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ON THE ASTRONOMICAL BASIS OF THE DATE OF *SATAPATHA BRĀHMAṆA*: A RE-EXAMINATION OF DIKSHIT'S THEORY

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A statement in *Śatapatha Brāhmaṇa* (SB) declares that *Kṛttikās* never deviate from the east. This statement was interpreted by Dikshit to mean that *Kṛttikās* rise exactly in the east, an event which could occur if *Kṛttikās* were on the celestial equator. Diskhit calculated that *Kṛttikās* were on the celestial equator at about 3000 BC and he proposed this date for the age of *Śatapatha Brāhmaṇa*. Pingree rejected this theory on the basis that other *nakṣatras* besides *Kṛttikā* were also on the equator on this date, a fact which would contradict the statement in SB that only *Kṛttikās* never deviate from the east. Dikshit's theory has been confirmed by the use of a planetarium software which is capable of generating views of the sky at any place on earth and at any time between 4000 BC and 8000 AD. Pingree's objection to this theory, when examined in the ritual context of SB, has been shown to be without basis. Furthermore, the statement about *Saptarṣis* in SB that they rise in the north, implies that the observations may have been made around 3000 BC, from a location whose latitude is well to the south of Delhi.

Keywords: Age of *Śatapatha Brāhmaṇa*, ancient Indian astronomy, *Saptarṣi maṇḍala*, *Kṛttikās*.

INTRODUCTION

It is well known that there are numerous references and allusions to astronomical phenomena contained in the Vedic literature. Many attempts have been

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made in the past (such as those of Tilak[1] and Jacobi,[2] just to cite a couple) to ascertain the age of the Vedas on the basis of that information. It is also obvious that the sky described in the Vedas is quite unlike what it appears now and extensive calculations have to be carried out before any meaningful comparisons with the stellar information in the Vedic literature can be made. As a result the Vedic sky has not received the full attention it deserves and many Vedic passages have remained, as noted recently by Witzel,[3] not yet fully understood. However, in recent years there have become commercially available, some very powerful astronomy software, the so called Planetarium Software. These software can generate and display on a personal computer, with a high degree of reliability, millions of stars and other heavenly objects as seen from any given location on earth and on any given date, all at the click of a mouse. These are used as tools in astronomical explorations with both conventional and automated telescope applications for determining when and in which part of the sky a particular object becomes visible. These computer programs, with the capability to generate and display the night sky at any date and place, can, therefore, be effectively used as research tools to generate and display the night sky as it was seen by the Vedic people. The Vedic passages describing the night sky can be studied in conjunction with such displays. It is to be expected that such an effort would lead to a better understanding of those Vedic passages.

It is the purpose of the present paper to illustrate the application of a planetarium software, "SkyMap",[4] as a tool to re-examine some passages in *Śatapatha Brāhmaṇa* (SB). These passages had been previously used by Dikshit[5] to propose a date of about 3000 BC for SB.

The SkyMap software takes into account the precessional motion of the earth's rotation axis and produces the images of the entire sky at any location on earth and at any date from 4000 BC to 8000 AD. It can generate two types of star maps, a Horizon Map, which shows all the heavenly objects above the horizon at any given location at any given time within certain limits. The other is an Area Map, which is a highly expanded map of a small region of the sky chosen from the Horizon Map and displays greater details. Furthermore, the celestial coordinates, right ascension and declination, can be determined for any object for the

epoch corresponding to a given date. The local rising and setting times for the object can also be determined. On the basis of the displays, it will be shown that Dikshit's ideas regarding the passages quoted from SB are basically correct and that Pingree's objections to them[6] are without a basis. Furthermore, the simulation gives an important clue as to the location where the observations recorded in these passages might have been made.

THE LINES IN *ŚATAPATHA BRĀHMAṆA*

etā ha vai prācyai diśo na cyavante SB (II.1.2.3)
"and again, they do not move away from the eastern quarter" (Tr. Eggeling[7])
amī hy uttarā hi saptarṣayaḥ udyanti pura etāḥ SB (II.1.2.4)
"these latter, the seven Ṛsis rise in the north and they (the *Kṛttikās*) in the east." (Tr. Eggeling[7]).

These lines occur in the second *brāhmaṇa*, the *nakṣatra brāhmaṇa*, of the first *adhyāya* of the second *kāṇḍa* of SB, in connection with *agnyādhāna*, the establishment of the ritual fires for the first time by a householder. The context is a discussion about the suitable time and *nakṣatra* under which it would be auspicious to perform this most important ritual. The first line is used to support the following statement: *kṛttikāsv agnī ādadhīta;* that is, the new householder should establish the traditional *gārhapatya* and *āhavanīya* fires on the day of *Kṛttikā*, for the presiding deity of the *Kṛttikā* is Agni. The *Kṛttikās* alone consist of many stars and they never swerve from east. He who performs *agnyādhāna* on the day of *Kṛttikā*, therefore, is blessed with 'plentifulness' and gets his household fires firmly established in the east. But, the second line quoted above, argues against this propositon; for, the *Kṛttikās* were married to the *Saptarṣis*, who rise only in the north and hence are constantly separated from their spouses, who rise in the east. This portends the same fate to befall the new householder, who establishes the household fires for the first time under *Kṛttikā*. Hence, the day of *Kṛttikā* is not to be considered suitable for performing this ritual. However, later in the section, counter arguments are presented and finally, it is argued, that *Kṛttikās* are the most auspicious; but some other *nakṣatras* which may also be considered auspicious are suggested.

The lines given above are obviously of great astronomical importance and Shankar Balkrishna Dikshit[5] was perhaps the first one to use them to determine the date of SB. Although this issue has been since discussed by many others[8-11] in the literature many times, none expresses more eloquently than Dikshit himself:[12]

> The statement that *Kṛttikās* never deviate from the east implies that these stars always rise in the east, i.e., they are situated on the [celestial] equator or that their declination is zero. At present they do not appear to rise exactly in the east, but at a point north of east; this happens because of the precessional motion of the equinox. Assuming 50" as annual motion, the time when the junction star of the *Kṛttikā* had zero declination comes to be 3068 years before *Śaka* and even 150 years earlier, i.e., the approximate time of the commencement of Kali era, if 48" be adopted as the precessional annual motion. Calculating the declination of some other stars in this age, we find that the northernmost star of *Rohiṇī* group, southern three of the *Hasta* group, two from *Anūrādhā*, one from *Jyeṣṭhā*, and one form *Aśvinī* were situated near the equator, only some one star from the *Hasta* group (if at all) could possibly have been situated exactly on the equator, otherwise none.
>
> The statement about *Kṛttikās* rising in the east is made in the present tense and they cannot always do so because of precessional motion of equinoxes. In our time we find them rising to the north of east and they used to rise to its south in 3100 BS [before *Śaka*]. From this it can be inferred that the corresponding portion in *Śatapatha Brāhmaṇa* was written about 3100 years before the *Śaka* era.

