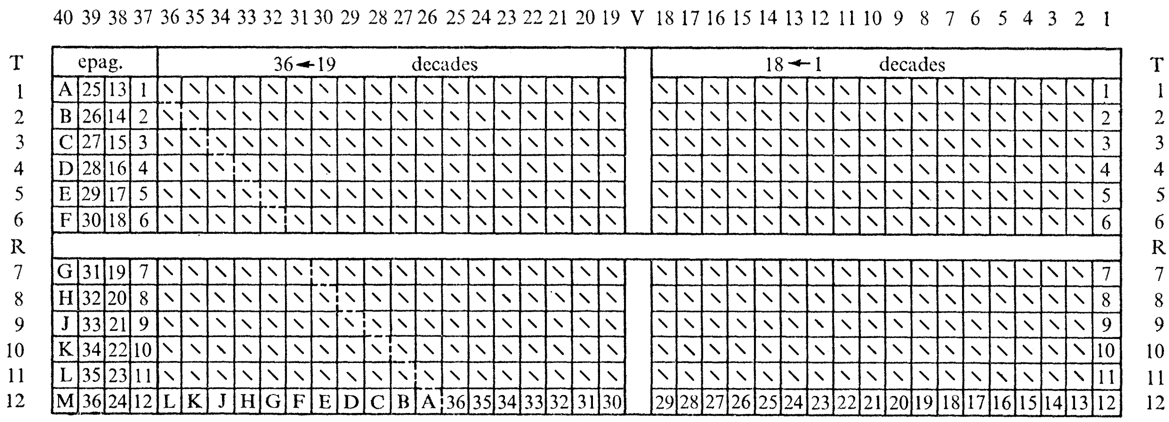

Figure 1. Schematic version of a star clock.

the hours through the epagomenal days. What was probably once only 1 column for the epagomenal days has been expanded to 4, the last of which (40) is for the epagomenal days while the intrusive 3 merely list the thirty-six stars found in the decades. The 18th and 19th columns are separated by a space (V) in which are to be found representations of the goddess of the sky, Nut, the Foreleg of an Ox (our Big Dipper), Orion and Sothis. A horizontal inscription (R) divides the 6th and 7th hours. In it funerary offerings are invoked for the deceased from Re‘, the sun god, the deities of the vertical strip and various stellar deities.

5. The star clock mechanism

The mechanism of such a clock was the risings of certain selected stars or groups of stars, that conventionally are termed 'decans', at 12 intervals during the night, and at 10-day intervals through the year. If we now examine the star clock of Idy (figure 2, plate 11)) even though it lists only 18 decades we can see very graphically how the name of a decanal star in any hour is always in the next higher space in a succeeding column, so that a star in the 12th hour rises over 120 days to the 1st hour and then drops out of the clock.

Behind this are the simple astronomical events of the rotation of the Earth on its axis and the travel of the Earth about the Sun.

We have already seen in connexion with the star Sirius–Sothis that it eventually disappears, because it gets too close to the Sun, and then after some days it reappears on the eastern horizon just before sunrise, its heliacal rising. And we have noted that the heliacal rising of Sothis was a very important event. It heralded the inundation and it regulated the original lunar calendar. We have also noted that the lunar month, for the Egyptians, began when the last crescent could no longer be seen just before sunrise, another event associated with the eastern horizon. Moreover, in the Pyramid Texts, the great body of religious literature from the third millennium B.C., there are many references to the Morning Star, with which the King wished to be identified, but none at all to an evening star. The focus is all on the eastern horizon, since a morning star is one which has just, or recently, risen heliacally.

Of course, a star which has just risen heliacally does not remain on the horizon but every day, because of the Earth's travel about the Sun, rises a little earlier and is thus a little higher in the sky by sunrise. Eventually another star, rising heliacally is likely to be called the Morning Star. In the early third millennium B.C., we may conjecture, the combination of 10-day weeks in the civil calendar and the pattern of successive morning stars led some genius in Egypt to devise a method of breaking up the night into parts, or 'hours'. He observed a sequence of stars each rising heliacally on the first day of a decade or week. From a text in the cenotaph of Seti I at Abydos (Neugebauer & Parker 1960, chap. 2) we learn that stars were chosen which approximated the behaviour of Sothis in being invisible for 70 days. The star which had risen heliacally on the 1st day of the 1st decade, thus marking the end of the night would 10 days later be rising well before the end of night. The interval between its rising and the new star's heliacal rising would be an 'hour'. Inevitably this pattern of heliacal risings at 10-day intervals would lead to a total of 12 hours for the night. Moreover, the stars selected to mark the hours after the pattern of Sothis would all fall in a band south of and parallel to the ecliptic as seen in figure 3 (Neugebauer & Parker 1960, p. 100).

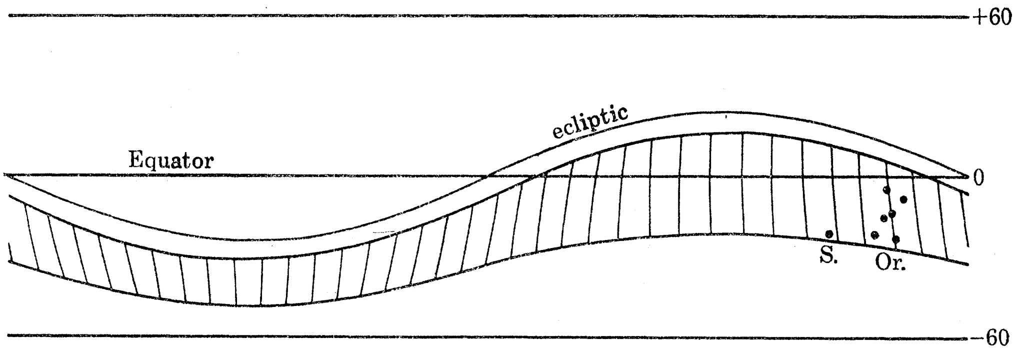

FIGURE 3. Orion and Sirius as hour stars in the decanal band south of the ecliptic.

6. Decanal hours

It can readily be seen that such hours were not all of equal length. As the night grew longer and dawn was postponed the last hours of the clock would also grow longer. Conversely they would shorten as the night grew shorter. It is this lengthening and shortening, combined with the periods of morning and evening twilight and the oscillation of the star clock itself, that explains why the night was divided into 12 hours though there were always 18 decanal stars from horizon to horizon in the night sky. Civil twilight, when very bright stars become visible, averages about half an hour, but astronomical twilight, from sunset until all the stars are to be seen may be well over an hour and the decans measured only the time of total darkness. The 1st hour on the star clock was then of indeterminate length since it began with darkness and ended only when a particular decanal star rose in the eastern horizon. This 1st hour would be longest at the beginning of a decade and would be a little bit shorter each night. At the other end the decanal star rising heliacally and so marking the end of the 12th hour and of night was on the 1st day closely followed by morning twilight. At the end of the decade the 12th hour would be followed by a period of darkness. But we may suppose that this was not of importance to the observer, and the 12th hour may have been considered as running until light.

7. The cosmology of Seti I and Ramses IV

The star clocks that we have preserved to us are funerary in purpose and more or less corrupt in makeup. None the less it is clear that after the 36 decans another 12 decans had been chosen to carry the hours through the 5 epagomenal days after which the 1st column of the clock would again become effective. But since the Egyptian civil calendar lacked a leap year, inevitably the clock would require adjustment by shifting decans in place and making new ones. There is some evidence of a revision as late as the Twelfth Dynasty (1991–1786 B.C.) but by this time as well the risings of stars had been abandoned in favour of their transits. This we learn from later texts which are known as the Cosmology of Seti I and Ramses IV (Neugebauer & Parker 1960, chap. 2). Accompanying a vignette of the goddess Nut, bending over the Earth and supported by Shu, god of the air, are numerous texts, many of which are purely mythological but a few of which represent the first astronomical thinking that we have from the ancient Egyptians.

One important insight is the statement that the disappearance and reappearance of Sun and stars are common phenomena. When the Sun disappears at sunset he goes to the Duat and spends the hours of the night travelling from west to east. When the decanal stars disappear they also spend their time in the Duat, but for 70 days, after which they again rise. In a simplified scheme of 360 days, we are informed that a star dies and a star lives every 10 days. After 70 days of death in the Duat a star is born again. It then spends 80 days in the eastern sky before it works, after which it passes 120 days (10 for each hour) telling time by its transit. When it has finished marking the 1st hour it passes 90 days in the western sky and then again it dies.

Since a star spends 80 days in the east before working, it is clear that it is transitting when it marks an hour. This change to transitting required a wholesale readjustment of decanal stars. When rising, two decanal stars could mark an hour between them but if they were at opposite sides of the decanal belt, thus some distance apart on the horizon they could, when transitting, either pass the meridian together or so far after one another as to result in an extremely long hour. Of the 36 decans of the star clocks nearest in time to the transit scheme only 23 remain exactly in place in the transit list. The other 13 have each a different place or drop out and are replaced by new decans.

