Nakkhattapadāni (Stars/Asterisms) and Basic Buddhist Calendrics

A Simplified Guide

A. Bhikkhu

Sāsanārakkha Buddhist Sanctuary (SBS)

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A. Bhikkhu

Sāsanārakkha Buddhist Sanctuary (SBS)

34000 Taiping, Perak, Malaysia

Tel.: + 60 11-1601 1198; Web: https://sasanarakkha.org/

September 2021

Author Note

Please refer to a.bhikkhu.pub@gmail.com for correspondence concerning the present work. Soft copies are available free of charge via: **(a)** https://sasanarakkha.org/teachings; **(b)** https://independent.academia.edu/S%C4%81san%C4%81rakkhaBuddhistSanctuary; **(c)** https://archive.org/details/@s_san_rakkha_buddhist_sanctuary. **(d)** It is, besides a number of other works, also available at: https://archive.org/details/@_h_nuttamo_bhikkhu.

About Sāsanārakkha Buddhist Sanctuary

Founded in the year 2543 B.E. (2000 CE), it throughout has been the main objective of Sāsanārakkha Buddhist Sanctuary (SBS) to provide high-quality theoretical and practical tutelage to bhikkhus of the Theravāda. It is a sanctuary for the protection (*ārakkho*) of the Buddha's teaching (*buddhasāsanaṃ*), heightening knowledge and wisdom in theory and practice. Suitably for these ends, SBS is situated within an extended primary forest near Taiping city in north-western Malaysia. Tailored individual spiritual consultations are offered besides guidance in the form of readings and discussions of the four main *nikāyas* and selected texts from the *Khuddakanikāya*, periodical vinaya classes and manual skills courses (sewing, broom making etc.) relating to the craft (*sippaṃ*) of a bhikkhu. The rules and regulations as found in the Pāḷi vinaya (monastic discipline; i.e. the *Bhikkhuvibhaṅgha* and the *Khandhakas*) comprise the most fundamental community guidelines for monastics residing at SBS.

Abstract

The purpose of this work is to provide a basis for the theoretical knowledge of and practical compliance with the Buddha's vinaya rule regarding the stars/asterisms (*nakkhattāni*) and cardinal directions (*disā*). It is incumbent upon wilderness-dwelling bhikkhus to possess at least some degree of learning as it relates to these. It also aims at demonstrating, with pertinence to all bhikkhus, how to calculate the half-months (*pakkhā*) and determine the seasons (*utū*) – by and large independent of technological assistance – tendering ample illustrations and simple mathematical formulas for that end.

Keywords: nakkhattapadāni, cardinal directions, time, *vinaya*, calendar

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Abbreviations

Abbreviations: Buddhist Scriptures

B^e	Burmese edition
Abh	*Abhidhānappadīpikā*
DN	*Dīghanikāya*
Kkh	*Kaṅkhāvitaraṇī*
MN	*Majjhimanikāya*
Mp	*Manorathapūraṇī*
Nidd I	*Mahāniddesa*
Pālim-nṭ	*Vinayālaṅkāra-ṭīkā*
Pj II	*Paramatthajotikā II*
Ps	*Papañcasūdanī*
SN	*Saṃyuttanikāyapāḷi*
Sn	*Suttanipātapāḷi*
Sp	*Samantapāsādikā*
Sp-ṭ	*Sāratthadīpanī-ṭīkā*
Sp-yoj	*Pācityādiyojanā-ṭīkā*
Sv	*Sumaṅgalavilāsinī*
T	*Taisho*
Vin	*Vinayapiṭaka*
Vmv-ṭ	*Vimativinodanī-ṭīkā*

Abbreviations: General

ALT	altitude
And	Andromedae (gen. of Orion)
Aql	Aquilae (gen. of Aquila)

Aqr	Aquarii (gen. of Aquarius)
Ari	Arietis (gen. of Aries)
AZ	azimuth
And	Andromedae (gen. of Andromeda)
Boo	Boötis (gen. of Boötes)
Cnc	Cancri (gen. of Cancer)
Crv	Corvi (gen. of Corvus)
C.S.	*Chulasakarat*
Dec	declination
Del	Delphini (gen. of Delphinus)
Gem	Geminorum (gen. of Gemini)
gen.	genitive
Hya	Hydrae (gen. of Hydra)
Leo	Leonis (gen. of Leo)
Lib	Librae (gen. of Libra)
MY	Malaysia
n.d.	no date
Ori	Orionis (gen. of Orion)
Peg	Pegasi (gen. of Pegasus)
Psc	Piscium (gen. of Pisces)
RA	right ascension
Sco	Sorpii (gen. of Scorpius)
Skt.	Sanskrit
Sgr	Sagittarii (gen. of Sagitarius)
Tau	Tauri (gen. of Taurus)
Vir	Virginis (gen. of Virgo)

Nakkhattapadāni and Basic Buddhist Calendrics

Introduction

It was laid down by the historical Buddha during his ministry and within the scope of his legislation (*vinayo*) for his order that forest (*araññnika*) bhikkhus ought to possess knowledge of the asterisms or stars (*nakkhattapadāni* or *nakkhattāni*) and cardinal directions (*disā*) for practical purposes (Horner, 1950, p. 2296). The cogitable objective re that ordinance was to enable them to determine the time of the night and the cardinal directions by the mere observation of the *nakkhattāni* or general stars (Sp-yoj, p. 243). Regrettably, this injunction is rarely followed through nowadays and remains a domain of fringe interest within the parties concerned.

Much better seems the status quo among generic bhikkhus with regard to another rule set up by the Buddha. He enacted that indeed all bhikkhus (*sabbeheva*) – irrespective of their mode of dwelling – should learn the calculation of the half-months (*pakkhā*) for "how can they know anything else that is good" when they don't know even this (Horner, 1950, p. 1556). A second rationale behind this injunction, besides preventing being looked down upon by the general peoples, is a duty for bhikkhus to announce the season (*utu*) and state what *pakkho* they are in directly prior to the actual recital of the *pātimokkha* rules (Horner, p. 1531; Ñāṇatusita, 2014, p. lxxxviii).

The Buddha and his eminent disciples stressed a punctilious upkeep of the *vinaya* as a means to practical religious advance, personal protection (e.g. MN I – *mūlapaṇṇāsapāḷi*, p. 20 [MN 6]; DN III – *pāthikavaggapāḷi*, p. 32 [DN 26]) and the longevity of his dispensation (Sp I – *pārājikakaṇḍa-aṭṭhakathā*, p. 5): "[...] the *vinaya* is the life of the Buddha's dispensation; when the *vinaya* remains, the *sāsana* will remain." [1] For that reason, an investigation and

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[1] *[...] vinayo nāma buddhasāsanassa āyu, vinaye ṭhite sāsanaṃ ṭhitam hoti.*

presentation of the topics mentioned above to enhance familiarity seems worthy a pursuit – also in this day and age – though being, no doubt, a matter of subordinate rank in the Buddha's overall soteriological semantics. The design of this book is, therefore, to capacitate sylvan bhikkhus to realize the first-mentioned directive of the Buddha regarding the acquaintance with the *nakkhattāni* as well as to show how to manifest this knowledge practically, thereby ultimately fostering discipline in monastic law. The aim in addition to that, but not being of subordinate importance, is to demonstrate for the average bhikkhu how to figure the *pakkhā* and determine the seasons[2] by means of documenting calendrical calculations and broaching a generic depiction of the Buddhist calendar with a focus on the version dominant in Myanmar.

As the title reveals, this work is intended as a simplified guide, which may serve some people's needs perhaps but insufficiently. It is neither a work of rigorous historical or generic investigation nor of precise mathematical methodology; however, a responsibility for fastidiousness was felt due and tried to be implemented as far as time, restricted access to resource materials and other obligations allowed it to.

To my knowledge, existing practical guides on the matter are few and unfortunately incomplete insofar as they are either too sweeping or too opaque for people without any background or interest in mathematics. Another shortcoming observed was the lack of academic methodology, especially consistent referencing, which undercut their overall reliability to a certain extent and proved cumbersome for further investigation of the subject on the side of those interested to do so. The present work attempts to fill the observed gaps though by no means presumes completion.

[2] Independent of adventitious calendric assistance from smartphones & Co.

Whenever possible, primary source materials and academic works were consulted. The references to works in the Pāḷi language as well as quotations from them are directed to and from the *Chaṭṭhasaṅgāyana* editions (PDF files) of the Vipassana Research Institute, Igatpuri, India,[3] if not indicated otherwise. Translations from the Pāḷi are mostly my own. Pāḷi and Sanskrit words are italicized unless they appear in modern English dictionaries, such as the word "bhikkhu", and *usually* given in their nominative forms, in singular or plural.

The first chapter of this book attempts to elucidate the given *vinaya*-legal situation for forest monks regarding the *nakkhattapadāni*, the term's morphology as well as their generic – though not exhaustive – occurrence in the Pāḷi scriptures of the Theravāda tradition in order to determine what exactly it is that should be comprehended; a brief glance at the Chinese canon is furnished as well. Subsequently, the treatise proceeds to a section presenting their historical context and development and a general explanatory guide regarding the Vedic calendar, of which one version was in all probability in use during the lifetime of the Buddha. Ensuingly, basic Buddhist calendrics and calculations are introduced and explained.