Pingree[6] has argued that the phrase *never swerve from the east* cannot be taken to mean *rise heliacally precisely at the east point* as was done by Dikshit, who deduced that this could have occurred only when the Pleiades were on the equator in about 3000 BC. Pingree counters, "unfortunately for this theory [of Dikshit], parts of the *nakṣatras, Hasta, Visākhe,* and perhaps *Śravaṇa* were also on the equator in 3000 BC." According to him, this fact would thereby contradict the claim in *Śatapatha Brāhmaṇa* that only the *Kṛttikās never swerve from the east,*' and hence he doubts whether that phrase can bear the meaning attributed to it by Dikshit. After rejecting Dikshit's interpretation, Pingree gives his own theory of the origin of the *nakṣatra* system.

One of the purposes of the present paper is to challenge Pingree's ideas and to demonstrate clearly that Dikshit's conclusions were basically correct by show-

ing views of the sky, generated by using the software SkyMap version 2.2. These views correspond to the latitude of Delhi and represent the sky the Vedic people might have seen in their own time.

THE SKY AT PRESENT

Figure 1 is a Horizon Map and shows the sky as it appeared at Delhi on July 9, 1999 AD, at 2:10 a.m. looking in the direction of east a few minutes after the moon rise. The coordinates in the map are the azimuth and altitude, with zenith at the top and the bottom arc represents the horizon. The azimuthal angle of 90° marks the east point. Only stars brighter than magnitude 5 are displayed to avoid clutter.

Views of the sky in other directions can also be generated, and one can choose the size of the field of view. In addition, one can use the equatorial system, the right ascension and declination for coordinates. From the map, one can also get information about the exact coordinates, the rising, setting and transit times of stars.

According to pañcāṅga, it is *kṛṣṇa ekādasī* and *Kṛttikā nakṣatra* on this day. As *Sāyaṇa* explains, "*yasmin dine candreṇa saṃyujyante tasmin dine,*" it is the day when *Kṛttikā* are joined with the moon. We take the Pleiades as *Kṛttikās* and *η Tauri* as the representative for the group. One can see in the picture the crescent moon and *Kṛttikā* just above the horizon, and both are considerably to the north of east. The *Kṛttikās* are displayed in an Area Map in Figure 2, which is an expanded view of the region whose boundaries are marked by the equatorial coordinates as shown. Figure 2 resolves the stars of the Pleiades group. *Taittirīya Brāhmaṇa* (TB) gives the names of the stars belonging to the group as *Ambā, Dulā, Nitanī, Abhrayantī, Meghayantī, Varṣayantī* and *Cupuṇikā*. There is a spread of about 30′ in the declination coordinates of different members of the group. From the display in Figure 1 it is determined that the moon has a declination of 11° 37′ and an azimuth of 78° 29′ and *η Tauri* has a declination of 24° 6′ and an azimuth of 63° 16′. Thus it is clear that the moon rises at a point about 11.5° north of east, and h Tauri rises at a point about 26.7° north of east. In fact, the

latter is further north than the sun on summer solstice. This is exactly as described by Dikshit, with reference to the current position of Kṛttikā. Figure 3 shows a view to the north and shows the *Saptarṣis* rising at a point east of north. At the present time then both *Saptarṣis* and *Kṛttikās* rise in the north.

Kṛttikā on the Equator

Using the software SkyMap, we can determine the date when η Tauri was at a position of zero declination. At that time it would be exactly on the equator and would rise exactly at the east point. Since there is a spread of about 30′ in declination of the different members of the Pleiades group, the other members will not be technically exactly on the equator at the same time and hence would not rise exactly at the east. However, this small spread in declination would have been hardly noticeable. In fact, for a couple of centuries on either side of this date, the *Kṛttikā* group would still be seen as rising in the east.

Figure 4 shows the Horizon Map for Delhi for July 8, 1199 BC. This is usually taken to be the date of *Vedāṇga Jyotiṣa*. It is *Kṛttikā* in *Kṛṣṇa* pakṣa. The picture shows the view of the sky to the east soon after moonrise and *Kṛttikā* is also seen just above the horizon. On this date η Tauri has a declination of 9°41′ and rises at a point about 10° north of east. Obviously, the event described in SB occurred much earlier than 1199 BC.

Figure 5 is a Horizon Map corresponding to August 16, 2926 BC, when *Kṛttikās* (actually, just *η*Tauri) rise exactly in the east. With *Kṛttikās* rising in the east, the Vedic people watching the sky would declare "*etā ha vai prācyai diśo na cyavante.*"

These figures also verify that this event occurred around 3000 BC.

Other *nakṣatras* on the Equator

Pingree has questioned the interpretation, that *never swerve from the east* means that *they always rise exactly at the east point.* For, according to Pingree, parts of *nakṣatras, Hasta, Viśākhe,* and perhaps *Śravaṇa* would also be on the

equator on this date and this would contradict SB's claim that only *Kṛttikās* "never swerve from the east". Figures 6-8 show the Horizon Maps for Delhi on August 16, 2926 BC, facing east and separated by six hours in time interval so that the entire sky for right ascension from 0-23 hours near the equator region could be presented. Table 1 presents, as obtained from figures 5-8, a list of stars, which are brighter than magnitude 4 and lie close to the equator by 2° or less. The table also gives the values of their magnitude, right ascension and declination for the epoch 2926 BC. It is seen that there are about a dozen stars close to the equator. Of these, three are 30′ or less away from the equator, four more are less than a degree away. There are additional four stars at about 1.5° and the last one is about 2° away from it.

Based on Pingree's scheme of identifying stars,[13] *Hasta, Viśākhe*, and *Śravaṇa* correspond to δ Corvi, t Librae, and αAcquila respectively. From Figures 5-8, it is seen that none of these stars are really close to the equator, and are not among those listed in Table1. In fact, the declinations of these stars are 7° 49′, 5° 38′, and 9° 41′ respectively. Therefore, these stars would rise noticeably far from the east point. None of the stars in Table 1 can be identified with the junction stars of the *nakṣatras* themselves. It is true, however, that there are stars in Table 1, that may be considered to be other members of the groups of some junction stars. For *Hasta*, it is β Corvi, with a declination 1° 5′ and ε Corvi, with a declination of just 41′. For *Viśākhe*, it may be α Librae with a declination of mere 23′; and/or δ Scorpi with a declination of 57′, and perhaps *U. Proṣṭhapada*, ε Pegasi, with a declination of -1°23′. Hence, these could also be described as "rising exactly in the east", or "not swerving from the east". No other stars in Table 1 can be regarded as belonging to the traditional list of *nakṣatras*.