At the same time the simplification of the decanal round to 360 days instead of 365 reveals the strongly schematic character of such a star clock and poses the question of its real utility. In actual practice one may speculate that all an observer would need to do would be to memorize a list of 36 decanal stars, preferably rising ones as being the easier to observe, watch to see which one was in or near the horizon when darkness fell and then use the risings of the next 12 to mark off the night hours. Whether this was done in fact cannot be said with certainty, but it is true that while we have lists of decans on various astronomical ceilings or other monuments to the end of Egyptian history, we have nothing at all approaching a star clock in form after the time of Merneptah (1223–1211 B.C.), and that that was a purely funerary relic is indicated by the fact that its arrangement of stars dates it 600 years earlier into the Twelfth Dynasty.

The most probable cause for the disappearance of star clocks was the invention of the water clock, the earliest example of which is dated to Amenophis III of the New Kingdom (1397–1366 B.C.), but before we consider all the implications of this discovery we must look into the hours of the day, and see how they were influenced by the night hours.

8. The twelve-hour night

We have discussed above how the diagonal star clock was based on the 36 10-day divisions or decades of the civil calendar and that this resulted in a division of darkness into 12 hours, with 2 to 3 'hours' of twilight before sunrise and after sunset. Now had the 'weeks' been only 5 days instead of 10 we should have had 36 pentades from horizon to horizon at night with perhaps 4 to 5 for twilight on either side, leaving about 26 for the 'hours' of darkness. We can see then that the 12-hour night was the direct result of the 10-day week, and was not an arbitrary choice.

9. The hours of the day

We have much less early information about the hours of the day. Again it is a text from the cenotaph of Seti I which helps us to suggest a plausible line of development. This funerary text gives directions for making a shadow clock consisting of a base with an elevated cross bar at its head (figure 4). With the head to the east 4 hours are marked off by decreasing shadow

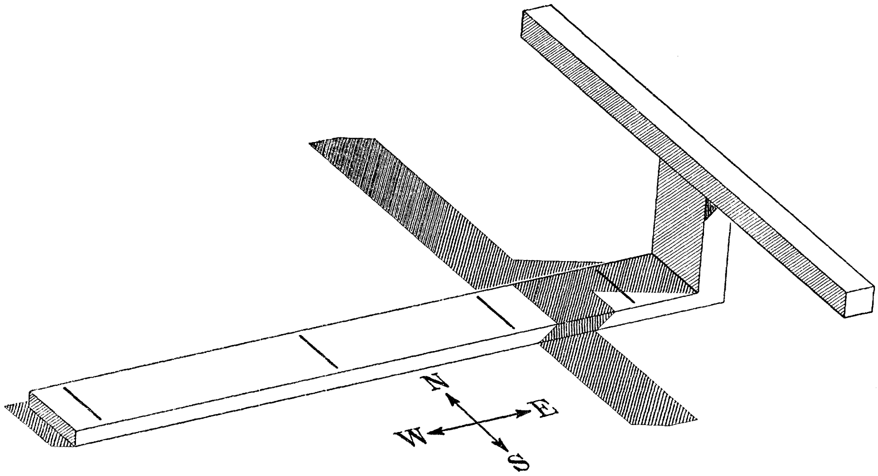

FIGURE 4. Shadow clock.

lengths after which the instrument is reversed with head to the west to mark 4 afternoon hours. In an illuminating statement the text concludes by saying that 2 hours have passed in the morning before the Sun shines on the clock and another 2 hours pass in the evening before the hours of the night (Neugebauer & Parker 1960, pp. 116–18). It is the most plausible assumption that the 2 hours before and after the clock is in use were divided by the observable phenomena of sunrise and sunset, and that the hour before sunrise was the whole period of morning twilight and the hour after sunset the whole period of evening twilight. Again it is plausible that the entire period of light between total darkness of one night and that of the next was divided into 12 parts on analogy to the 12 parts of the night. The day hours would obviously be, on the average, much longer than the night hours in this initial stage of the 24 hour concept.

The next development, and this can be documented from a shadow clock of the time of Thutmose III (1490–1436 B.C.), and so earlier than the funerary text of Seti I, is the division of the sunrise to sunset interval into 12 hours. A complementary division of the sunset to sunrise interval could only be done by means of a water clock. The earliest water clock, however, was still adapted to dividing the period of real darkness.

The concept of hours of constant length, and not merely 'seasonal' hours that are always only one-twelfth of the time from sunset to sunrise or sunrise to sunset, is attested by a Ramesside papyrus of the twelfth century though it describes the calendar situation of a somewhat earlier time. This text gives the hours of daylight and darkness for each month of the year. The total is always 24 and the extreme figures are 18 hours to the day and 6 to the night and conversely 6 hours to the day and 18 to the night. Such figures are impossible for Egypt unless they start from the basis that the 6 night hours correspond to the shortest night of 12 decanal hours which do in fact total about 6 equal hours (Neugebauer & Parker 1960, p. 119).

With the concept of 24 equinoctial hours to the day we have come to the end of the Egyptian contribution to the telling of our time. The division of the hour into 60 minutes and the minute into 60 seconds comes from Babylonia with its sexagesimal system.

10. The Ramesside star clocks

The diagonal star clocks using decans seem not, as has been remarked, to have lasted in use much past the Twelfth Dynasty. By at least the middle of the second millennium B.C. the water clock had been invented. At about that time also was introduced a new star clock which is preserved to us three centuries later in several royal tombs of the Ramesside period as a ceiling adornment. The new clock differed in many ways from the old. Where the decanal clock had 36 tables of 12 stars marking the ends of hours, the new had 24 tables (2 to a month) of 13 stars, the first of which marked the beginning of the night. The decanal clock used transits, the new clock used not only transits of the meridian, but of lines before and after. The decanal clock had stars that never changed from hour to hour. The new clock had stars which moved in very irregular fashion from hour to hour and frequently skipped 2 or 3 hours, being replaced by other stars. The hours of the decanal clock were fixed in length, once established; those of the new clock varied in length. The stars of the two clocks are very rarely the same. Of the 36 decanal stars listed on the ceilings of Seti I and Ramses IV only 3 can be found in the new clocks. There can be little doubt that the stars used in the new clocks, in the main, lay outside the decanal belt and, as we shall see, south of that belt.

We have noted that the new clocks used lines before and after the meridian. These are indicated by notes to each star and also by a chart accompanying each table. The chart has 13 horizontal lines and 9 vertical lines above a seated figure (figure 5, plate 12). Stars are located in the inner 7 vertical lines to agree with a location as given in the table. Thus a star on the central vertical line corresponds to the text *r ʿḳꜣ ib* 'opposite the heart'; one on the first vertical to left or right is *ḥr irt wnmy* 'on the right eye' or *ḥr irt iꜣby* 'on the left eye', with 'right' and 'left' used from the standpoint of an observer facing the target figure. A star on the second vertical left or right is *ḥr msḏr wnmy* 'on the right ear' or *ḥr msḏr iꜣby* 'on the left ear'. Finally, a star on the third vertical left or right is *ḥr ḳʿḥ wnmy* 'on the right shoulder' or *ḥr ḳʿḥ iꜣby* 'on the left shoulder'.

The procedure is clear. On a suitable viewing platform, probably a temple roof, two men would sit facing one another on a north–south line. The northernmost would hold a sighting instrument like a plumb bob (called by the Egyptians a *mrḫt*) before him and would call out the hour when a star had reached either the meridian or one of the lines before or after as sighted against the target figure. The effort for such precision points to the use of the water clock as an independent means of marking when an hour had ended, and emphasizes as well the reluctance of the Egyptians to abandon telling time at night by the stars. Indeed, a water clock of the Ptolemaic period has an inscription on its rim that its purpose is to tell the hours of the night only when the decanal stars cannot be seen (Borchardt 1920, p. 8).

Unfortunately the texts of the new clock are all more or less corrupt, but the fact that we have four sets of tables from three tombs helps considerably in the effort to establish the prototype. New constellations such as the 'giant' and the 'hippopotamus' which appear in the Amenope onomasticon are found besides others such as *mꜣi* 'lion', *mnit* 'mooring post' and *ꜣpd* 'bird'. The presence of Sirius–Sothis in the new clock ensures that, while most of the new hour stars are out of the decanal belt they must appear in the southern sky and probably in a belt parallel to, or slightly overlapping, and south of the decanal belt.

11. Astronomical monuments

Before proceeding further it will be found useful to review briefly the sources of what we do know about Egyptian astronomy. We have already discussed the star clocks found on the inside of coffin lids. These are 12 in number and they range from the Ninth to the Twelfth Dynasties. Other than these there are some 81 monuments in great or less part concerned with astronomy. In the main these are ceilings, the majority in tombs, though there are many in temples. There are a few water clocks with astronomical depictions on the outside, and in the Graeco–Roman period zodiacs are found on the inside of coffin lids. Many of these monuments include lists of decans, either rising or transitting hour stars. From variant decans it is possible to group these lists into families, so that we have (after the earliest monument in each case) the Senmut family, the Seti I A family and the Seti I C family, all three of rising decans. The Seti I B family is surely of transitting decans, since it accompanies the texts we have referred to above. One other family, Tanis, is not classifiable with certainty. It has the appearance of being a mixed and artificial list and is probably indicative of the decline of the decans as time measurers.

Besides decanal names an astronomical monument may include decanal stars, one or more with each name, and also deities associated with the individual decans as well as decanal figures. Decans of the triangle, usually replaced in part by planets, are also listed. Constellations, notably a group usually referred to as 'northern', may appear and these may be accompanied by deities. Other less frequent elements may be present, such as calendar years, cosmic deities, hours of the day and night. Lastly the zodiacs become frequent in the Graeco–Roman period.