A Scriptural Conception

The prime purpose of this chapter is to lay out and explain the legal situation for forest monks regarding a certain degree of acquaintance with the *nakkhattapadāni* and cardinal directions and to make out – according to Theravāda monastic legislation – what kind of practical skill they ought to obtain by knowing these. We'll come to ascertain that the familiarity with the *nakkhattapadāni* should enable forest dwelling monks to determine both general time and the cardinal directions (*Pācityādiyojanā-ṭīkā*). Neither the Pāḷi nor the commentary (*aṭṭhakathā*) contain much data to help us with that — only

[3] These are also commonly known as the Burmese editions (Be).

one sub-commentary (*ṭīkā*), the Chinese canon and, to some degree, the given etymology assist us here. Simply noting de novo the duty for bhikkhus to announce the season and *pakkho* they are in as the preceding motions to the actual *pātimokkha* recitation (Horner, 1950, p. 1531; Ñāṇatusita, 2014, p. lxxxviii) shall suffice – no detailed textual analysis appears necessary.

First, the traditional etymology of the term *nakkhattaṃ* is given, providing some useful clues. Subsequently, we'll look into selected and relevant key terms in the Pāḷi as well as the respective exegesis in the accompanying commentarial literature before we take a peek at the *Mahīśāsakavinaya* from the Chinese Buddhist canon.

Etymology

The etymology of the term *nakkhattaṃ* permits us to infer that the *nakkhattāni* might have been used in land and marine navigation and that the moon in conjunction with them bears some significance too. The following informative extract from the word grammar of the *Tipiṭaka Pali-Myanmar Dictionary* can be found ("Nakkhatta", n.d.):

> (*Na* + √*khī* + *a*; *na* + √*khara* + *a*) A *nakkhattaṃ* does not destroy (*khayati*) or wrecks (*kharati*); by falling upon, there is pointing out rule [presumably regarding the planets of the asterisms, which are said to rule the *nakkhattāni* or perhaps the moon as he enters each of them]. Again and again, a *nakkhattaṃ* does not wreck (*na khīyate*) by being on one's guard on the water. *Nakkhattaṃ*: It does not destroy or ruin (*vināseti*) one's occasion of travelling.[4]

[4] *(Na + khī + a; na + khara + a) na khayati na kharatīti vā nakkhattaṃ, khattādeso nipātanā. punappunaṃ udapayattā na khīyate nakkhattaṃ, attano gamanaṭṭhānaṃ na kharati na vināsetīti vā nakkhattaṃ. gamanavīthiṃ na dharati na vināsetīti nakkhattaṃ.*

In the Pāḷi

There are several duties forest monks are expected to observe *vinaya*-wise. Among other things, they are obliged to set out water for drinking and washing purposes, a walking staff and kindling wood. However, aside from those relatively easy to realize injunctions, for most forest monks perhaps the nowadays most difficult to implement directive in this category (lacking easy-access information) is that which stipulates either full or partial knowledge of the asterisms (*nakkhattapadāni*; Vin IV – *cullavaggapāḷi*, p. 202):

> Monks, the asterisms (*nakkhattapadāni*) […] ought to be learned by a monk who is a forest dweller, either the whole or a part, he should become skilled in the cardinal directions (*disākusalena*). This, monks, is the duty for monks who are forest dwellers and which should be practiced by monks who are forest dwellers.[5]

What we find in the origin story, setting the background for the rise of the rule under discussion, is a depiction of thieves approaching forest monks and asking them several questions seemingly relevant and likely expected by the general populace such class of monks should have an answer to. Pertinent for our purposes, they were asked if they knew the asterisms or stars (*nakkhattapadāni*), the cardinal directions (*disā*) and today's junction (*yutta*), referring presumably to the coupling of the moon with the individual *nakkhattapadāni*, supposedly to know about the specific day, as was customary in ancient times and is even commonplace to this day in India. The *Suttanipāta* has a verse (Sn, p. 47, v. 574), part of which maintains that the moon is chief among the *nakkhattāni* – *nakkhattānaṃ mukhaṃ cando […]* – and this, as we'll come to see further below, does likely refer to the moon in coupling with them,

[5] *[Ā]raññikena, bhikkhave, bhikkhunā [...] nakkhattapadāni uggahetabbāni—sakalāni vā ekadesāni vā, disākusalena bhavitabbaṃ. idaṃ kho, bhikkhave, āraññikānaṃ bhikkhūnaṃ vattaṃ yathā āraññikehi bhikkhūhi sammā vattitabbanti.*

thus tallying with taking the junction the thieves asked for to be made up of the moon and the *nakkhattāni*. Because they were unable to reply in the positive to all the questions posed, suspicions as to their identity as authentic forest bhikkhus were raised by the thieves and therefore gave them a professional thrashing, so to speak. Following that instance, the Buddha legislated for his forest monks in the manner introduced above. This matter of affairs can only be fully understood through extraneous material (in relation to Buddhist scriptures), the particulars of which will be portrayed only tangentially in the subsequent chapter. "Only tangentially" was said because the method of determining the day according to actual observation of the *nakkhattapadāni* in that manner is likely not in the range of Buddhist monastic legislation (*vinaya*).

It seems also fit to note at this point that it is a reprehensible form of seeking a livelihood for fully ordained Buddhist monks (bhikkhus) to practice astrology (*nakkhattavijjā*, lit. "science of the asterisms", SN III – *khandhavaggo*, p. 112 [SN 28.10]; cf. Nidd I, pp. 153, 210), which likely expresses itself in such forms as foretelling when a house should be entered (on the basis of the *nakkhattapadāni*), a diadem be tied on (coronation?) or a marriage be conducted etc. (Nidd I, p. 157). [6] Therefore, the knowledge of the *nakkhattapadāni* and cardinal directions in Buddhist monastic circles must, evidently, merely underpin such practical manifestations as the determination of time, seasons and the like.

Finally, the just-cited early Buddhist *Mahāniddesa*, the chief disciple Sāriputta's commentary on the *aṭṭhakavagga* of the *Suttanipāta*, recognizes 28 *nakkhattāni* (Nidd I, p. 157),[7] but very antique lists of 27 are also found, although

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[6] *Iminā nakkhattena gharappaveso kattabbo, iminā nakkhattena makuṭaṃ bandhitabbaṃ, iminā nakkhattena vāreyyaṃ kāretabbaṃ [...]*

[7] *[N]akkhattapāṭhakā nakkhattaṃ ādisanti. aṭṭhavīsati nakkhattāni*.

outside of early Buddhist literature. These were the objects of primary importance for the early Buddhist community, especially the forest dwellers.

To understand the rationale and intentions for the Buddha's ordinances under discussion better, at least a plausible approximation of it, we need to divert our attention now to the commentaries (*aṭṭhakathā*) and, mainly, to the sub-commentaries (*ṭīkā*) in addition to one work of a lexicographic genre.

In the *Aṭṭhakathā*, *Ṭīkā* and *Abhidhānappadīpikā*

The *aṭṭhakathā* and *ṭīkā* gloss in several illuminating ways germane to the above, though only one *ṭīkā* (at least) accounts for the precise purpose of the legislation under discussion. To begin with, we find a straightforward annotation regarding our passage in the *Samantapāsādikā*,[8] which maintains that the terms *nakkhattapadaṃ* and *nakkhattaṃ* in our context are used synonymously (Sp IV – *cūḷavagga-aṭṭhakathā*, p. 48).[9] Possibly, the word *pada* ("characteristic", "ingredient", "item", "thing", "element" etc.) of the compound *nakkhattapadāni* (pl.) stands for each element, i.e. the asterism or the section covered by it, within or near the ecliptic and which in the plural signifies entirety. A single element (*pada*) or asterism, or the complete set (in our case of textual analysis), being a pointer and marker to establish the current day and month (see previous section and next chapter). The *Vimativinodanī-ṭīkā* (Vmv-ṭ, p. 156) notes that the scopes or spheres (*visayā*) of the *nakkhattapadāni* and the cardinal directions were the objects of inquiry by the thieves when asking about the *nakkhattapadāni*,[10] presumably referring to the partition of the ecliptic into the individual constituents of the *nakkhattapadāni* and the quarters

[8] The commentary on the first major section of the *Tipiṭaka* that deals mainly with monastic legislation.

[9] *[N]akkhattāneva* ***nakkhattapadāni****.*

[10] ***Atthi, bhante, nakkhattapadānī****ti nakkhattapadavisayāni ñātāni atthi, assayujādinakkhattaṃ jānāthāti adhippāyo. […]* ***Atthi, bhante, disābhāga****nti etthāpi eseva nayo.*

respectively, again likely with relevance to the given day. The *Sāratthadīpanī-ṭīkā* (Sp-ṭ III, p. 156) explicitly states that the coupling of the moon is what should be understood regarding the thieves' question about the day's junction.[11] The *Suttanipāta-aṭṭhakathā* (Pj II, p. 237) reinforces this conception, elucidating the part of the verse referenced above with this passage: "By the control of the junction of the moon, from perceived brightness (*ālokakaraṇato*) and gentleness one can say: 'Today is *Kattikā*, today is *Rohinī*' [names of two asterisms denoting days as well as months]. It is said [therefore]: 'The moon is chief of the *nakkhattāni*.'"[12] Lastly and most importantly, the *Pācityādiyojanā-ṭīkā* (Sp-yoj, p. 243) goes on to comment, it seems, that the actual objective of acquaintance with the individual *nakkhattāni* beginning with *Assayuja* (the first of the entire set of the asterisms) is knowledge of the cardinal directions (*disābhāgo*) and time (*samayo*).[13]

Now I surmise that it was just a mere commonplace to know the *nakkhattaṃ* day, in a way which resembles the knowledge of any given weekday in our modern times – perhaps with precalculated relevant data, based upon official observations, being disseminated in that ancient era. It appears plausible that there were astronomic authorities involved because the moon's velocity happens to vary not insignificantly and relying on sheer observation would possibly be insufficient (see next chapter). The above-cited passages may well simply be interpreted as depicting the thieves saying basically no more than: "What's the day?" So, to take Pāḷi language *samayo* above from the *Pācityādiyojanā-ṭīkā* as having a practical significance that exceeds the