Pingree's point (namely, SB's statement that only *Kṛttikās* never swerve from the east cannot have the meaning that they rise exactly in the east) would appear to be well taken since *Hasta, Viśākha* and even *U. Proṣṭhapada*, are also on or near the equator, just as the *Kṛttikās*. However, this objection does not really have any validity when one examines carefully the context under which that statement is made. It is choosing the most auspicious *nakṣatra* for performing *agnyādhāna*. If the ritual of *agnyādhāna* is to be done under *Kṛttikās* because, "they never swerve

from the east," then, Pingree's point would be equivalent to stating that the same ritual could be performed under *Hasta, Viśākhe* and even *Proṣṭhapada,* because they also would "never swerve from the east". In fact, *Hasta* is considered as an alternate auspicious star for *agnyadhāna,* as discussed later in the same section in SB. *Āśvalāyana Sūtra* (II.1.10) permits *Viśākhe* and *U. Proṣṭhapada* for the same ritual. Pingree might have scored a point, had these *nakṣatras been denied the* status of auspiciousness for performing *agnyādhāna.* While "never swerving from the east" is a criterion for selection as a suitable *nakṣatra* for the ritual, there may be other reasons why *Kṛttikās* are preferred, such as the presiding deity being Agni. Thus the phrase "never swerve from east" cannot mean anything other than "rising heliacally exactly at the east point", for, SB itself declares: *udyanti pura etāh "they rise in the east."* On this point, *Sāyaṇa* also says in his exegesis: *śuddhaprācyām evodyanti,* "they rise in the true east." To say otherwise is to deny what SB itself declares. Thus Pingree's objection has no basis whatsoever.

Table 1. Stars which were located very close to the equator in 2926 BC (Epoch: 2926 BC)

Stars	Magnitude	Right Ascension	Declination
41Arietis	3.70	22h 31m	1° 28′
ε Pegasi	2.50	17h 38m	-1° 23′
θ Acquila	3.40	15h 56m	-1° 7′
ξ Serpentis	3.60	13h 14m	1° 21′
δ Scorpi	2.50	11h 38m	0° 57′
σ Librae	3.40	10h 46m	0° 23′
ν Hydrae	3.30	6h 46m	1° 12′
λ Hydrae	3.80	6h 6m	1° 54′
π Hydrae	3.50	9h 53m	-0° 10′
α Hydrae	2.20	5h 21m	0° 48′
β Corvi	2.80	8h 29m	1° 5′
ε Corvi	3.20	8h 7m	0° 41′
Eridanus	4.00	4h 18m	-1° 27′

Saptarṣis in the North

It was mentioned earlier that at the present time all members of the group the *Saptarṣis*, except α Ursa majoris rise (and set) in the north as observed from Delhi (Figure 3). However, in 2926 BC, from figure 9 it is seen that all members of the *Saptarṣis* are circumpolar and are quite to the north, and that Thuban (*Dhruva*) is the pole star. Hence they would not rise or set. We have verified that the *Saptarṣis* remain circumpolar at Delhi from about 4500 BC to about 100 BC, at which time only one star of the group, η *Ursae majoris*, becomes non-circumpolar and rises and sets. It is only at about 600 AD that a second member of the group becomes non-circumpolar at Delhi. If they are all circumpolar as seen in Delhi at about 3000 BC, what is the meaning of "they rise in the north"? In order to see at least one of them rise and set, one would have to observe from a place south of Delhi. In fact, β *Ursae majoris*, which has a declination of +66° 8′ could be observed as rising from a place whose latitude is about 24°N, compared to Delhi's 28°22′N. One would have to be at latitude of about 10°N to observe all of *Saptarṣis* to rise and set. Then of course, Vedic people could say what indeed holds true: *amī hy uttarā hi saptarṣayah udyanti pura etāh.*

Conclusions

A simulation using SkyMap has verified that the statements in SB about the *Kṛttikās* never swerving from east and about *Saptarṣis* rising in the north refer to events that could have been observed around 3000 BC and from a location well south of Delhi. This also confirms that Dikshit's theory is essentially correct and that Pingree's objections to it on the basis that there are other *nakṣatras* which also do not deviate from the east are not valid. For, these other *nakṣatras* have also been suggested in *śāstras* as alternate choices for performing the *agnyādhāna* ritual.

Acknowledgement

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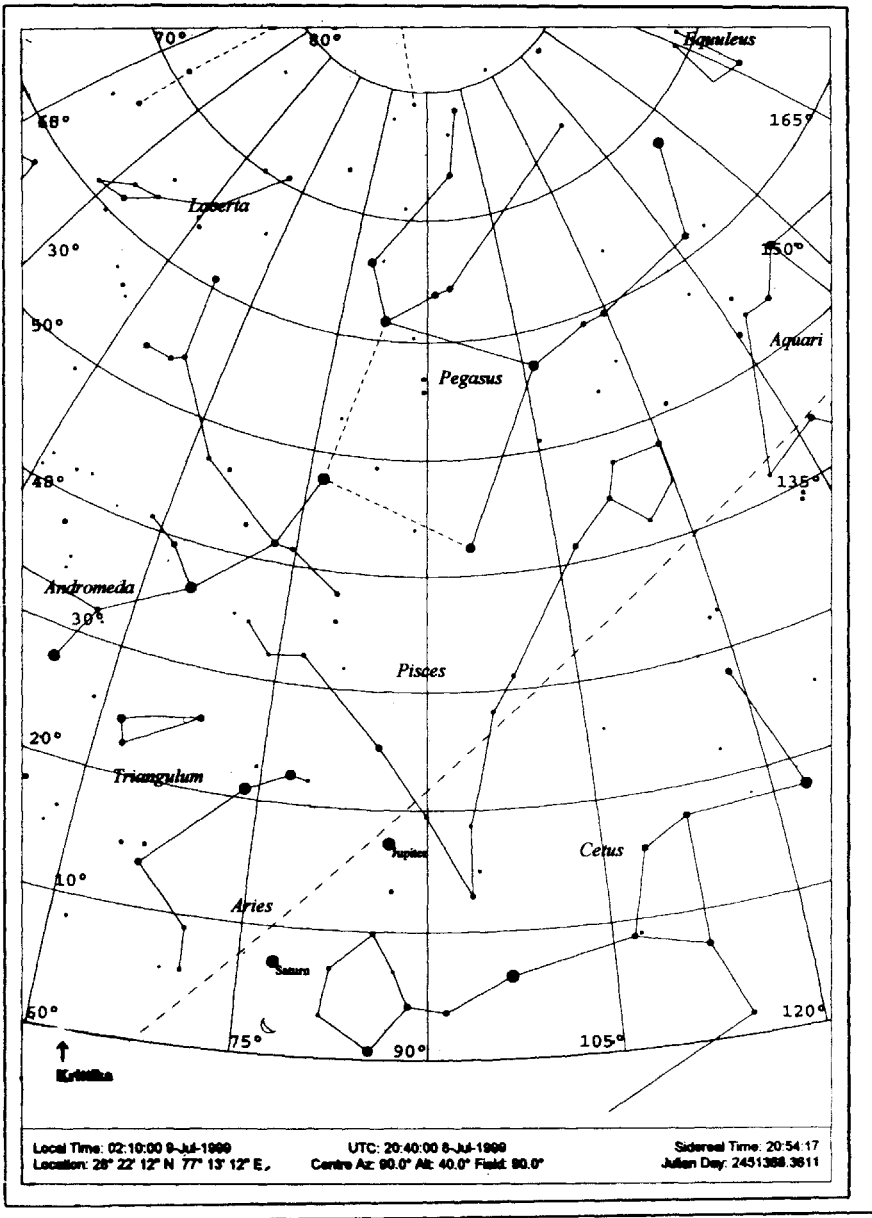