12. The astronomical ceiling of Senmut

An example of an astronomical ceiling, and the earliest one we presently know of, is from the tomb of Senmut, the architect and favourite of Queen Hatshepsut (about 1473 B.C.). At the top of figure 6, plate 13, which is to the south, is found the decanal list beginning on the right. The method of presentation of the decans shows unmistakeably that a star clock was copied. After the first six columns the horizontal line dividing decans from deities is nothing other than the 12th hour line of a star clock and the 11 decans listed in the first six columns are hours 1 to 11 of the first column of a star clock. The last decan is Sirius–Sothis and her position is such that the star clock copied on the ceiling must be dated to the last revision in the Twelfth Dynasty, four centuries earlier. Accompanying the names of the decans are stars, and below the 12th hour line are various deities and more stars. Figured also are the constellations of the ship, the sheep, Osiris in a bark representing Orion and Isis in a bark representing Sothis. On the left of the decans, where a star clock would continue with the triangle decans for the epagomenal days, Senmut has a mixture of decans and planets. Jupiter and Saturn precede the triangle decans as two falcon-headed figures in barks and Mercury and Venus follow the decans, which are only 6 instead of the normal 12, Mercury is shown as a small Seth and Venus as a heron. Mars was omitted, whether intentionally or by error we do not know. One of the decans is figured as two turtles.

Correctly on the northern half of the ceiling is the group of constellations called 'northern' (see below). They are flanked on the base line by two rows of deities, headed on the right by Isis. These are deities of the days of the lunar month in origin (Parker 1950, § 222), and they are present because the 12 circles, divided by the northern constellations into seasonal groups of 4 each, represent the original lunar calendar with the name of each month above its circle. The circles themselves are divided into 24 segments, no doubt for the 24 hours. Later ceilings omitted the lunar calendar, though retaining the lunar day deities and the northern constellations, thus suggesting a relationship which had no basis in fact.

13. The planets

How early all five planets were identified and named is not known to us. The first monument on which they appear is the astronomical ceiling of Senmut but they surely were known well before then. By choice or by error Senmut omitted Mars, but that planet is present with the others on the astronomical ceiling of the Ramesseum, two centuries later. The usual order is Jupiter, Saturn, Mars, Mercury and Venus, that of most distant planet to the one nearest the sun. The first three planets are frequently separated from the last two on the monuments and these were as well considered aspects of the sky god Horus. Thus Jupiter was 'Horus-who-bounds-the-Two-Lands' or 'Horus-who-illuminates-the-Two-Lands' with later variants 'who-illuminates-the-land' or 'who-opens-mystery'. Saturn was always 'Horus-bull-of-the-sky' or 'Horus-the-bull'. Mars was 'Horus-of-the-horizon' or 'Horus-the-red'. As Horuses these planets, when figured, were normally falcon-headed with human bodies.

Mercury had the simplest name *Sbg(w)* but its meaning is unknown. Also unknown are the reasons Mercury was identified with the god Seth, who was an enemy of Horus. Frequently Seth's animal-headed figure was mutilated or replaced on the monuments. Venus in the earlier texts was 'the crosser' or 'the-star-which-crosses', and was pictured as a heron. Later Venus was often termed 'the-morning-star', and had human representation, sometimes with falcon head and occasionally two-headed or two-faced. The indentification of all the planets is secure from the planetary tables of the Graeco–Roman period.

The scraps of texts which usually accompany Jupiter and Saturn tell us little. However, 'Horus-the-red', as the name of Mars, identifies it securely. Another epithet, 'he travels backwards', speaks to be sure of the planet's retrograde movement, but all planets share this peculiarity. A Ramesside text about Mercury is instructive. 'Seth in the evening twilight, a god in the morning twilight'. This shows conclusively that by Ramses VI (1148–1138 B.C.) Mercury was recognized as both evening and morning star. Presumably as evening star and Seth, Mercury was of a malevolent disposition. As morning star and unidentified, it may have been the opposite. We do not know how much before Ramses VI the planet was known to be both evening and morning star.

That Venus also was both evening and morning star was surely known as early as Mercury but there is no textual proof of this. The name 'the crosser' may indicate movement back and forth about the sun and this name is found on the ceiling of Senmut. The late depiction of Venus as two-headed or two-faced also points to this knowledge. It is at least probable that by the middle of the second millennium B.C. the Egyptians had come to the realization that both inner planets could be evening or morning star and that these stars were one.

14. The northern constellations

The term 'northern' has been given to a group which includes one securely identifiable constellation, our 'Big Dipper'. While we are reasonably sure that they are all north of the ecliptic, they may not necessarily be all circumpolar. The number and arrangement vary from monument to monument, but like the decan lists they tend to fall into families. One such family begins with the depiction on the ceiling of the tomb of Seti I, and that will serve us as an illustration differing from Senmut of these constellations (figure 7, plate 12).

On early and again on late monuments shown as the foreleg of a bull, the Big Dipper is here depicted as a bull (Meskhetiu) on a platform. On the right is the constellation 'Hippopotamus' with a crocodile on her back and forefeet resting on a mooring-post. The Foreleg or Bull and the Hippopotamus are essential to the depiction of the northern constellations and they are always present. A falcon-headed god, called An, apparently supports the Bull, while an unidentified man holds the cords which link the mooring-post and the Bull. Above, on the left is the goddess Serket. A bird seems to perch on the head of the constellation Lion, shown with many stars on its head and back. Underneath is the constellation Crocodile with a second unidentified man facing it and in the gesture of spearing it, though here the spear has not been drawn.

The peculiar relationship shown between the Foreleg (or Bull) and the Hippopotamus is mentioned in several mythological texts. One may be quoted from the Book of Day and Night (time of Ramses VI) as follows: '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' (Neugebauer & Parker 1969, p. 190).

15. Zodiacs

To this point we have been dealing with purely Egyptian astronomical concepts. The zodiac was not native to Egypt but was a Babylonian import. Exactly when it arrived is not known, but the first depiction of it we have is from a temple at Esna, now destroyed, dating from 246 to 180 B.C. Though influenced by Egyptian art the basic design of each sign is Babylonian. In combination with the zodiac, however, are to be found all the traditional elements of Egyptian astronomy, the decans, the Sun, Moon and planets, and the constellations. In particular it is the decans which combine with the importation. They lose their old role of telling the night hours by rising or transits and they become mere 10° subdivisions of the zodiacal belt with three decanal names to each zodiacal sign.

More than one decanal list was thus combined with the zodiac. The Esna ceiling has the decans of the Seti IB family in a strip above and those of the Tanis family in a strip below the one bearing the zodiacal depictions. If the two lists are compared, only 12 decans will be found in the same position in both lists, 16 decans are common to both lists but do not correspond in position, and there are 8 variant decans in both lists.

Now the first complete list in Greek, so far known, of the decans in the zodiac comes from Hephaestion of Thebes in the fourth century A.D. When his list is compared with either the Seti IB list or that of Tanis, no complete agreement is found with either. This suggests that Hephaestion's list is an arbitrary and eclectic one and such a conclusion can be documented in this fashion. The Seti IB list begins with the decan *spdt* (Sothis) and that of Tanis with *knm(t)*. If we place the two lists in columns beginning with these decans and place Hephaestion's list in between we have table 1 (the Greek names in the left column agree with Seti IB, those in the right column with Tanis).

TABLE 1

From Neugebauer & Parker (1969), pp. 170–171.

	Seti IB	Hephaestion		Tanis
Cancer	*spdt*	σωθις		*knm(t)*
	št(w)	σιτ		*ẖry (ẖpd) knm(t)*
	knm(t)	χνουμις		*ḥꜣt ḏꜣt*
Leo	*ẖry ẖpd knm(t)*	χαρχνουμις		*ḏꜣt*
	ḥꜣt ḏꜣt	ηπη		*pḥwy ḏꜣt*
	pḥwy ḏꜣt	φουπη		*tm(ꜣt)*
Virgo	*tm(ꜣt)*	τωμ		*wšꜣt(i)*
	wšꜣt(i)bkꜣt(i)	ουεστεβκωτ		*bkꜣt(i)*
	ipsd	αφοσο	αφοσο	*ipsd*
Libra	*sbẖs*	σουχωε	σουχωε	*sbẖs*
	tpy-ꜥ ẖnt	πτηχουτ	πτηχουτ	*tpy-ꜥ ẖnt*
	ẖnt ḥr(t)	χονταρε		*ḥry-ib wiꜣ*
Scorpio	*ẖnt ẖr(t)*		στωχνηνε	*s(ꜣ)pt(i)ẖnwy*
	tms (n) ẖnt		σεσμε	*sšm(w)*
	spt(y) ẖnwy		σισιεμε	*sꜣ sšm(w)*
Sagittarius	*ḥry-ib wiꜣ*	ρηουω		*knm(w)*
	sšmw	σεσμε		*tpy-ꜥ smd*
	knm(w)	κομμε		*pꜣ sbꜣ wꜥty*
Capricorn	*tpy-ꜥ smd*		σματ	*smd*
	smd		σρω	*srt*
	srt		ισρω	*sꜣ srt*
Aquarius	*sꜣ srt*		πτιαυ	*tpy-ꜥ ꜣẖw(y)*
	ẖry ẖpd srt		αευ	*ꜣẖw(y)*
	tpy-ꜥ ꜣẖw(y)		πτηβυου	*tpy-ꜥ bꜣw(y)*
Pisces	*ꜣẖw(y)*		βιου	*bꜣw(y)*
	tpy-ꜥ bꜣw(y)		χονταρε	*ẖnt(w) ẖr(w)*
	bꜣw(y)	πτιβιου		*ẖnt(w) ẖr(w)*
Aries	*ẖnt(w) ḥr(w)*	χονταρε		*ḳd*
	ẖnt(w) ẖrw	χονταχρε		*sꜣ ḳd*
	sꜣ ḳd	σικετ		*ẖꜣw*
Taurus	*ẖꜣw*	χωου		*ꜥrt*
	ꜥrt	ερω		*rmn ḥry*
	rmn ḥry	ρομβρομαρε		*ṯs ꜥrḳ*
Gemini	*ṯs ꜥrḳ*	θοσολκ		*rmn ẖry*
	wꜥrt	ουαρε		*wꜥr(t)*
	tpy-ꜥ spdt		φονορι	*pḥwy ḥry*