[11] ***Kenajja, bhante, yutta****nti kena nakkhattena ajja cando yuttoti evaṃ vadantena nakkhattaṃ pucchitaṃ hoti.*

[12] *Candayogavasena 'ajja kattikā ajja rohinī'ti sañjānanato ālokakaraṇato sommabhāvato ca 'nakkhattānaṃ mukhaṃ cando'ti vutto.*

[13] *Nakkhattāneva nakkhattapadānī'ti iminā assayujādinakkhattāneva (abhidhānappadīpikāyaṃ 58-60 gāthāsu) disābhāgajānanassa, ca samayajānanassa ca kāraṇattā nakkhattapadāni nāmāti dasseti.*

establishment of general time and directions into crossing over to determine the *nakkhattaṃ* day by observation seems not warranted. To read into the Buddha's injunction regarding the *nakkhattapadāni* now that the wilderness bhikkhus should simply know the *nakkhattaṃ* day seems, however, quite likely. For this reason, a simple reference to a modern calendrical/*panchangam* authority being Ennexa Technologies Pvt. Ltd. (2020) is surely able of fulfilling the need for announcing in what *nakṣatraṃ* (Skt. for Pāḷi *nakkhattaṃ*) the moon is in. Thus it is held here for now, constituting the predicate for further presentations in this text and thereby also forming a limiting frame to be drawn concerning further treatment. The first complete list of the *nakkhattāni* in Buddhist Pāḷi literature, to complete this section, is provided by the medieval (12th century CE) thesaurus *Abhidhānappadīpikā*. With its tally of 27 items in toto, the list closely resembles the earliest ones found in the Vedic corpus (Abh, vv. 58–60).

In the Chinese

Though the textual records of the Theravāda so far handled demonstrate that the motivation behind the monastic prescriptions for forest monks under discussion was the practical knowledge of the cardinal directions and general time, reasons of a higher and more detailed order are not provided. Even if we might invoke convincing rationales lightly for ourselves and perchance despite the fact that there exists no essential *vinaya* related want to dig deeper, a passage from the Chinese Buddhist canon is deemed worthy to be presented in the following – succinctly corroborating what we have gathered so far. The snippet, as paraphrased by Kotyk (2018, p. 149), reads thus:

> The *Mahīśāsakavinaya* 五分律 (T 1421) states that the *āraṇyaka-bhikṣu* [forest monk] should fully understand the features of the four directions, *nakṣatras* [*nakkhattāni*], seasons and dates, although these are for practical purposes. Knowing the four directions helps one escape from bandits. Knowing the *nakṣatras* helps one know when it is

time to sleep and move on the road. One will know the way back after being released from captivity by observing the stars. Knowing the seasons and dates helps one to determine the times for *poṣadha* [*uposatha*] and [rains] retreat. Although familiarity with the *nakṣatras* assumes some traditional astronomical knowledge, there is nothing concerning astrology here.

Summary

Although the *vinaya* rule of the Theravāda regarding an acquaintance with the *nakkhattapadāni* and cardinal directions does not spell out what purposes such a familiarity may serve, we gathered the following from the landscape of the literature in the Pāḷi language and a fleeting peek into the Chinese: **(a)** The cited etymology gives useful hints that the *nakkhattapadāni* were in ancient times likely used for navigation and determining the days, being adumbrated by explaining that there is pointing out rule by falling upon, referring likely to the moon's junction with the *nakkhattāni* used for stating the current day. **(b)** The expositions in the *ṭīkā* literature about the specifics of the inquiries by the thieves about the day's junction reveal things in such a manner that we may be permitted to understand the *moon's junction* with the individual *nakkhattāni* as the underlying motive for their question, dovetailing in that well with the inkling of that state of affairs in the etymology. They seem to maintain that their scopes or spheres are relevant as well. **(c)** Again, with the aid of another *ṭīkā* we were able to make out that the *nakkhattapadāni* themselves should be taken to be applied for the establishment of time. **(d)** The Chinese passage referred to confirms and specifies the Theravāda perspective that forest monks need to know about the *nakkhattāni* in order to establish general time and to secure navigation, supplying some niceties. The last-mentioned point is most relevant for the present work's purpose of tendering explanations in the framework of the *vinaya*, as it pertains to the bhikkhus' daily dos and don'ts to be complied with and may predicate the further deliberations of it – thus it is held here. A limiting frame was set as to treatments relating to general night time and cardinal directions (seasons and *pakkhā* are to be dealt with in sections yet to follow), precluding methodological discussions regarding the *nakkhattaṃ* days beyond simple reference and accounts (see next chapter). Legally binding it appears not to be to have knowledge about the settlement of the *nakkhattaṃ* day, that not being borne out by the texts consulted. It seems to be in the least the case, however, that the Buddha's forest bhikkhus should simply know about the given *nakkhattaṃ* day.

Having thus established from Buddhist source materials the *vinaya*-legal situation for forest bhikkhus regarding the *nakkhattapadāni* and skill in cardinal directions (what the textual matrix for that is and what that implies practically), now a turn mainly to adventitious guides to gain a historical and more generic vantage point and some degree of further practical counsel — a lack thereof in works of Buddhist origin compels us to make this move.

The Vedic Calendar

In the previous chapter a fair perspective on the relevant textual parameters in Buddhism was gained; these do, however, merely proffer an opportunity for limited insight, insufficient for understanding the astronomical background and employing the basic data probably involved at the Buddha's time. Due to self-imposed limitations in time and the not always insignificant complexity of the issue, the prospect of this chapter will focus merely on generalities of the Vedic calendar without touching on excessive details or algorithms etc., such being allocated treatment in the chapter on calendrics currently in practice within the Buddhist world. Another reason for not going into more detail as to the math of the Vedic calendar is that this system is, among Buddhists at least, virtually obsolete. Canvassed, therefore, are only historical context and development, and merely a generic explanatory guide regarding Vedic calendrics and the *nakkhattāni* therein in particular is tendered. But even with this rudimentary information a glimpse into the mechanics is possible and even a more or less crude practical application.

The Vedic Context

Early Buddhists without Own Calendric System. A precise knowledge of the movements especially of sun and moon, the eclipses and solstices was and still is instrumental for the socio-religious life of large sections of the Indian people, marking the time for and avoidance of sacrifices, religious observances, marriages etc. (Subbarayappa, 1989, p. 27). There is no evidence, though, that the Buddha or his followers of the earliest epoch devised their own calendrical system (Sobhana, n.d.; Chatterjee, 1998, p. 143); instead, the calendrics employed were, in all likelihood, that of the Vedic tradition (Sobhana, n.d.; Clancey, 1906, p. 54). It seems impossible – and certainly heavily exceeds the limits of this book – to determine which particular textual and oral transmissions were primarily in use in the regions where the Buddha preached his doctrine and monastic law and which he and his disciples probably used. Opinions among scholars as to the dating of the texts concerned as well as the information itself within them are (or seem to be) at variance in certain respects, e.g. concerning the listing of the individual *nakṣatrāṇi* as 27 or 28 (Pingree & Morrissey, 1989, pp. 100–2) or the reckoning as to the beginning of the month after new moon (*amānta-mānaḥ*) or full moon (*pūrṇimānta-mānaḥ*). Note that Prasanna (2011, p. 576) stipulates that: "Vedic and post-Vedic texts unambiguously refer to the *amāntaḥ* scheme […]", in addition to it being "[…] clear that the *amāntaḥ* scheme was in vogue in the Vedic and post-Vedic period in north India." Convincing is also the analogy of the moon's death due to its conjunction with the sun (at new moon) and its "rebirth" on the first day after (Prasanna, p. 576). Both schemes, however, coexist among different groups of people probably since the time of the *brāhmaṇas* (Bag, 2015, p. 6) or alternatively much later since circa 300 CE in a different form from the earlier one (Prasanna, pp. 576 – 7).

***Earliest Astronomical Treatise Vedāṅgajyotiṣa*.** After all, the earliest systematic treatise containing fundamental astronomical explanations and data for calendrical purposes may be taken to be the *Vedāṅgajyotiṣa*, of which exist two recensions: *Rgvedic* (aka *Ārcajyotiṣa*) and *Yajurvedic* (Shukla, 1969, p. 100) – very likely known and in use in the era of the *Mahājanapadas* into which Buddha Gotama was born. It is one of the six ancillary sciences connected with the Vedas and can be assigned a date somewhere between 1400 and 1100 BCE, though no clear-cut indications exist for this dating (Chatterjee & Chakravarty, 1985, pp. 252–3). Both recensions are basically the same and tender accounts of the year, half year (*ayanam*), season (*ṛtuḥ*), asterisms (*nakṣatrāṇi*), solar month (*sauramāsaḥ*), sidereal month, synodic month or lunation (*cāndramāsaḥ*), half synodic month (*pakṣaḥ* or *parva*), new moons and full moons, civil day (*sāvanam-dinaḥ*), lunar day (*tithiḥ*) and day-divisions. The segmentation of the year is as follows:

- 2 half years (northward [*uttarāyaṇam*] and southward [*dakṣiṇāyanam*] paths of the sun respectively, changing with the sun's crossing of the celestial equator).
- 6 seasons (spring – *vasantaḥ*; hot – *grīṣmaḥ*; rainy – *varṣā*; autumn – *śarat*; winter – *hemantaḥ*; cool – *śiśiraḥ*).
- 12 solar months (each: 30 civil days).
- 12,4 synodic months (each: 30 lunar days).
- 13,4 sidereal months (one lunar revolution relative to the 27 *nakṣatrāṇi*).
- 24,8 half synodic months (each: 15 lunar days).