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Fig. 1. Horizon Map facing east at Delhi on July 9, 1999 AD at 2: 10 a.m. Azimuth-Altitude system, Crescent moon and Kṛttikās seen towards north

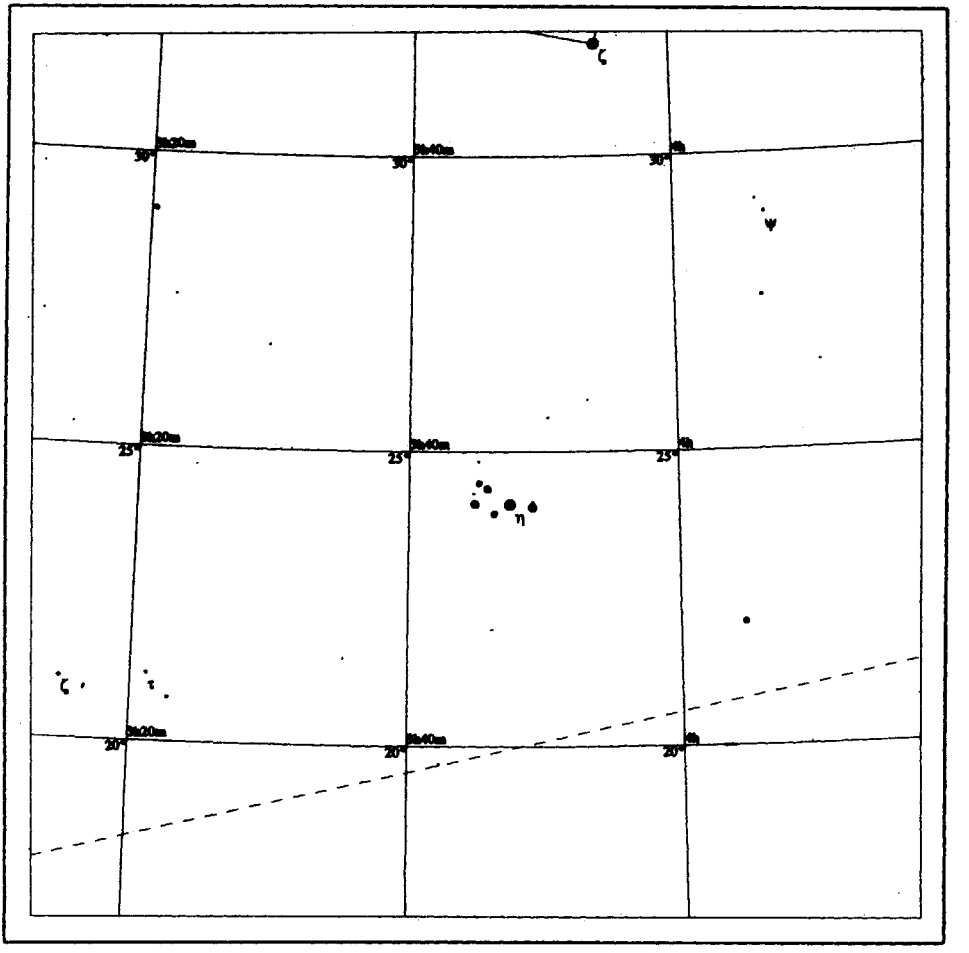

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Fig. 2. Area Map at Delhi on July 9, 1999 at 2:10 a.m.
Right Ascension-Declination system