Agreement between Seti IB and Hephaestion is found in 24 cases and there are 15 agreements between Hephaestion and Tanis. Only three instances are common to both. This result is astonishing, but it clearly emphasizes the arbitrary character of Hephaestion's list. Though the Tanis list is a doubtful one, Seti IB's list of transit decans was surely based on observation, and any attempt to keep the decans in their proper place in the zodiacal belt must have given much closer agreement between Hephaestion and Seti IB. Instead, we have decans which are off by a whole zodiacal sign. It is clear that the decanal names were adopted merely to name the 10° divisions of the zodiac, and little if any attention was given to their actual location in the sky.

16. The Dendera circular 'zodiac'

This astronomical ceiling (Dendera B), now in the Louvre, but originally part of the ceiling of a chapel on the roof of the temple, is the best known of all such depictions and comes closest to an effort to reproduce the heavens with some degree of exactitude (figure 8, plate 14). In the centre are the two most important northern constellations, the Foreleg and the Hippopotamus. These must mark the location of the pole. The 12 figures of the zodiac are in a circle which does not centre at the pole but is properly askew. Among the figures of the zodiac are to be found the five planets. They are in exaltations, that is in signs in which they are supposed to be particularly influential. Thus Venus is in Pisces, Jupiter in Cancer, Mercury in Virgo, Saturn in Libra and Mars in Capricorn. At the perimeter of the sky are the 36 decans, named and figured. A few selected constellations occupy the area between the zodiac and the pole in addition to the two northern ones. These are presumably all north of the ecliptic but none is depicted in the usual group of northern constellations. Between the zodiac and the decans is a crescent-shaped area also occupied with figures of constellations. Of these we can easily identify Orion and Sothis and the presumption is that the other figures, except for the goddesses Satis and Anukis who accompany Sothis, are of constellations in the decanal band or perhaps slightly south of it. The texts about the figures of the goddesses who support the sky are without astronomical significance.

The circular zodiac (Dendera B) dates to before 30 B.C. In another part of the temple of Dendera, in strips on the ceiling of the Outer Hypostyle Hall, and dated to Tiberius (A.D. 14–37), appears much of what is found in the circular zodiac but this time in linear form (Dendera E), with the constellations placed in particular signs. The combination of the two depictions is thus of considerable importance. The circular zodiac locates constellations north or south of the ecliptic and the linear one locates them in specific signs. A brief catalogue follows.

17. Constellations north of the ecliptic

A. Dendera B, above Sagittarius and Capricorn and between them and the pole. Dendera E, A and C together are between Sagittarius and Capricorn.
B. Dendera E, in Scorpio.
C. Dendera B, between Gemini and the pole.
D. Dendera E omits.
E. Dendera B, near Gemini. Dendera E, in Gemini.
F. Dendera B, above Leo. Dendera E omits.
G. Dendera B, near Libra and Scorpio. Dendera E omits.
H. Dendera B, near Scorpio and Aquarius. Dendera E, in Aquarius.
J. Dendera B, near Aquarius. Dendera E, in Aquarius.
K. Dendera B, near Aquarius and Pisces. Dendera E, in Aquarius between H and J.
L. Dendera B, nearest to Aries. Dendera E, in Taurus.
M. Dendera B, between Pisces and Aries. Dendera E omits. This may possibly represent the full moon.

18. Constellations south of the ecliptic

N. Dendera B, near Pisces. Dendera E, in Pisces.
O. Dendera B, near Aries and Taurus. Dendera E, in Taurus.
P. Orion. Dendera B, near Taurus and Gemini. Dendera E, after Gemini and before Cancer.
Q. Dendera B, near Gemini. Dendera E omits.
R. Dendera B, under Gemini. Dendera E, after P.
S. Sirius. Dendera B, under Cancer. Dendera E, after R.
T. The goddess Satis, a companion to Sirius–Sothis.
U. The goddess Anukis, another companion to Sirius–Sothis.
V. Dendera B, near Leo. Dendera E, in Leo.
W. Dendera B, under Virgo. Dendera E, in Virgo.
X. Dendera B, near Virgo and Libra. Dendera E omits. This constellation of a lion could be that of the hour stars. The lion is in the area of the *ḏ3t* and *tm3t* decans and these are in Virgo.
Y. Dendera B, near Libra and Scorpio. Dendera E, in Scorpio.

In Dendera E are two constellations, one in Libra and one in Leo, which are not present in Dendera B and so may be either north or south of the ecliptic. In our listing, to be sure, north or south and location in a sign are very imprecise, and do not give us more than a general idea of where a constellation is located.

19. Late demotic texts

In the Graeco–Roman period were written a number of demotic documents which concern astronomical or astrological matters. Except for two, these all have their origin in the Hellenistic world and, but for the accident of being written in the demotic script and on papyrus, have little or nothing to do with ancient Egypt. The more important are planetary tables listing the dates of entry of the planets and the Moon into the signs of the zodiac. These were no doubt primarily used for the casting of horoscopes of which we have a number of examples from this period (Neugebauer & Parker 1969, chap. 6).

The two late texts exceptionally Egyptian in content are *P. Carlsberg* 1 and *P. Carlsberg* 9. The former offers a commentary on the texts of Seti I and Ramses IV which we have discussed above, when we analysed the behaviour of the decans in transit. The second papyrus outlines a 25-year lunar cycle, with dates for beginning lunar months in terms of the civil calendar. Though the papyrus itself was written in A.D. 144 or later, the scheme surely goes back to the fourth century B.C. At that time, the cycle reflected the beginning of the Egyptian lunar month with the morning of invisibility of the last crescent. Though the text gives only dates in alternate months it has been found possible to establish the rules for the intervening months and the whole reconstructed cycle may be seen in table 2 (Neugebauer & Parker 1969, pp. 220–225; Parker 1950, §§ 49–119).

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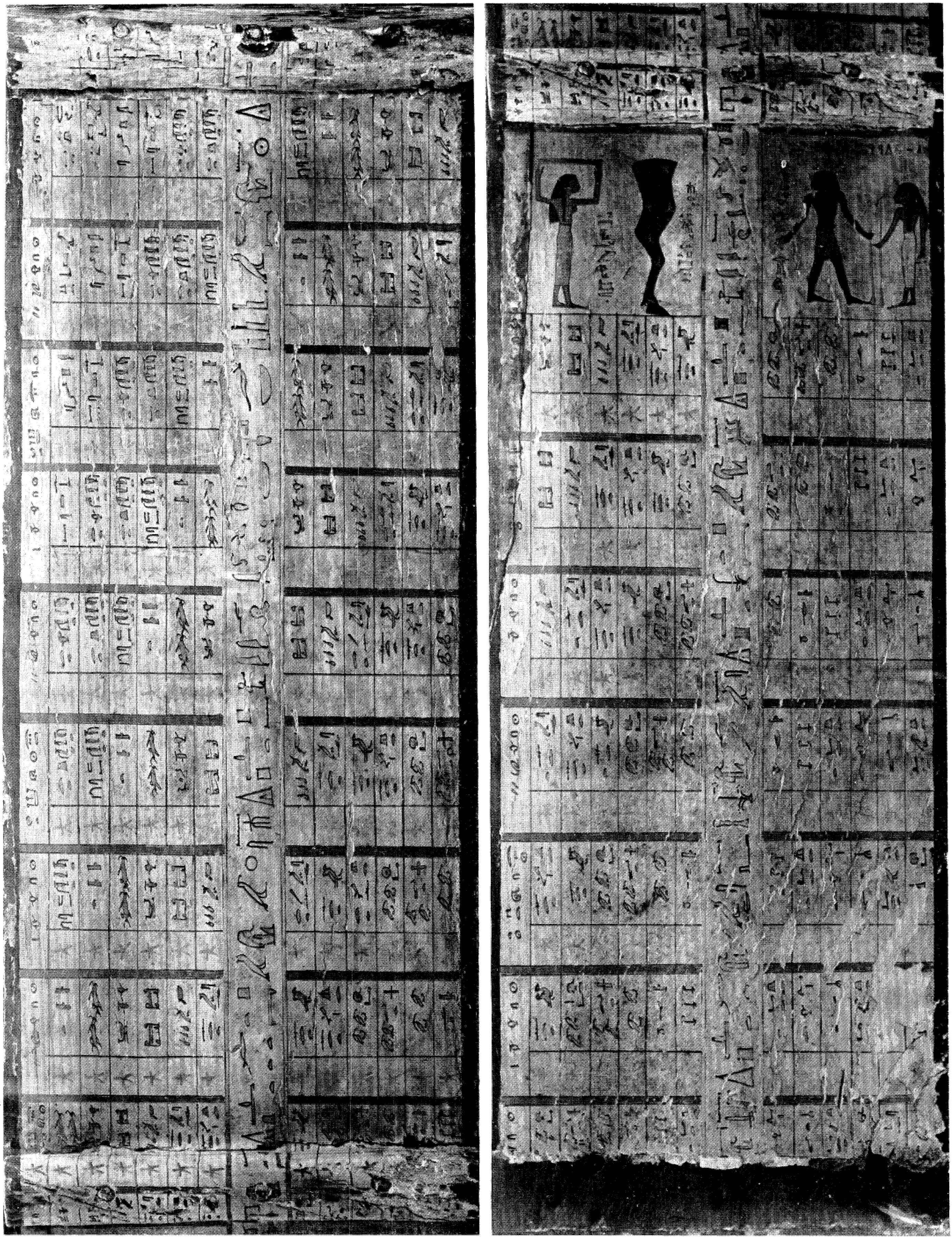