- 366 civil days (each: 30 *muhūrtāḥ* = 24 h; 60 *nāḍikāḥ* = 24 min.; 603 *kalāḥ* – 2,4 min).
- 372 lunar days.

Five of such years make up a cycle used for time reckoning called a yuga and are named respectively: 1. *saṁvatsaraḥ*, 2. *parivatsaraḥ*, 3. *idāvatsaraḥ*, 4. *anuvatsaraḥ*, 5. *idvatsaraḥ*. Each year starts at the winter solstice (Abhyankar, 2007). Although the text states that a yuga consists of 1830 civil days, the actual number of days is 1826 and an additional day should be added to 62 synodic months (Kak, 2019). Due to differences in length, there is of course a lack of synchronization between solar and lunar days. The *Vedāṅgajyotiṣa* recommends, therefore, two extra months (*adhikamāsāḥ*) to be added at the middle and the end of a yuga (Bag, 2015, p. 22). The addition of such intercalary months is the main feature of a luni-solar calendar (Abhyankar, 1999, p. 240).

The Nakṣatrāṇi. The *nakṣatrāṇi* (27 in the treatise) are divided into equal segments of the ecliptic, and each is divided into 124 parts respectively, known singled out as a *bhāṃśaḥ* (Bag, 2015, p. 16). The meaning of *star* might simply be carried as a connotation (*Sūrya Siddhānta*, 1860/1935, p. 239; Kotyk, n.d.) The position of sun and moon is identified by these *nakṣatrāṇi* and the leading *bhāṃśaḥ* of its sector (Gondhalekar, 2009, p. 479). The ecliptic division into 12 zodiac signs (*rāśis*) was not known (Bag, 2015, p. 14). From Vedic times onwards, days were named after the *nakṣatraṃ* into which the moon traversed, usually at sunrise – weekdays (Monday, Tuesday etc.) were introduced much later (Abhyankar, 1999, p. 242). In a similar fashion the lunar months were named according to the *nakṣatraṃ* which was inhabited by the full moon – both day and month establishment following these methods were carried into our modern era (Abhyankar, 1991, p. 1). For instance, the month of *Māgho* implies a full moon near *Maghā-nakṣatraṃ* (Prasanna, 2011, p. 575), though it is possible that the actual *nakṣatraṃ* is one, sometimes two, ahead or behind because all *nakṣatrāṇi* are capable of being in junction with the full moon (Abhyankar, 1997, p. 36). The reason why only 12 *nakṣatrāṇi* were selected for nomenclature from all 27 possible might be the magnitude of certain stars concerned (Bag, 2015, p. 5). It was stated that *Abhijit-nakṣatraṃ* was dropped for mathematical reasons during the *Vedāṅgajyotiṣa* period and that the ecliptic was originally divided into 28 *nakṣatrāṇi* (Abhyankar, 2002, p. 1), although we saw already that the original Buddhist community seemingly recognized 28 too, perhaps indicating a concurrence of the two systems. It was stated, in fact, that the number may had undergone fluctuations (Thompson, 2017). Another reason might be that ("Nakṣatra", 1912): "[…] it [*Abhijit-nakṣatraṃ*] was faint, or too far north, or because 27 was a more mystic (3 x 3 x 3) number […]".[14] The earliest Buddhist and Vedic texts speak of crude partitions into a 360-day year and 30-day month (Sobhana, n.d.), though this may not fit to stand as any chronological evidence since that was said to be just a way of roughly speaking (Sarma, 1985, p. 11).

Indian Astronomy – Timeline. In spite of the fact that the *Vedāṅgajyotiṣa* is the earliest scripture in India exclusively dedicated to astronomy, the four Vedic *Saṃhitās* (*Rgveda*, *Yajurveda*, *Sāmaveda*, *Atharvaveda*), the *Brāhmaṇas*, the *Āraṇyakas* and the *Upaniṣads* accommodate a fair amount of astronomical lore too (Subbarayappa & Sarma, 1985, p. xx). All of these texts are probably of pre-Buddhist provenance (Levitt, 2003, p. 356) and must have provided the material for the astronomical backdrop in which the *vinaya* rule regarding the *nakkhattāni* and cardinal directions under discussion was formulated. The traditions of Indian astronomy may be said to span three time periods (Abhyankar, 1997, p. 33):

[14] For a list of the *nakkhattapadāni*, including the number of stars attributed to them, the predominant junction star (*yogatārāḥ*) and the corresponding degrees of the modern zodiac see Table 2 and Figure 16 in the respective sections.

1. Vedic period – prior to 1500 BCE.
2. *Vedāṅgajyotiṣa* period – 1500 BCE to 500 BCE.[15]
3. Buddhist-Jain period – 500 BCE to 400 CE (said to be a dark period in Indian astronomy).
4. Classical *Siddhāntic* period – 400 CE to 1200 CE
5. Late *Siddhāntic* period –1200 CE to date.
6. Modern period – 1800 CE to date.

Summary

In this chapter the *Vedāṅgajyotiṣa* was presented as at least a likely predominant force upon the astronomical system underlying segments of the original Buddhist culture (which lacked their own system), summarized features of its propounded luni-solar calendar and classified it into the wider frame of India's astronomical history. It was explained that with the help of the *nakṣatrāṇi* and the full moon's conjunctions with them the astronomers from Vedic times onwards used to name days and months. This practice continues to be in use in our modern world but since it can be imprecise due to the moon's potential aberrant positioning among the *nakṣatrāṇi*, we may be right to assume that certain calculations based upon mean values are employed in addition to that. The following section aims to usher and elucidate a possible and more detailed approach for determining the time of the night and the cardinal directions by the aid of the *nakkhattāni* and relevant stars within the bounds of modern astronomy.

[15] The *Vedāṅgajyotiṣa* continued to work its influence for a considerable time throughout, probably into the first few centuries of the Common Era (Subbarayappa & Sarma, 1985, p. xii).

Tracking Night Time – A Modern Approach

The aim of this book is to enable bhikkhus abiding in the wilderness to obtain theoretical sapience of the *nakkhattapadāni* and cardinal directions to capacitate skill for basic navigation and time establishment. We saw that the scriptures in the Pāḷi language offer no practical advice to be followed in this respect and due to reasons already given, the Vedic calendric system was not scrutinized in detail and so does not provide much assistance in this instance as well. However, this does not have to be a deterrent to introducing with this chapter a perchance equally valid approach based upon a modern astronomical understanding, being – all things considered – a rather straightforward affair founded upon the *nakkhattāni* or selected stars within them. Their predictable changes over each day and within each night are used here as a basis for keeping track of the time, using the coordinates of Taiping (MY). Providing clues and keys for figuring due east and west, a relevant yet brief account of three stars near the celestial equator is presented as the finish of this chapter. The resulting acquaintance, it is hoped, fills the potentially existing knowledge gap and gives the mentioned sapience.

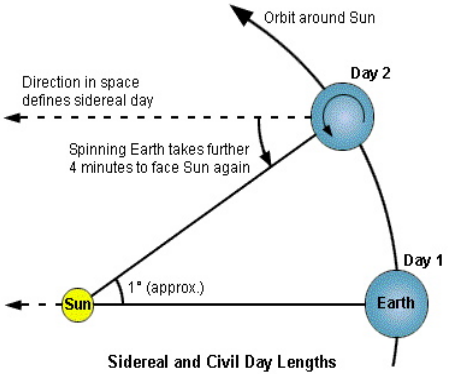

Figure 1. Sidereal Time vs. Solar Time. Note as per Evans (2015): “The Earth has to turn a little bit extra for the Sun to cross the local meridian. We call this the Solar day. The sidereal day is the time for the Earth to rotate 360 degrees.”

Sidereal and Solar Day

The earth rotates from west to east about its axis of rotation, which is an imaginary line going straight through the globe touching both the north and south pole. If this axis is hypothetically produced far enough north into open space, it would intersect the celestial sphere almost exactly at the point where the star "Polaris" is situated. This star appears to be stationary and the other stars apparently move from east to west around it; however, the stars are the (more or less) fixed elements, and it is the earth itself which is rotating from west to east which renders this effect of westward motion in the night sky (Case, 2017; Evans, 2015).

Sidereal Day. The time taken for a star to fully circuit around Polaris, to return to its initial position measured on the day before, to cross through a local meridian a second time, is called a sidereal day, which is 23 hours, 56 minutes and 4 seconds (3.93 minutes short mean solar time). If the sidereal day would be an exact 24 hours – as is one day measured by *mean* solar time – then the stars would rise and set at the same time each day throughout the year ("Sidereal period", n.d.; Case, 2017; Evans, 2015).

Solar Time. It is measured from the immediately successive return of the sun to the position of the same meridian (say at exact noon) from where it started the day before, thereby hitting or crossing through it a second time (commonly known as "one day"). Since there are variations of earth's speed throughout the year, averages are taken, denoting "mean solar time." It is the basis for civil and standard time ("Sidereal period", n.d.; Case, 2017; Evans, 2015).

The Observational Difference. While earth is spinning around its axis, it moves also around the sun. After the time of one rotation – sidereal day– the earth has to travel about 1° further on its path around the sun in order for the earth to face the sun again on the same meridian the second time. Accordingly, for the 24-hours cycle of the mean solar time to be completed, the earth needs to rotate slightly more as is needed for a sidereal day, taking around 4 minutes. Therefore, a given star will rise the next solar day nearly four minutes earlier.