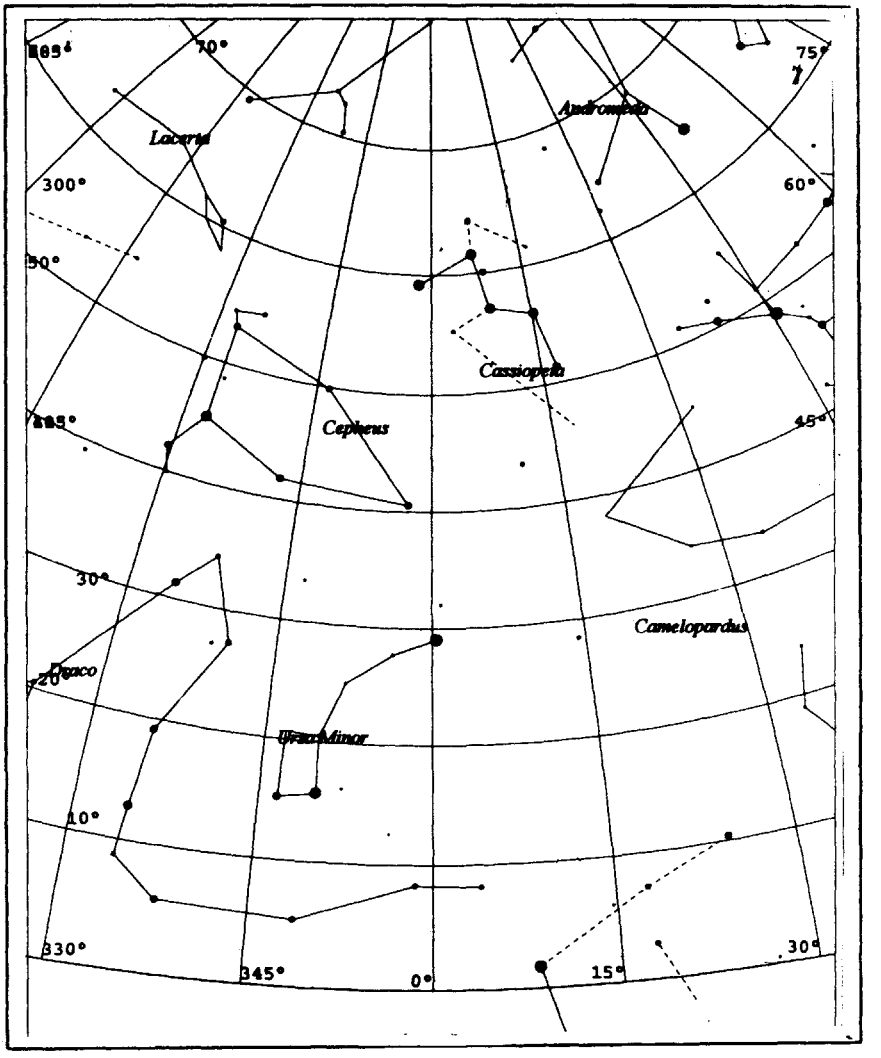

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Fig. 3. Horizon Map facing north at Delhi on July 9, 1999 AD at 5:32 a.m. Azimuth-Altitude system, Saptarṣi just rising above the horizon

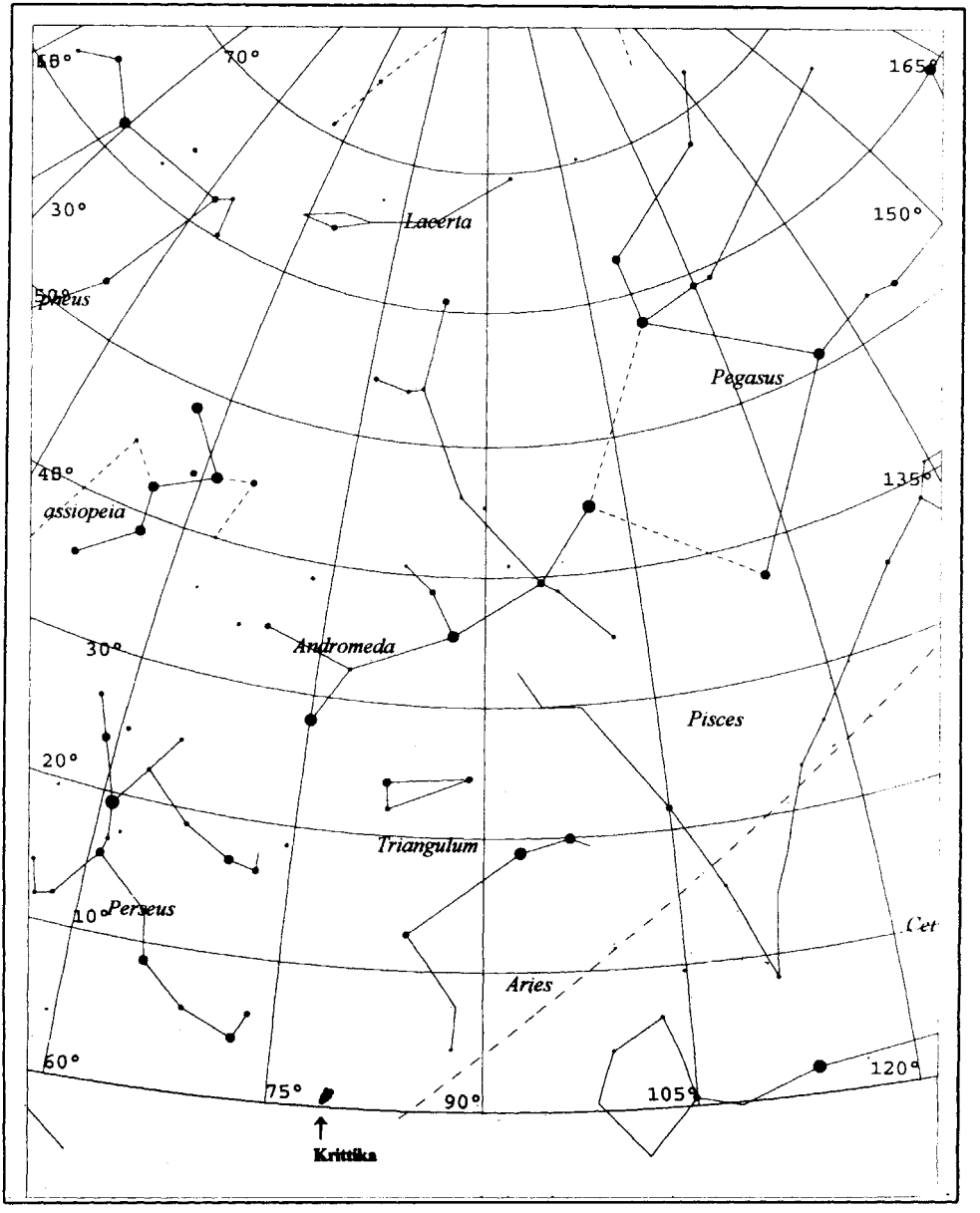

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Fig. 4. Horizon Map facing east at Delhi on July 8, 1199 BC at 0:35 a.m. Azimuth-Altitude system, Crescent moon towards south and Kṛttikās seen towards north.