FIGURE 2*a*, *b*. Star clock on coffin lid of Idy.

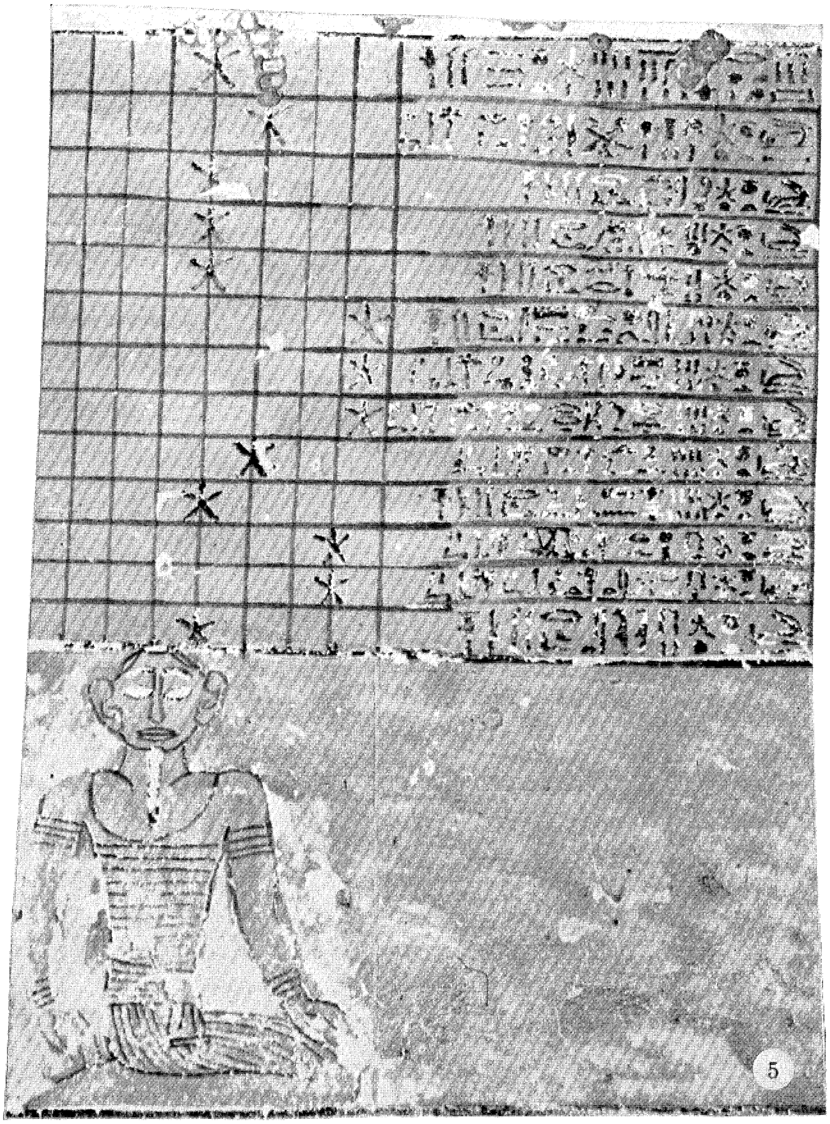

FIGURE 5. Hour table, Tomb of Ramses VII.

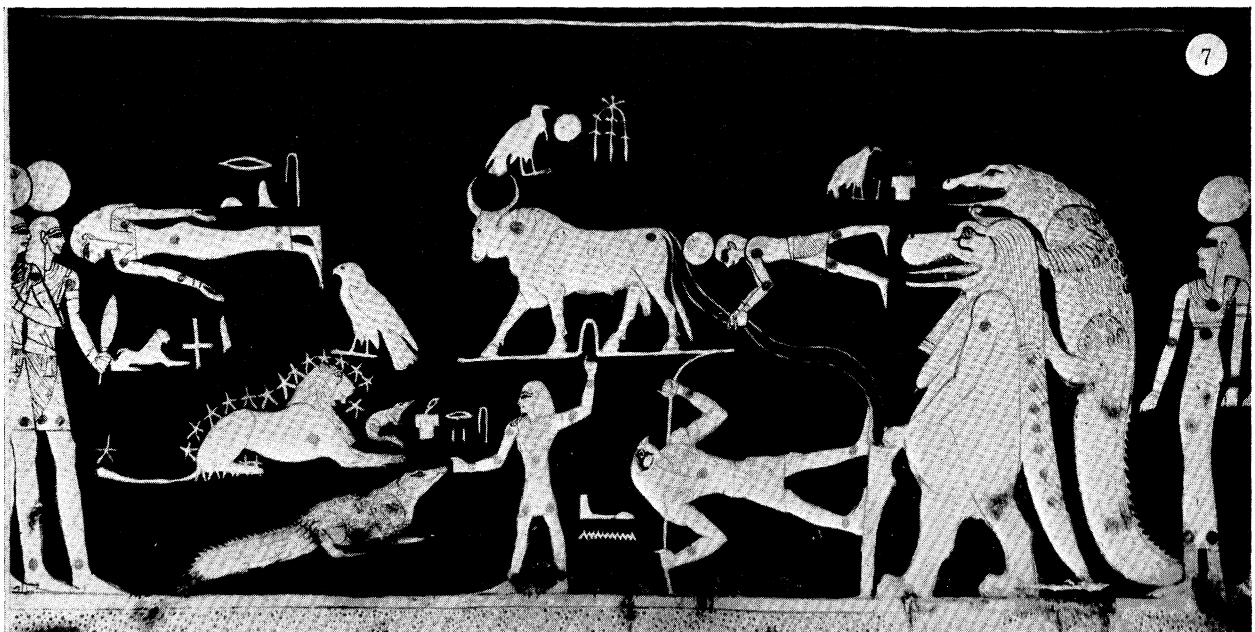

FIGURE 7. Northern constellations, Tomb of Seti 1.