This piece of information is key in determining the position of a star on a given night and thereby the actual given time (“Sidereal period”, n.d.; Case, 2017; Evans, 2015). Figure 1 above illustrates this. Based upon the above-mentioned informations, it suggests itself now to set certain parameters to determine the changes over time in those selfsame markers: selected stars on a certain day/night, at a given time and in a specific position.

Predicting Position of Stars and Time. Based upon a selection of four *nakkhattāni’s* representive stars (*yogatārāḥ*), the following attempts to aid in determining the time of the night for every day of the year. The chosen *nakkhattāni* are, with various alternative names of the respective *yogatārāḥ* in parentheses, the number among the 27 *nakkhattāni* after the dash and the time span covered and approximate altitude after the semicolons:

- *Magasiraṁ* (HD 35468, Bellatrix, 24-Ori, γ-Ori) – No. 5; Dec. 1–Feb. 28/29; 88°
- *Maghā* (HD 87901, Regulus, 32-Leo, α-Leo) – No. 10; Mar. 1–Apr. 30; 82°
- *Jeṭṭhā* (HD 148478, Antares, 21-Sco, α-Sco) – No. 18; May 1–Aug. 31; 58°
- *Uttarabhaddapadā* (HD 358, Alpheratz, 21-And, α-And) – No. 26.; Sept. 1–Nov. 30; 65°

The above selection was merely by sway of the respective star’s magnitude and conspicuousness of the constellations in which they are situated – to use other stars would be perfectly feasible as well. Since most stars and constellations are not visible throughout the night all year round in the locality of Taiping (except some faint ones very close to Polaris), more than one *nakkhattaṃ* had to be chosen – four in our case, to promote ease of identification in the night sky. Opted for were times ranging from around 00:00 to circa 03:00 (see Figures 5–12). Starting projections from these times gives results for significant (but not all) parts of the night. At those preselected moments, the respective star is either at 0° azimuth (due north) or 180° azimuth (due south) and not lower than 58° altitude, with stars Bellatrix and Regulus even nearly overhead, approaching 90° altitude – all to lubricate identification. See Figure 2 below for a straightforward illustration and explanation regarding azimuth and altitude. In the selected locality of Taiping – being near the equator – it is within six hours (circa ± 15 min) that stars rise and set at the horizon relevant to the position (zenith) that was chosen, comparable to the sun at noon. Note that this time frame changes relevant to a given latitude – some stars which rise and set in Taiping (latitude: 4.8519° N) never do so in Bremen (latitude: 53.0793° N), Germany (Vincent, 2003). Roughly speaking, for instance, given that the star Bellatrix is at 0° azimuth (due north) on the 1st of January at 23:58, it will be halfway down between its zenith and the horizon at circa 02:58 and set into the horizon around 05:58. It is very much comparable to a clock, just with divergence in time for which we must make adjustments. In our example of Bellatrix, it would nicely correspond to nearly 12 o'clock midnight (00:00). According to our principle of a star's rise 3.93 minutes earlier each day – as discussed above – Bellatrix would be in the same position (zenith) on the 2nd of January at 23:54 (ca.), on the 3rd of January at 23:50 (ca.) and so forth, making in 30 days a total of 118 min (ca. two hours); accordingly, Bellatrix would be standing in its zenith January 31, guess when – correct, no rocket science! – at 22:00. Thus, when we know the initial position of a few stars on a given day at a given time, we can easily plan for each day of the year. Note that a four-minute approximation would suffice actually – which is used for the first few days above – since on the same day each year the selected star would be there at roughly the same time and no long-term desynchronization would occur.

To further aid tracking the movement of the given stars in time, Figures 5–12 in the section of figures are given as a practical visual guide. Included are figures featuring both an altitude/azimuth (ALT/AZ) grid and a right ascension/declination (RA/Dec) grid. For an adequate spotting using the relevant figures, it is important to understand that the coordinates of right ascension and declination are fixed on the imaginary celestial sphere (though appear to move with the stars) and altitude and azimuth are relative to the observer's position, the cardinal directions and the horizon (appearing stationary and stars moving through). So Bellatrix, for example, would in the course of the night undergo changes in altitude and azimuth (at one time being nearer the zenith, at another nearer the horizon) but never in respect to right ascension and declination. Therefore, in order to predict the course of a respective star during the night, it is imperative to refer to the figures providing the RA/Dec grid. The fields or RA lines extending to the left and right from the star need to be tracked, the position of the star does not change within the field or along the RA lines but moves with it. As an approximation, when facing north, the stars move from

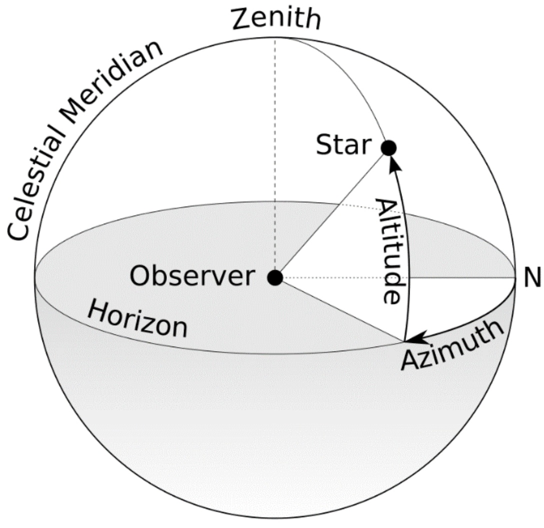

Figure 2. Azimuth and Altitude. Azimuth and altitude are coordinates in reference to celestial objects (sun, moon, stars) as seen from earth. Azimuth measures the angle of a celestial object relative to due north clockwise and the altitude the upwards position, both either on (AZ) or from (ALT) the horizon. They are comparable to latitude and longitude of the geographic coordinate system. *Source*: Azimuth (n.d.) In *Wikipedia – The Free Encyclopedia.* Retrieved December 13, 2019. https://en.wikipedia.org/wiki/Azimuth.

right to left with the RA/Dec grid and when facing south from left to right. Of additional value is surely to know in which constellation of the occidental tradition the given *yogatārāḥ* lie: (1) Bellatrix ϵ (element of) Orion, (2) Regulus ϵ Leo, (3) Antares ϵ Scorpius, (4) Alpheratz ϵ Pegasus. With further help of Figures 5–12 these constellations will be recognized without much hassle. This section of the present chapter presented an avenue based upon modern astronomical lore in combination with the *nakkhattāni* to find out the time of the night; their predictable changes over each day and within each night as seen from the Malaysian city Taiping were introduced as the means for measurement. In order to fulfill this work's assignment of introducing theoretical knowledge on how to ensure basic navigation besides the establishment of time, a simple method on how to determine the *due* cardinal directions is sketched with the section now following.

Cardinal Directions. "The sun rises in the east and sets in the west," that is what we heard probably countless times since the time of our childhoods, but actually it is only true for handful of days each year around both the spring (or vernal) and fall (or autumnal) equinoxes (ca. 21st of March and September re-spectively). To give an example for our location of Taiping (a change in latitude renders different results): After the sun rises at the vernal equinox at 90° azimuth (due east) and sets at 270° azimuth (due west) for a few days, it rises and sets further north on the days to come up to 66° east-northeast and 294° west-northwest respectively at the summer solstice. Then it moves back southwards until the autumnal equinox, reaching the same values as its vernal counterpart and finding its southernmost apex by rising at 113° east-southeast and setting at 247° west-southwest for most of December and a few days in January, with the winter solstice in the middle ("Taiping, Perak, Malaysia - Sunrise, Sunset, and Daylength", 2019). As we can see, there can be a local deviation of up to 24° within a total range over the year of nearly 50° (!), which can serve only as a crude estimate for navigational purposes. Figure 3 below illustrates this well. A perhaps more accessible path to determine due east and west is to track the faring – or better rising and setting – of stars across the night sky near or on the celestial equator, which always rise and set due east and due west apiece. This holds true for making observations in most regions of the planet, except at the north and south pole (Lacy, Jeon, & Li, n.d.; “The celestial sphere”, n.d.) Hence, the spotting of rise and set of these equatorial stars

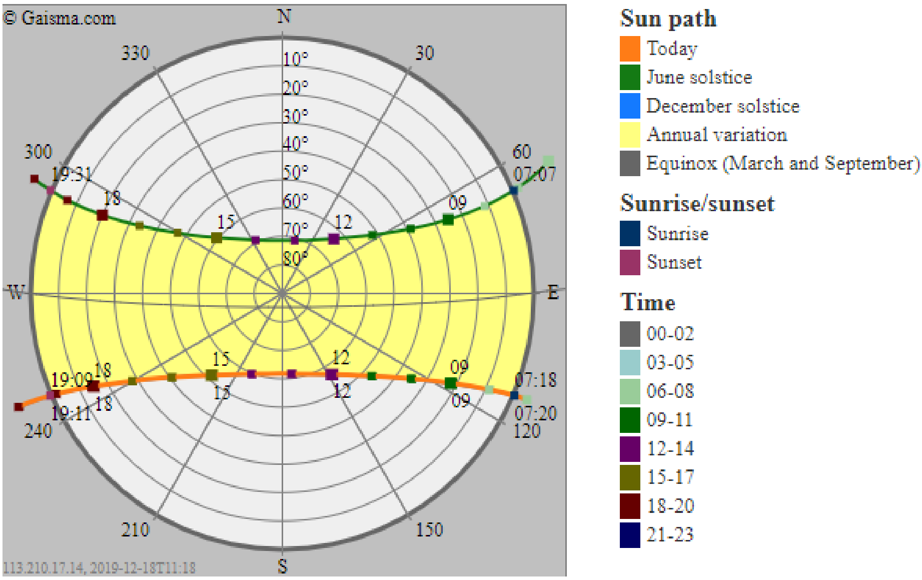

Figure 3. Sun’s Path in Time and Season. “Today” = December 18, 2019. The orange line eclipses the blue line for “December solstice”, i.e. it is nearly equivalent to it because the date of the creation of this figure happens to be close to the winter solstice. *Source*: Tukiainen, M. (2005–2019). *Taiping, Malaysia - Sun Path Diagram*. Retrieved December 18, 2019. https://www.gaisma.com/en/location/taiping.html

corresponds to making out due east and due west respectively. It is deemed helpful, therefore, to render some sample stars on or very near the mentioned celestial equator (for which see also Figures 13–15):

- Mintaka (HD 36486, 34-Ori, δ Ori) ϵ Orion’s Belt ϵ Orion (the Hunter).
- Porrima (HD 110379, 29-Vir, γ Vir) ϵ Virgo (Virgin).