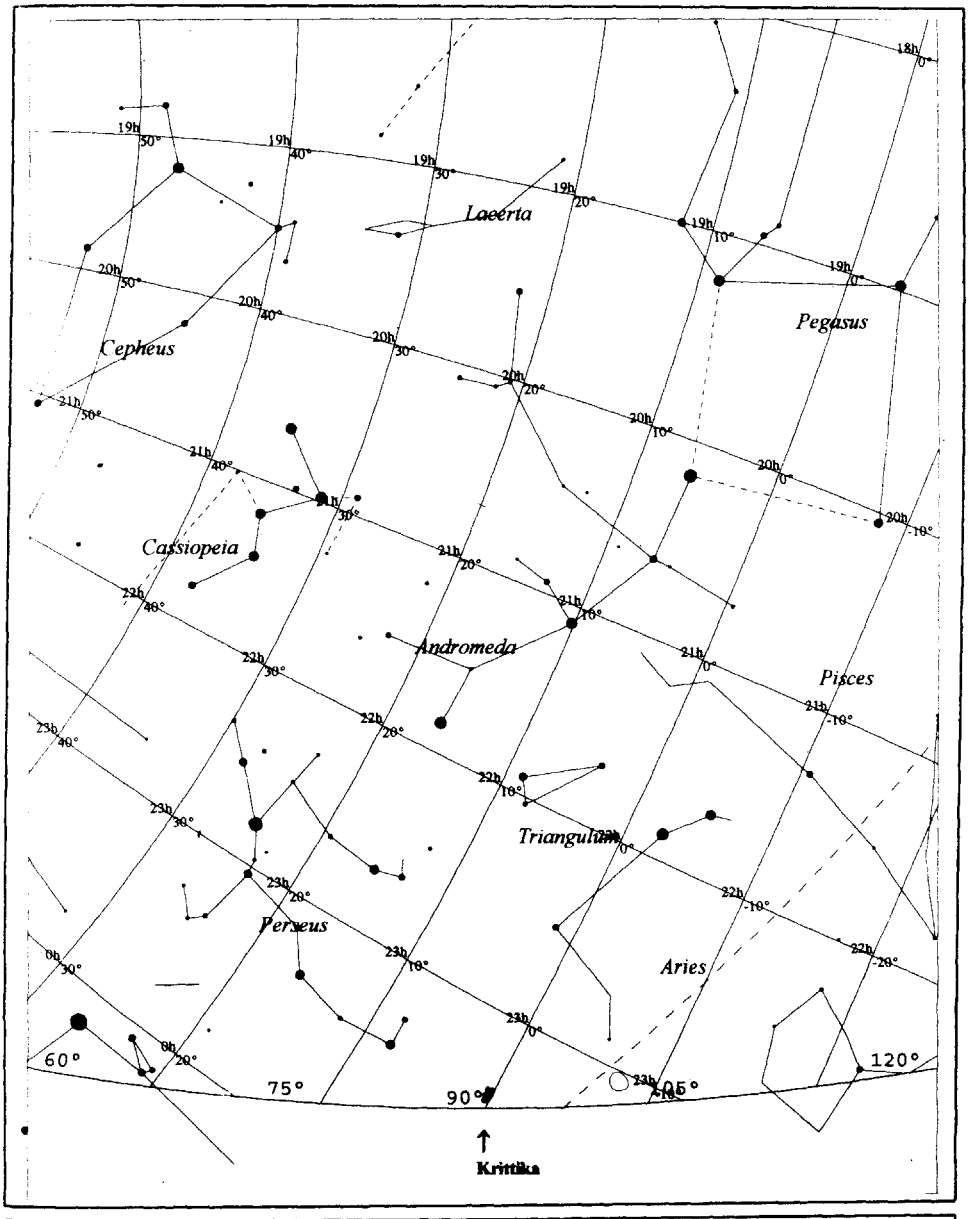

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Fig. 5. Horizon Map facing east at Delhi on August 16, 2926 BC at 9:45 p.m. Right Ascension-Declination system, Kṛttikās exactly at the east.

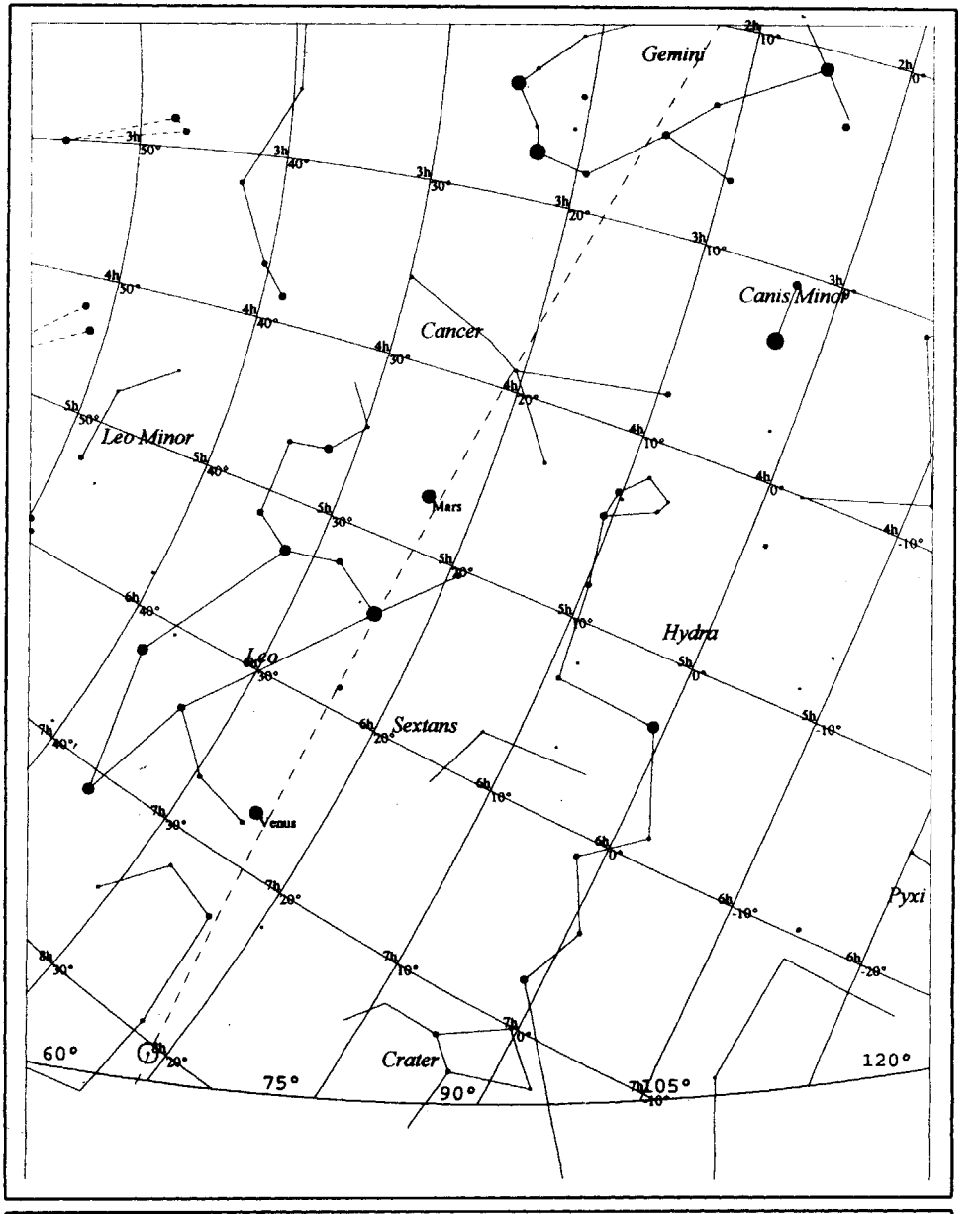

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Fig. 6. Horizon Map facing east at Delhi on August 16, 2926 BC at 5:45 a.m. Right Ascension-Declination system