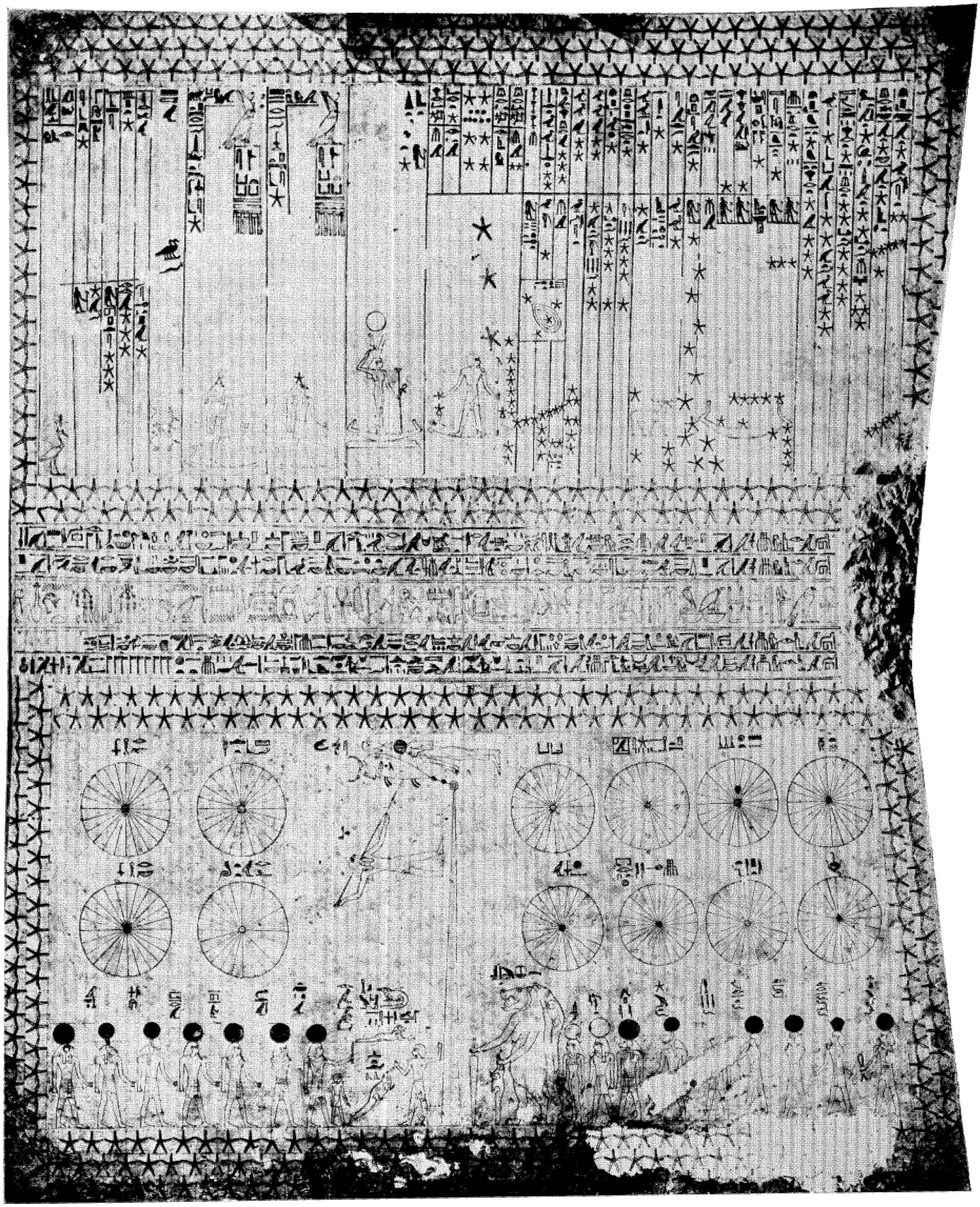

FIGURE 6. Ceiling, Tomb of Senmut.

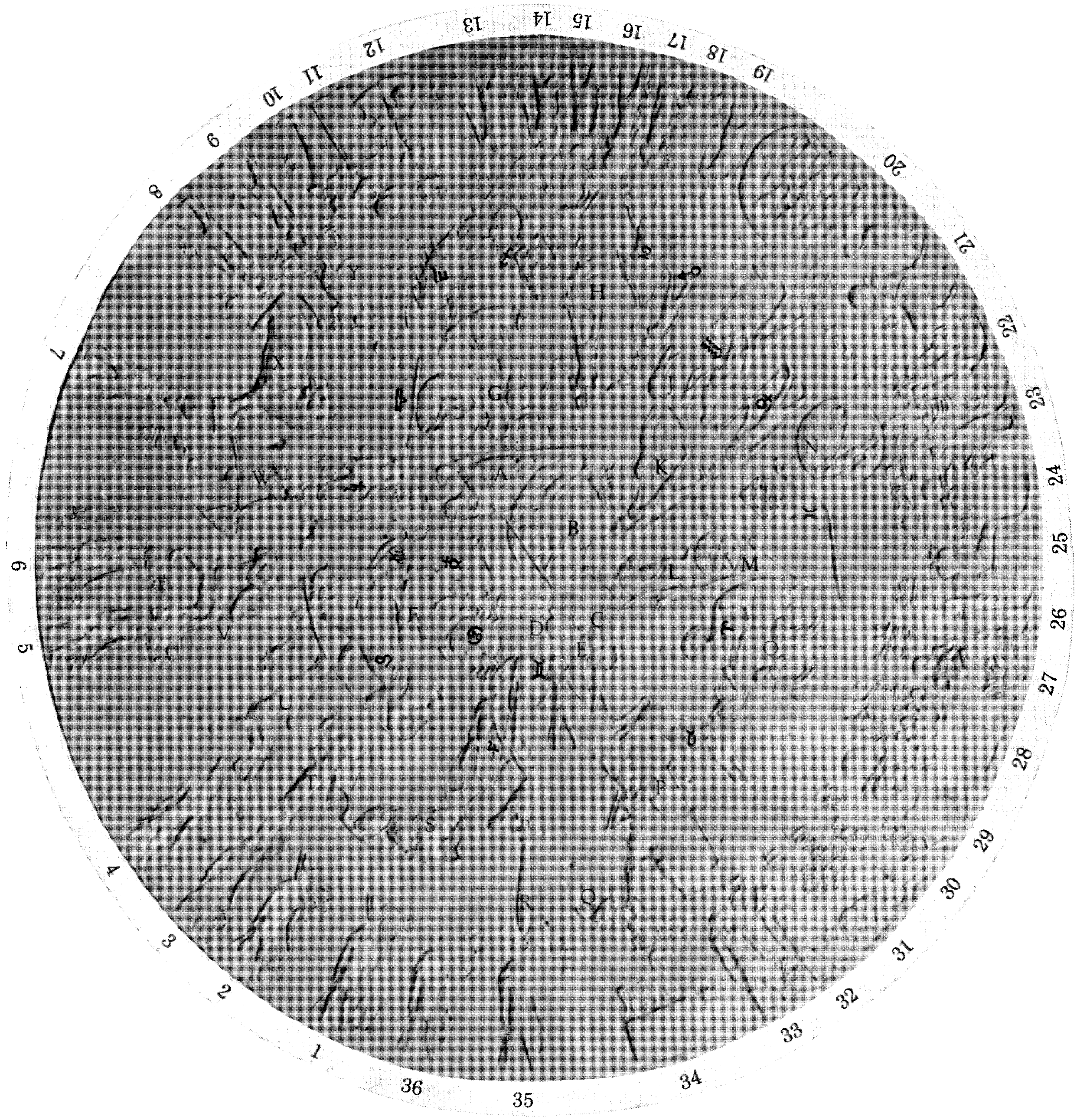

FIGURE 8. Zodiac ceiling, Dendera.

Table 2. The 25-year lunar calendar cycle

From Parker (1950), p. 25.

	Akhet				Peret				Shomu				
months ...	I	II	III	IIII	I	II	III	IIII	I	II	III	IIII	Epag
year 1	1	1	1–30	30	29	29	29	28	27	27	27	26	–
2	20	20	19	19	18	18	18	17	16	16	16	15	–
3	9	9	8	8	7	7	7	6	5	5	5	4	4
4	28	28	27	27	26	26	26	25	24	24	24	23	–
5	18	18	17	17	16	16	16	15	14	14	14	13	–
6	7	7	6	6	5	5	5	4	3	3	3	2	2
7	26	26	25	25	24	24	24	23	22	22	22	21	–
8	15	15	14	14	13	13	13	12	11	11	11	10	–
9	4	4	3	3	2	2	2	1	1–30	30	30	29	–
10	24	24	23	23	22	22	22	21	20	20	20	19	–
11	13	13	12	12	11	11	11	10	9	9	9	8	–
12	2	2	1	1	1–30	30	30	29	28	28	28	27	–
13	21	21	20	20	19	19	19	18	17	17	17	16	–
14	10	10	9	9	8	8	8	7	6	6	6	5	5
15	30	30	29	29	28	28	28	27	26	26	26	25	–
16	19	19	18	18	17	17	17	16	15	15	15	14	–
17	8	8	7	7	6	6	6	5	4	4	4	3	3
18	27	27	26	26	25	25	25	24	23	23	23	22	–
19	16	16	15	15	14	14	14	13	12	12	12	11	–
20	6	6	5	5	4	4	4	3	2	2	2	1	1
21	25	25	24	24	23	23	23	22	21	21	21	20	–
22	14	14	13	13	12	12	12	11	10	10	10	9	–
23	3	3	2	2	1	1	1–30	30	29	29	29	28	–
24	22	22	21	21	20	20	20	19	18	18	18	17	–
25	12	12	11	11	10	10	10	9	8	8	8	7	–

20. Summary

With *P. Carlsberg* 9 we have returned to time measurement, with which we began our discussion. We have seen that Egyptian astronomy, in a quantitative sense, was almost non-existent. To it we may award the determination of the length of the year, the division of the day into 24 hours and the decan names in the zodiac. Overshadowing all these is the pictorial element of which the Egyptian was a master, and the portrayals of astronomical figures on ceilings and other monuments continue to interest and charm us.