- Tseen Foo (HD 191692, 65 Aql, θ Aql) ϵ Aquila (Eagle).

Summary

Initially furnished in this chapter was an introduction on sidereal and solar days, and the resulting difference of 3.93 minutes each day between them was determined. Predicated upon that instrumental knowledge followed an exposition on how to track time through the observation and informed anticipation of the actual position of selected *yogatārāḥ* of the *nakkhattapadāni* on any given night of the year. Lastly, a discussion on certain equatorial stars in the night sky – they always rise and set due east and west – provided the theoretical underpinning for making out the true cardinal directions. It is hoped that with the information tendered in this chapter nescience as to how to track time and determine the cardinal directions by the *nakkhattapadāni* – two main objectives of this work – is, in the least, reduced up to a workable degree and lets us smoothly proceed to the as of yet not posed illustrations on how to become adroit in determining the *pakkhā* and seasons.

The Buddhist Calendar

With this chapter the present work has progressed in its purpose to facilitate *vinaya*-legal acquaintance (in its self-imposed scope) to a point where the only things left to be grasped are how to settle the half months (*pakkhā*) and seasons (*utū*). At first, it introduces for that end the general features (including months, seasons, years) of the calendrics presently used mainly by Buddhist stemming from Myanmar. The relevant algorithms for establishing the intercalary days and months (*adhikavārā* and *adhikamāsā*) are based upon a method from Myanmar and extended as the explanatory finish of this chapter and overall treatise.

Background

The traditional calendar of Myanmar resembles the ancient Indian system to a material degree and is still used in our modern times to determine religiously significant occasions, such as the birth, awakening and decease of our present Buddha (Gotama) and other festivities (Chatterjee, 1998, p. 143). It was said having been introduced either about 78 CE (Clancey, 1906, p. 54) or in the 7th century CE according to Chatterjee (p. 143) and was adopted from Indian astronomer savants (Chatterjee, p. 143). The system that has been used (at least from some time on) is that of the original and present *Sūryasiddhānta* (Irwin, 1909, p. 2; Clancey, p. 58), which seems more likely to date back to circa 400 CE (Math, 2017).

The Myanmar calendar was in use in several Southeast Asian kingdoms – such as Arakan, Cambodia, Lan Na, Siam, Sukhothai – and in 1889 CE, with Siam's abolition of it, ceased as an official calendar ("Burmese Calendar", 2018, p. 266; "Buddhist calendar", n.d.) Minor differences seem to have existed at least from the 16th century onwards (Eade, 1995, p. 58). In contemporary Myanmar there appears to be a deviation from the ancient version only insofar as the intercalation method is concerned ("Buddhist calendar", n.d.)

This calendric system, in fact any other transnational variant of it, seems designated Buddhist merely due to the fact that it was/is "[…] utilised by Buddhist communities of the past and present for calculation and determination of time for purposes related to their religious activities" (Sobhana, n.d.), which tallies with the fact – as shown in the chapter on the Vedic calendar – that the Buddhists of old had no calendar of their own but were heirs to the Vedic ways of doing calendrics. It is also distinctly Buddhist since there happens to be a difference in co-existing eras (see just below). Today, Buddhist calendars no longer have an official status anywhere ("Buddhist calendar", n.d.)

General Features

The calendar of Myanmar in vogue is a luni-solar one (Clancey, 1906, p. 56), which means that the lunar months are kept in sync with the solar year by means of intercalary months and days (West, 2019; Clancey, p. 56). Months are founded upon lunar months, while years have their basis in solar years ("Burmese Calendar", n.d.) Lunar months are a theoretical contrivance using new moon syzygies (i.e. an occasion when the moon is between sun and earth) – or, in other words, from one new moon to the other. This type of month is circa 29 days, 12 hours and 44 minutes long ("Synodic month", 2008).

Eras: *Chulasakarat* and Buddhist

In Myanmar, years are commonly reckoned after the so-called *Chulasakarat* (C.S.; *Culāsakaraj*), a calendar inaugurated in March 638 CE; the present year 2020 CE would correspond to 1382 C.S. More relevant for our intent is the era which is used for religious purposes, namely the Buddhist (*Buddhasakaraj*), with its commencement in Myanmar taken to be in 543 BCE (the year of the Buddha's demise; cf. Eade, 1995, pp. 15–6; Irwin, 1909, p. 2). The distinctly Buddhist era commenced on the full moon day of the month *Vesākho*, the point in time stated by the commentaries (Sv I – *sīlakkhandhavagga-aṭṭhakathā*, p. 2) to be the day of the Buddha's decease (Ariyadhamma, 2016, p. 183), although Eade (1995, p. 15) posits a pinpoint date of March 11 (543 BCE).[16] Its duration is said to be 5,000 lunar years, corresponding to the duration of the Buddha's dispensation (*sāsanaṃ*) as proposed by the Pāḷi commentarial tradition (Ariyadhamma, p. 171; Nattier, 1991, pp. 56–58). Ultimately, though, the provenance of the Myanmar calendar can be traced to the beginning of the *Kaliyuga* – stemming from ancient India –

[16] Note the resulting discrepancy with the sequence of the year's seasons as found in the canon and its exegetical literature. Please refer to the section "Years, Months and Days" below.

with its nascency in 3102 BCE ("Burmese Calendar", n.d.), which appears to serve as an underpinning for astronomical purposes (Irwin, p. 2).

Prior to the Göttingen symposium on the dating of the historical Buddha (Bechert, 1991; 1992; 1997), it was practically proclaimed in unison that the Buddha's *parinibbāna* occurred about 480 BCE (Cousins, 1996, p. 58). However, Härtel's panel presentation (1991) on the ancient Buddhist sites recorded in the earliest strata of Buddhist literature proofed, in the light of archaeological investigation, being the "major factor" (Cousins, 1996, p. 60) for sanctioning a later date and being pivotal in moving distinguished scholars like Heinz Bechert, André Bareau, Lance Cousins, Hermann Kulke or Otto Georg von Simson (inter alia) into accepting a date more advanced in time (Narain, 1993, p. 196; Cousins, pp. 60, 63). However, Narain (1993) and Deva (2003) – both of which were archaeologist personally involved at selected excavation sites – convincingly demonstrated, referring in the main to carbon-14 datings, that virtually all ancient Buddhist sites (such as *Rājagaha* or *Kosambi*) well predate 500 BCE, at the same time pointing out several flaws in Härtel's approach and interpretations. From that perspective, a date of about 480 BCE appears much more preferable – Cousins (p. 63) opines that even the long chronology, presumably referring to the traditional date of 543 BCE, might be rehabilitated, given someone might undertake the task. This stance is a lone and loosely posited one, though. Nevertheless, the strength of the archaeological presentation of Härtel, to conclude, does not seem to warrant such a strong and widespread response of estimating the date down to circa 400 BCE (however polished it may sound), as it is done almost by convention at present. Especially so since most of it seems to be predicated upon plain unfamiliarity with the symposium fathered by Narain (2003), which was preferring a date of about 480 BCE.

Years, Months and Days

Although the Myanmar calendar recognizes altogether three years (tropical, sidereal and anomalistic), it is synced with the solar year, aka tropical year or year of the seasons (“Burmese calendar”, n.d.; “Buddhist calendar”, n.d.) A solar year denotes a period between two successive vernal (spring) equinoxes, the given time when the sun apparently crosses the celestial equator moving north (“Year”, 1998) and is 365 days, 5 hours, 48 minutes and 46 seconds long (“Tropical year”, 2012). The given times are mean values. Nominally, the year starts with the month of *Citto* (Tagu) (Irwin, 1909, p. 10) around mid-April.