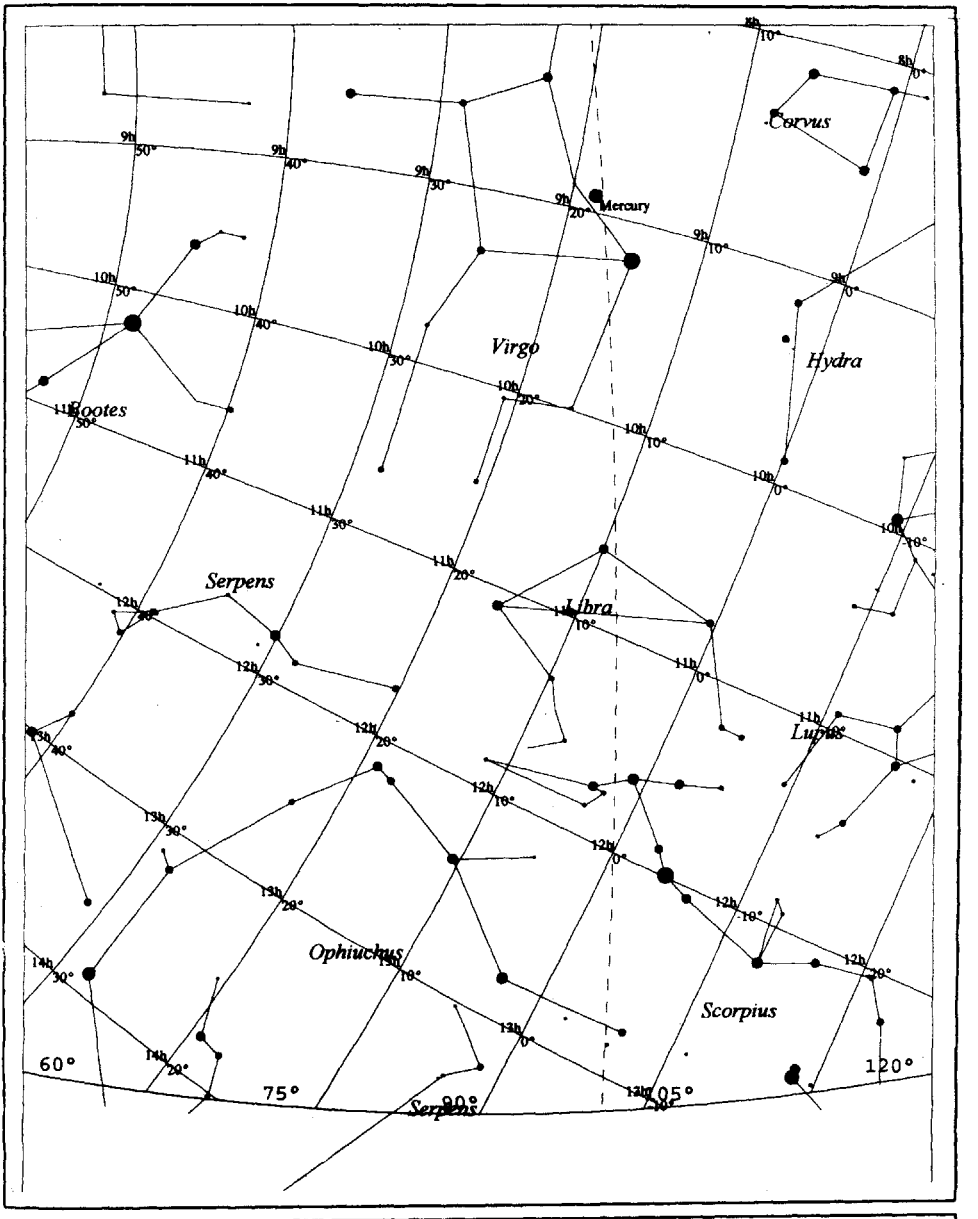

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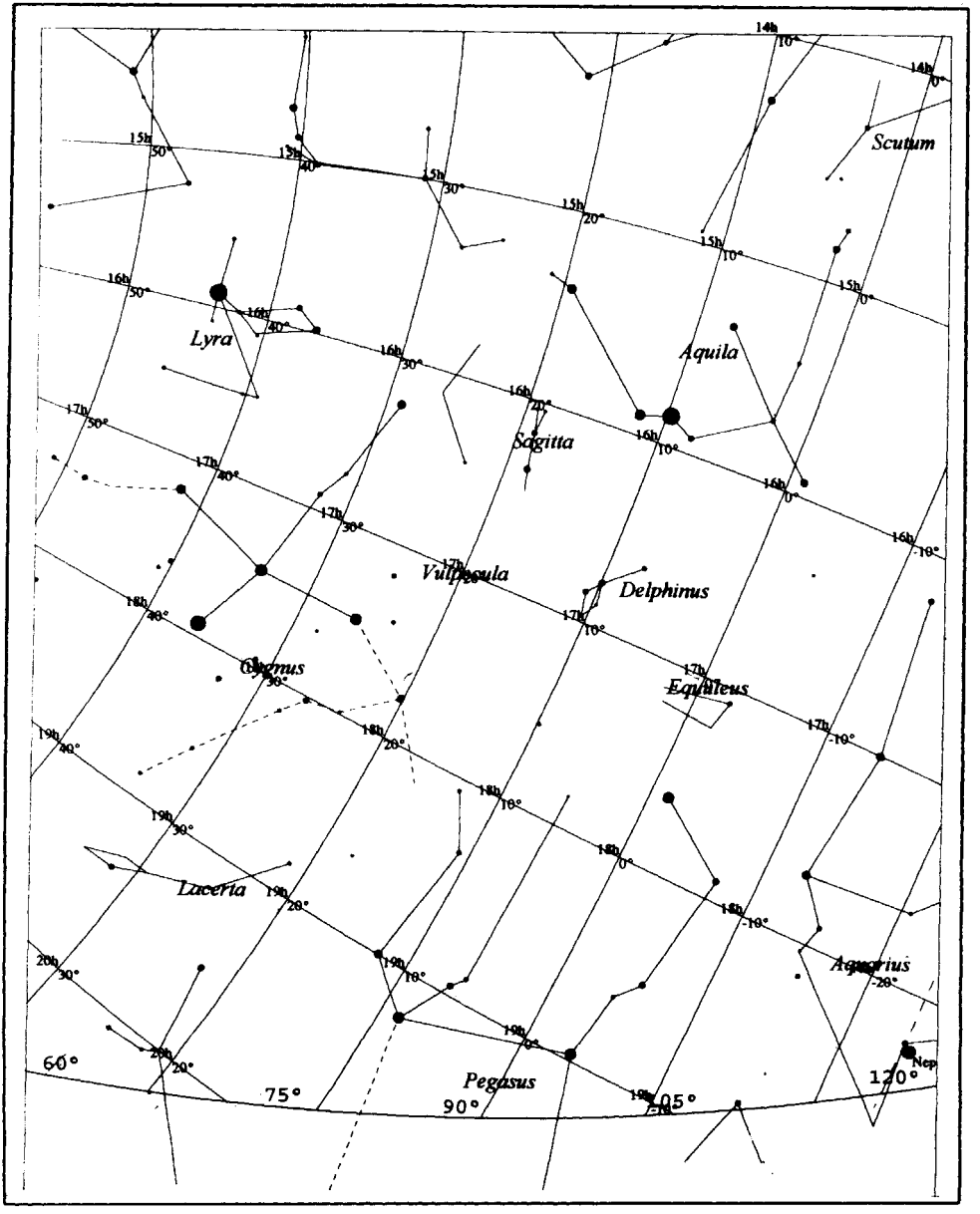
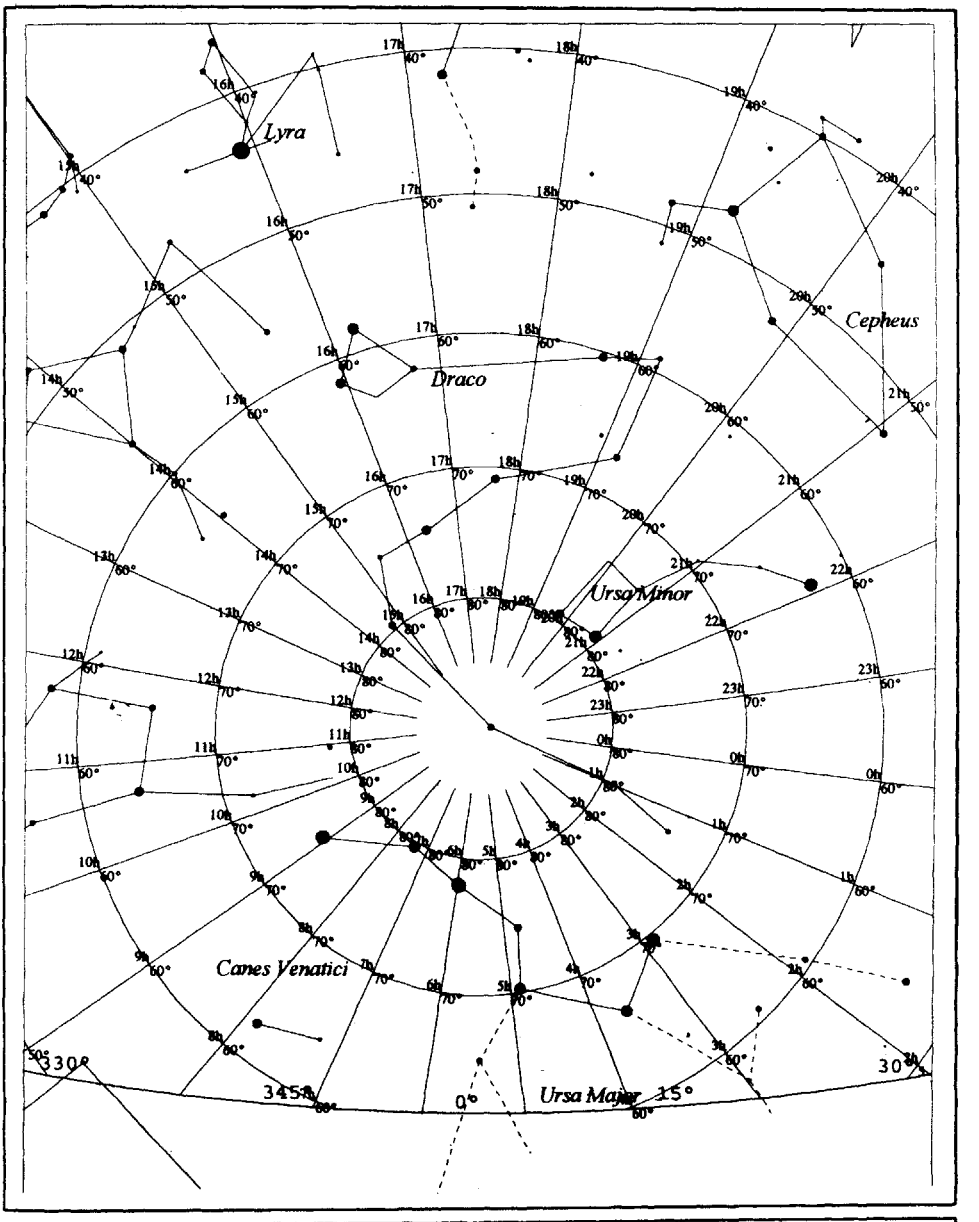
Fig. 7. Horizon Map facing east at Delhi on August 16, 2926 BC at 11:45 a.m.
Right Ascension-Declination system



Local Time: 17:45:00 16-Aug- -2926 UTC: 12:15:00 16-Aug- -2926 Sidereal Time: 13:26:00
Location: 28°22'12" N 77°13'12" E Centre Az: 90.0° Alt: 35.0° Field: 90.0° Julian Day: 652564.0104

Fig. 8. Horizon Map facing east at Delhi on August 16, 2926 BC at 5:45 p.m. Right Ascension-Declination system



Local Time: 21:45:00 16-Aug- -2926 UTC: 16:15:00 16-Aug- -2926 Sidereal Time: 17:26:39
Location: 28°22'12" N 77°13'12" E Centre Az: 0.0° Alt: 35.0° Field: 90.0° Julian Day: 652564.1771

Fig. 9. Horizon Map facing north at Delhi on August 16, 2926 BC at 9:45 p.m.
Right Ascension-Declination system