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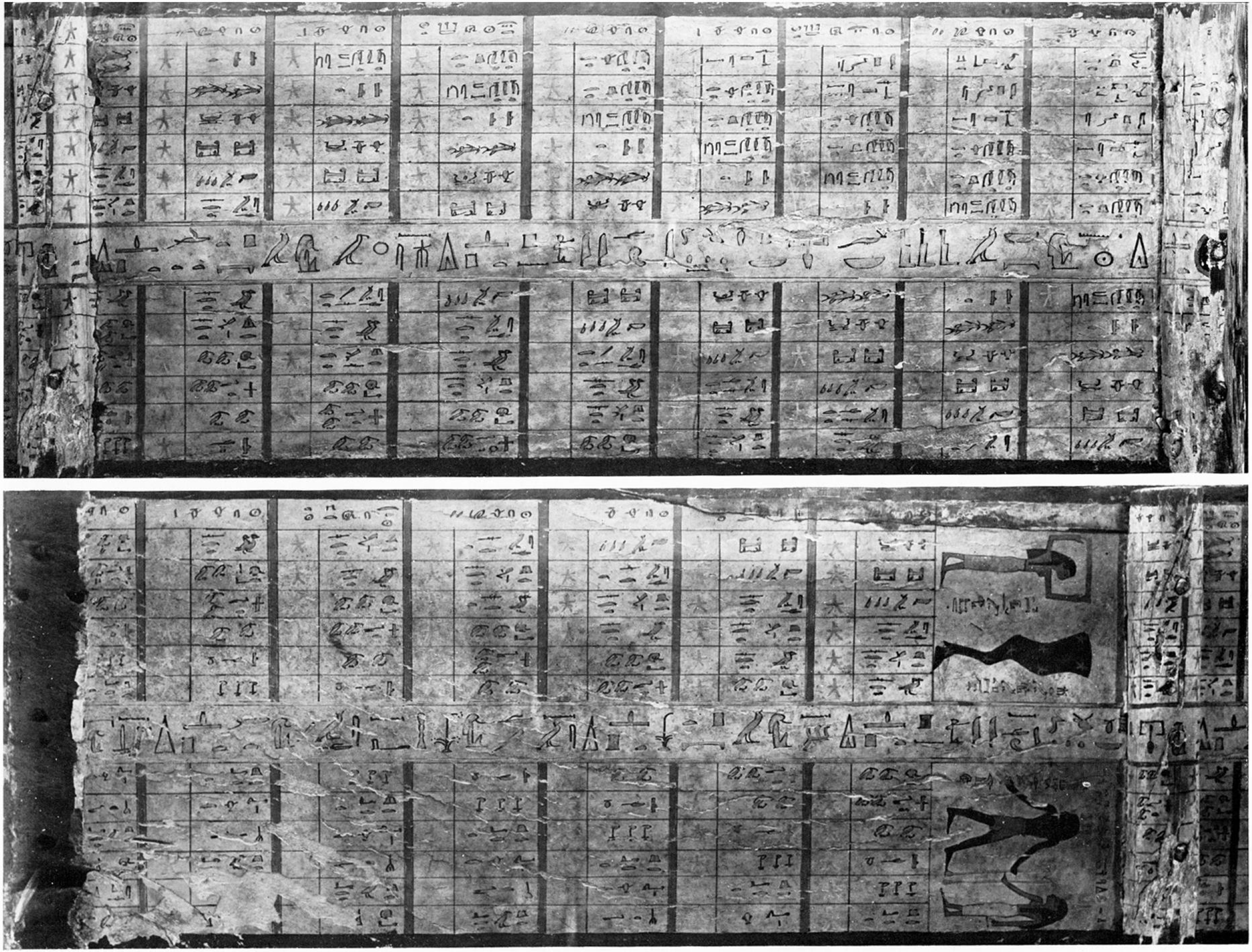

FIGURE 2*a*, *b*. Star clock on coffin lid of Idy.

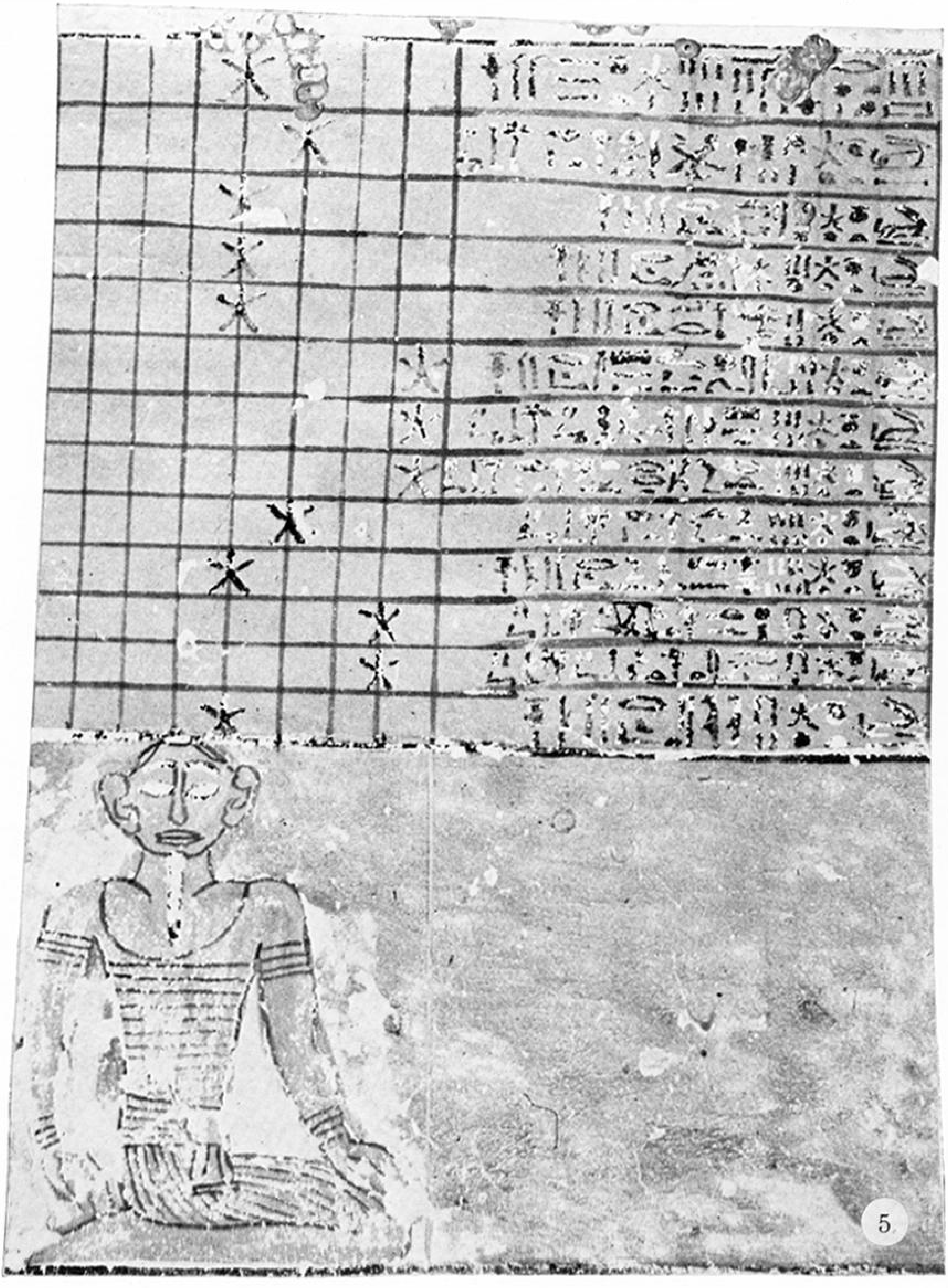

FIGURE 5. Hour table, Tomb of Ramses VII.