However, from the partitioning of the year as implied by some passages contained in the Pāḷi canon, its commentaries and sub-commentaries, it appears conceivable that for the early Buddhist communities (and possibly also the Theravādins of somewhat later periods) the year started with *Māgasiro*, i.e. the first month of the winter season: “Now one who lives a hundred years, bhikkhus, just lives three hundred seasons: a hundred winters, a hundred summers, and a hundred rains (AN VII – *sattakanipātapāḷi*, p. 59).”[17] As mentioned, this trend is also reflected in the commentaries and dovetails with the reckoning as employed by the *Mūlasarvāstivādins* (Vogel, 1997, p. 677), to quote one of the former (Kkh, p. 34; Norman, Kieffer-Pülz & Pruitt, 2018, p. 10):

> There, having carried out two [observances] in each of the three seasons of winter, summer, and the rains, [namely] in the third and in the seventh fortnight, [there are] six [observances] belonging to the fourteenth [day]; the remaining eighteen [observances] belong to the

[17] *[V]assasataṃ kho pana, bhikkhave, jīvanto tīṇiyeva utusatāni jīvati — utusataṃ hemantānaṃ, utusataṃ gimhānaṃ, utusataṃ vassānaṃ.*

fifteenth [day]. Thus, [there are] twenty-four observances in a single year.[18]

The *Abhidhānappadīpikā* (v. 75) starts its enumeration of months contained in a year with the month of *Citto*, a fact that moved Vogel (1971, p. 297) and Weber (1862, p. 333) to assume that the Theravādins were following this particular scheme of year partitioning in general; however, a few verses down (v. 78), it explicitly states that "by means of sequence there are winter, summer and rainy season, [which is divided] into two."[19] It would thus stand in agreement with the scheme underlying some occurrences in the canon – as touched upon above – and the commentarial literature, not unlikely even with the system used by the *Sarvāstivādins* (cf. Vogel, 1971, p. 301). Please note that the *Vinayālaṅkāra-ṭīkā* (Pālim-nṭ, p. 88; 17th century) explicates that winter lasts from the first day of the waning lunar fortnight following the month of *Kattikā* until the full moon day of *Phagguno*; its explanations for the beginnings and endings of all seasons correspond to the data as contained in Table 1, although its sequence of seasons conforms to that found in the *Abhidhānappadīpikā*.[20] From the preceding elaborations we could gather that there appears to be some degree of incongruity as to the inaugural season and general inception of the year, a particularity that Vogel (1971, p. 307) expresses in the following words: "Any more or less fixed beginning of the year, as could be established for the

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[18] *Tattha hemantagimhavassānānaṃ tiṇṇaṃ utūnaṃ tatiyasattamapakkhesu dve dve katvā cha **cātuddasikā**, avasesā aṭṭhārasa **pannarasikā**ti evaṃ ekasaṃvacchare catuvīsati uposathā.*

[19] *Kamā hemantagimhānavassānā utuyo dvīsu.*

[20] ***Hemantagimhavassānaṃ tiṇṇaṃ utūna**nti ettha **hemantautu** nāma apara-kattikakāḷapakkhassa pāṭipadato paṭṭhāya phaggunapuṇṇamapariyosānā cattāro māsā. **Gimhautu** nāma phaggunassa kāḷapakkhapāṭipadato paṭṭhāya āsāḷhipuṇ-ṇamapariyosānā cattāro māsā. **Vassānautu** nāma āsāḷhassa kāḷapak-khapāṭipadato paṭṭhāya aparakattikapuṇṇamapariyosānā cattāro māsā.*

Hindus to be [lit. 'with'] spring, was apparently entirely alien to them [i.e. the Buddhists]."[21]

Because there is a need for intercalary days and months (see below), the actual length of a year can vary in days as follows: (a) regular: 354, (b) regular + intercalary month: 384, (c) regular + intercalary month + intercalary day: 385 (Eade, 1995, p. 57). Regularly, the lunar year contains 12 lunar months of alternating 29 and 30 days, making up 354 days in toto ("Buddhist calendar", n.d.) To achieve homogeneity, it alternates between these values because an average lunation is a little fraction over 29.5 days – 29,53065 as per the Myanmar calendar presumably (Irwin, 1909, pp. 7–8). The days of the month are divided into waxing and waning halves. The day of full moon in the waxing half (*sukkapakkho*) always falls on the fifteenth (*paṇṇaraso*) of each month. New moon marks the last day of the month and invariably is either the fourteenth (*cātuddaso*) or the fifteenth day of the waning half (*kāḷapakkho*) of the respective months (Irwin, p. 9) and can be counted from full moon on the fifteenth. A fortnight of this kind is called *aḍḍhamāso* in Pāḷi (lit. "half-month"). Thus, it becomes evident that the Myanmar calendar follows the *amāntaḥ* method, with a monthly reckoning from new moon to new moon (Chatterjee, 1998, p. 143).

There is, however, one important distinction to be made in that Theravāda Buddhist communities (incl. those in Myanmar) follow in practice the *puṇṇamānto* (Skt.: *pūrṇimāntaḥ*; "full moon ending") system, in which the months start after each full moon day, as explained earlier (Ariyadhamma, 2016, p. 183; Ñāṇamoli, 1977, p. 191, f.n. 804/2; Vogel, 1997, pp. 677–8). For one, this practice reflects the explanations as found in the main Pāḷi commentaries and sub-commentaries, but it may well be regarded as a continuation of north Indian

[21] Irgendein mehr oder weniger fester Jahresbeginn, wie er bei den Hindus mit dem Frühling eruiert werden konnte, war ihnen offenbar gänzlich fremd.

practice customary in the time of the Buddha. The *Papañcasūdanī* (Ps III – *uparipaṇṇāsa-aṭṭhakathā*, p. 24) states the following regarding the reckoning of months:

> From the fullness, fulfilment and completion of a month [it has been said:] ***puṇṇā*** (i.e. "full"). The moon is designated [by means of the morpheme] ***mā***. So "**full moon**" is herein [named] "filled". Thus, the meaning regarding these two words "filled [or 'full'] full moon" has to be understood.[22]

This does unequivocally refer to the *puṇṇamānto* system. The *Sumaṅgalavilāsinī* (Sv I – *sīlakkhandhavagga-aṭṭhakathā*, p. 61) explains along similar lines that the word "full" (*puṇṇā*) as occurring in "full moon" (*puṇṇamā*) signifies the fullness or completion (*puṇṇatā*) of month (*māso*), season (*utu*) and year (*saṃvaccharaṃ*), with the same exegesis for the morpheme *mā* as given by the *Papañcasūdanī*.[23] As indicated earlier, the *Vinayālaṅkāra-ṭīkā* spells this out in more definite terms, stating that the seasons end on full moon days.[24] The ordinance of the Buddha (Vin III – *mahāvaggapāḷi*, p. 100)[25] that the traditional rains retreat (*vasso*; either the earlier or the later) has to be observed within the actual rainy season (*vassāno*) further harmonizes well with an assumed underlying *puṇṇamānto* system when read together with the corresponding exposition contained in the *Manorathapūraṇī* (Mp II – *dukanipāta-aṭṭhakathā*, p. 4), which posits that both rains retreats start after a full moon and that a month ends in such as well. It explains:

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[22] *[M]āsapuṇṇatāya puṇṇā saṃpuṇṇāti* ***puṇṇā. mā****-iti cando vuccati, so ettha puṇṇoti* ***puṇṇamā****. evaṃ puṇṇāya puṇṇamāyāti imasmiṃ padadvaye attho veditabbo*.

[23] *[M]āsapuṇṇatāya utupuṇṇatāya saṃvaccharapuṇṇatāya puṇṇā sampuṇṇāti puṇṇā. mā iti cando vuccati, so ettha puṇṇoti puṇṇamā.*

[24] Please refer to f.n. 20 for the Pāḷi quotation.

[25] *Anujānāmi, bhikkhave, vassāne vassaṃ upagantunti.*

> It has been said: “Bhikkhus, there are these two [rains entries] etc.” Therein, “**rains entries**” means spending the rains. **The earlier [rains]**: It is to be entered upon when the following day from the *Āsaḷhi* [full moon] has arrived; it is the first three months ending on the full moon of the earlier *Kattikā* [i.e. *Assayujo*]. **The later [rains]**: It is to be entered upon when a month from the *Āsāḷhi* [full moon] has arrived; it is the later three months ending on [the full moon] of the later *Kattikā*.[26]

Another dimension of complexity is added when considering a passus found in the already quoted *Kaṅkhāvitaraṇī*. It postulates (Kkh, p. 34) that when those bhikkhus who are about to finish the earlier rains are troubled by makers of strife, they may postpone (*paccukkaḍḍhanti*) the Invitation (*pavāraṇaṃ*),[27] so that it may also be the fourteenth of the waning half (i.e. new moon) occurring in the month of the former *Kattikā* (i.e. *Assayujo*; see, e.g., Abh, v. 76, for this identification).[28] Here we must assume an underlying *amānto* (Skt. *amāntaḥ*) scheme since a new moon on a fourteenth day exists only within the frame of such (see Figure 4 below).

[26] ***[D]vemā, bhikkhave****tiādimāha. tattha* ***vassūpanāyikā****ti vassūpagamanāni.* ***purimikā****ti aparajjugatāya āsāḷhiyā upagantabbā purimakattikapuṇṇamipariyosānā paṭhamā temāsī.* ***pacchimikā****ti māsagatāya āsāḷhiyā upagantabbā pacchimakattikapariyosānā pacchimā temāsīti.*

[27] A ceremony at the end of the rains retreat on occasion of which the bhikkhus who have spent the rains retreat together invite each other for admonishment in regard to seen, heard or suspected offences.

[28] *Purimavassaṃvuṭṭhānaṃ pana pubbakattikapuṇṇamā vā, tesaṃyeva sace bhaṇḍanakārakehi upaddutā pavāraṇaṃ paccukkaḍḍhanti, atha pubbakattikamāsassa kāḷapakkhacātuddaso vā, pacchimakattikapuṇṇamā vā.*

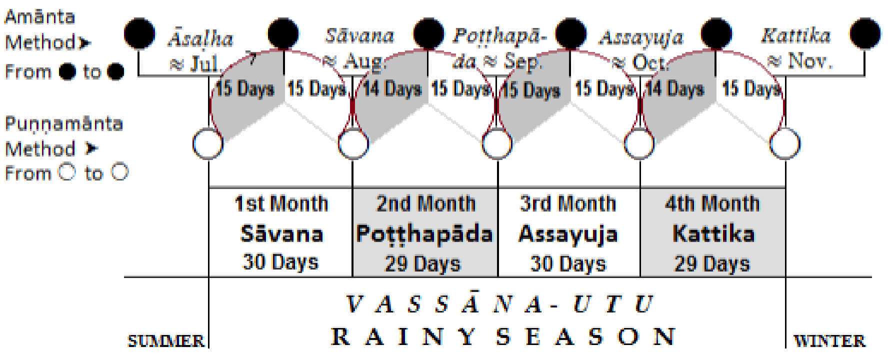

Figure 4. *Amānto* and *Puṇṇamānto* System. The year according to the *amānto* scheme starts 14/15 days later than the year as calculated by means of the *puṇṇamānto* system, having as a result that the new moon on the fourteenth day in the month of *Assayujo* according to the former system falls into the month of *Kattikā* according the latter.