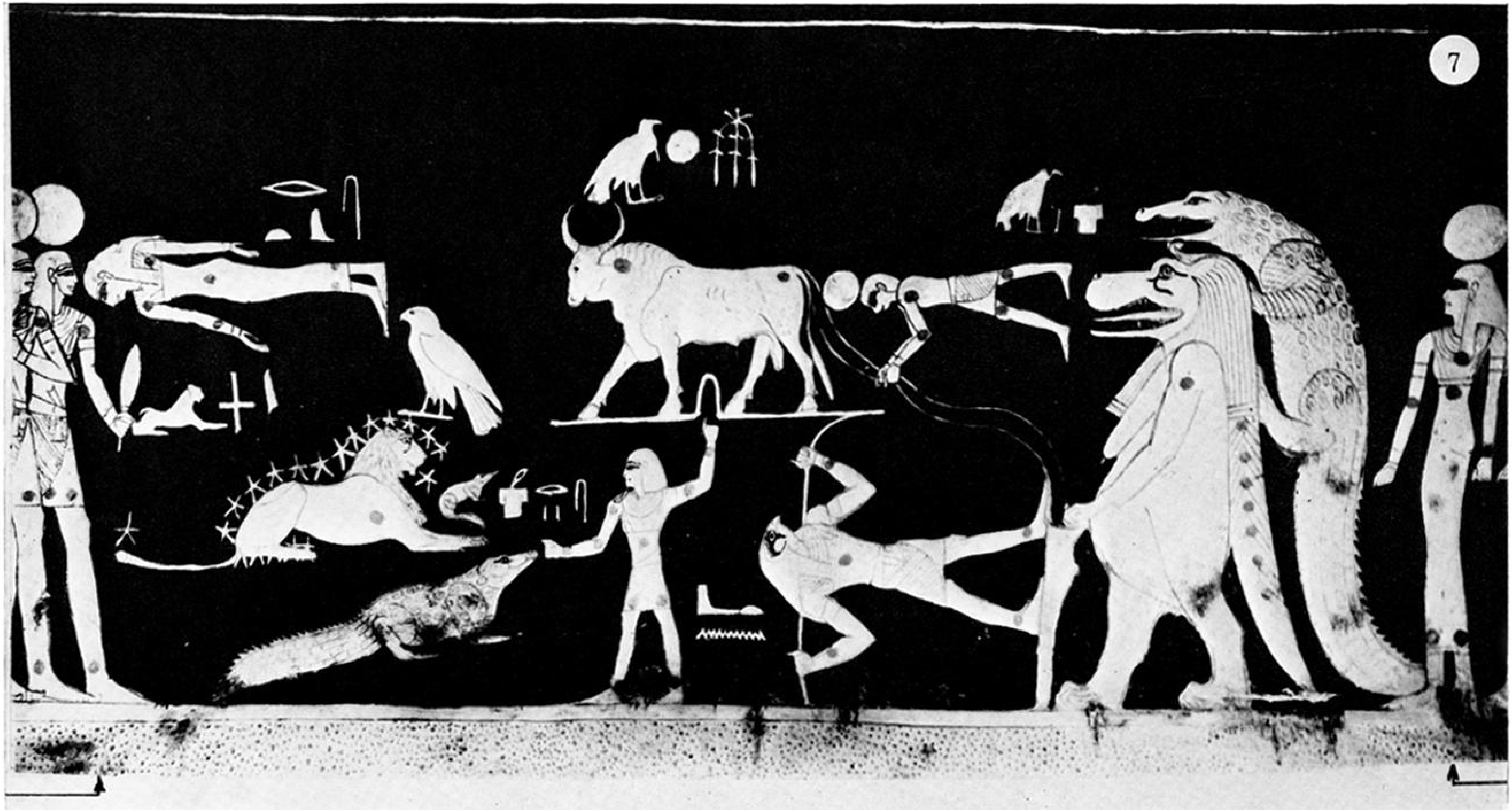

FIGURE 7. Northern constellations, Tomb of Seti 1.

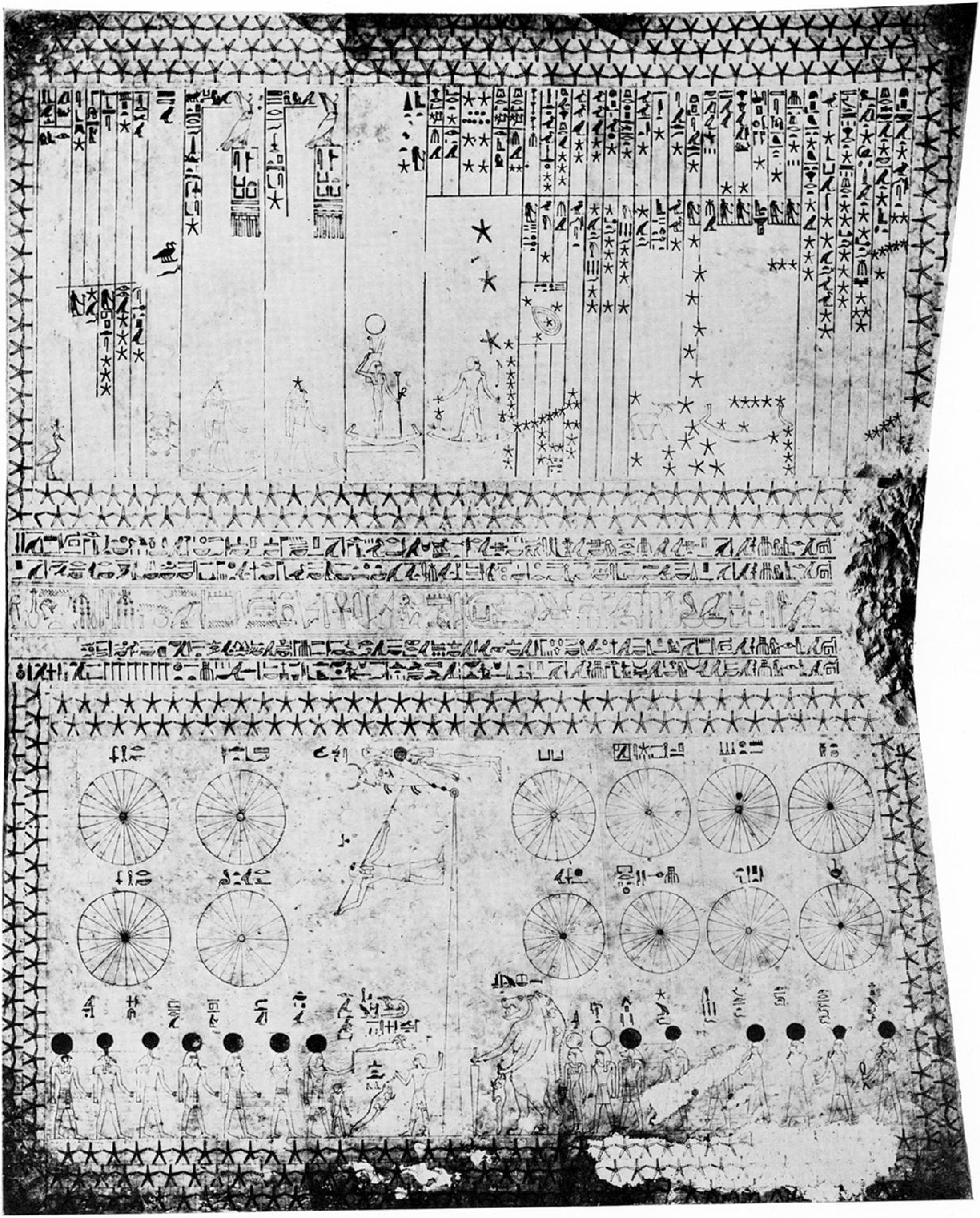

FIGURE 6. Ceiling, Tomb of Senmut.

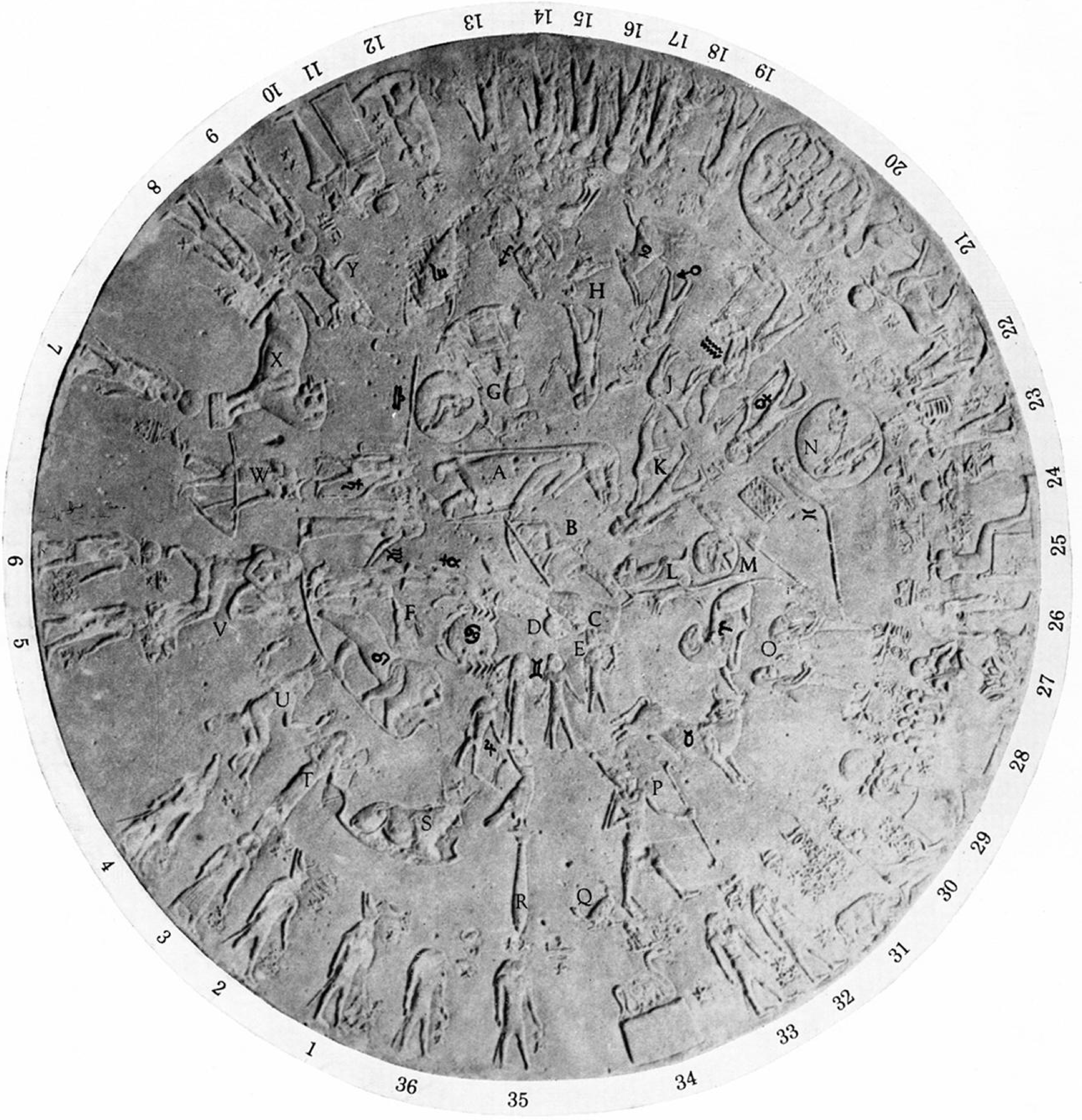

FIGURE 8. Zodiac ceiling, Dendera.