This conflicts with the already quoted commentarial passages, with the help of which it has been demonstrated that they used the *puṇṇamānto* system as their underpinning. It is possible that this reflects either a parallel use of both methods or some degree of Sri Lankan influence on the side of the *Kaṅkhāvitaraṇī*. The former assumption fits in well with the theory that both methods coexisted since the time of the *brāhmaṇas* (Bag, 2015, p. 6), as mentioned earlier. The latter suggestion rests upon the fact that the *Sāratthadīpanī-ṭīkā* (Sp-ṭ I, p. 68) distinguishes between the two systems on regional grounds. On the one hand, we find the *puṇṇamānto* system, which it says is followed in India: “since there [i.e. in India] one month lasts from the beginning of one full moon day until the next full moon day [...]”[29] On the other hand, it implies (p. 68) that the *amānto* system was, at least at some point in time, customary in Sri Lanka:

[29] *Tattha pana puṇṇamito paṭṭhāya yāva aparā puṇṇamī, tāva eko māso ti.*

On the first day of the lunar fortnight: the first day of the waxing lunar fortnight [i.e. the first day after new moon]. It is called the first day of the lunar fortnight in that respect because of not having adopted the first day of the waning lunar fortnight [i.e. the first day after full moon], and this has been said considering the current use on this island [i.e. Sri Lanka]."[30]

With that as a theoretical underpinning, calculations of the fortnights and the moon days (*uposathā*) can be undertaken rather smoothly, complexities aside. In Myanmar, the use of names within a 12-year cycle are not in use anymore, as is the case in other Buddhist countries ("Buddhist calendar", n.d.) The 12 months (also rendered in Myanmar) and seasons in the Pāḷi tradition, are as shown in Table 1 in the "Tables" section. The days are seven in number, just as it is common in all the world's countries. It is said that the day comprises 30 hours (of 48 min each) (Abh, v. 74; Ānandajoti, 2013). They are named after the sun, moon and the five planets (visible to the unaided eye), just as in India and Europe (Chatterjee, 1998, p. 154). They read as follows (Ānandajoti; "Burmese Calendar", 2018, p. 266), with the Pāḷi equivalents in Myanmar script as per Htin Kyaw (2017) as the first entry and the transliteration of the proper Myanmar weekdays as the last items within the parentheses:

1. Monday: *Candavāra* (စန္ဒဝါရ).
2. Tuesday: *Kujavāra* (ကုဇဝါရ).
3. Wednesday: *Budhavāra* (ဗုဒ္ဓဝါရ).
4. Thursday: *Guruvāra* (ဂုရုဝါရ).
5. Friday: *Sukkavāra* (သုက္ကဝါရ).
6. Saturday: *Sanivāra* (သနိဝါရ).

[30] ***Paṭhamapāṭipadadivase****ti sukkapakkhapāṭipadadivase. Tañhi kaṇhapakkhapāṭipadadivasaṃ apekkhitvā "paṭhamapāṭipadadivasan" ti vuccati. Idañ ca imasmiṃ dīpe pavattamānavohāraṃ gahetvā vuttaṃ.*

7. Sunday: *Ravivāra* (ရဝိဝါရ).

Although Ānandajoti (2013) refers to Buddhadatta's *Concise Pāli-English Dictionary* as furnishing and rendering the days of the week in the Pāḷi language, I was unable to trace the references – except for Wednesday ("Budhavāra", 1968). Fortunately, U Hoke Sein's Burmese-English-Pali Dictionary (1978) contains all the relevant entries without omission. This piece of information lets it stand out in relief, as a brief aside, that the available Pāḷi-English dictionaries are insufficient for some purposes, in fact, in quite many instances which do not have bearing on the main canonical books. It is not clear to me where the weekdays in the texts of the Pāḷi tradition (i.e. Theravāda) occur.

The Intercalation System

The overall intercalation matrix is a cycle of 57 years. In every 19 years seven months of 30 days each are inserted into the lunar year, and within a period of 57 years (three 19-year cycles) further eleven days are appended ("Buddhist calendar", n.d.; Eade, 1995, p. 56).[31] These periods are based upon the so-called Metonic cycle (Bikos, n.d.) The need for intercalary months and days arises from the fact that the lunar year of 354 days is shorter by about 11 days than the solar year of circa 365,25 days (Chatterjee, 1998, p. 150). Employing the mentioned intercalation series of extra days and months within the 57-year cycle manufactures a nearly equal number of 20819 days for lunar and solar years; thus, a (rough) synchronization is realized (Eade, p. 56).

The intercalation scheme was said to have changed from time to time and the last one probably ended with the year 1368 C.S. (2006 CE) with a pattern of years within the cycle for the intercalary months as follows: 1, 4, 6, 9, 12, 15, 18 (Chatterjee, 1998, pp. 150–1). Aye (2013) generated various utile algorithms applying true mean values to figure, inter alia, the intercalary months and days

[31] See note to Table 1 in the "Tables" section for specifics.

for a given year. Refer to Aye's work for detailed discussions on the background of the material portrayed in the remainder of this section – introduced here are only the most rudimentary components necessary for working calculations. The details as to that are as follows:

Calculations: Intercalary Month. Formula: ed = (SY × (my + ky)) mod LM.

- ed: excess days.
- SY: solar year = 365.2587565.
- my: Myanmar year (e.g. 1382).
- ky: *kaliyuga* (era) = 3739.
- LM: lunar month = 29.53058795.

If the number of excess days (ed), which we want to determine, is greater than 22.2694539, the year which was used in the arithmetic has to contain an intercalary month. For this year (1382 C.S. = 2020 CE) the above would practically amount to the following – simply keying the sequence as rendered here into a scientific calculator: (365.2587565 × (1382 + 3739)) mod 29.53058795 = 22.6512835. The number of excess days at 22.6512835 is greater than the above-given constant of 22.2694539 and thereby signals that the year of 1382 C.S. (2020 CE) is a year with an intercalary month. If the quotient – i.e. the result – of a calculation using the above formula should happen to be less than 3.630567, then there is need to add to this number LM (= 29.53058795), e.g. 2.3260363 + 29.53058795 = 31.8566243. This informs us about the necessity of inserting an intercalary month for that particular year we used in the equation, since it, too, is greater than the mentioned constant of 22.2694539.

Calculations: Intercalary Day

Step 1. Ascertain full moon day as per Julian Date (JD) of the second *Āsalho* for two consecutive years (w2 and w1) with an intercalary month thus: w = round(SY × my + MO – ed + 4.5 × LM + WO).

- w: full moon day of second *Āsalho* as per JD.

- MO: Myanmar (C.S.) year zero as per JD = 1954168.050623.
- WO:[32] constant to adjust full moon time of second *Āsalho* = -0.5.

To exemplify two successional years with an intercalary month in practice: The year 1382 C.S. (2020 CE) – as demonstrated on the preceding page – will have an intercalary month and when the above-given formula for the intercalary month is exercised with 1380 C.S. (2018 CE), it becomes apparent that it, in like manner, should have an intercalary month, with excess days amounting to 30.39846925 and a Julian Date full moon of 2458327, as being ascertained by the step-1 formula for the intercalary day. So, we note the second value (w1), the Julian Date, as one member of our required pair of dates. Now, to find out the full moon of second *Āsalho* as per JD for 1382 C.S. (2020 CE) – which is w2 – and to offer an illustration, the formula of step 1 for the intercalary day calculations needs to be applied thus: 365.2587565 × 1382 + 1954168.050623 – 22.6512835 + 4.5 × 29.53058795 - 0.5 = 2459065 (JD).

Step 2. The difference between the two years and the remainder are now required to determine the intercalary day. They can be established with the help of this formula: id = (w2 - w1) mod rLY.

- id – intercalary day;
- rLY – rounded lunar year = 354.[33]

A remainder of 30 signifies that for the year which contains full moon day 2 (w2) – a random date for the year of which we want information as to the intercalary day – just an intercalary month has to be added but no intercalary day. 31 as a remainder means that in addition to the intercalary month, the intercalary day also has to be grafted. In our case of JD full moons of 1382 C.S. (2020 CE) and 1380 C.S. (2018 CE) we get the following, with the JD date of the

[32] The rest of the symbols are as above.
[33] The rest of the symbols are as above.

year for which we want information standing first: (2459065 – 2458327) mod 354 = 30. No intercalary day for 1382 C.S. (2020 CE)!

Accuracy of Myanmar's Calendar

It was recognized, after all, that the year as defined by the calendar is in fact ca. 24 min longer than the actual tropical year, thus constituting really a sidereal year. Consequently, like all sidereal based calendars, the luni-solar calendar of Myanmar (and other Buddhist countries) slowly drifts away from the seasons, approx. one day every 60 years and 4 months – in contrast to the tropical year reckoning ("Buddhist calendar", n.d.; "Burmese calendar", n.d.) By utilizing apparent reckoning and periodically altering the schedule of the Metonic cycle, Myanmar calendrists have maneuvered past the issue ("Burmese Calendar", n.d.), there seemingly also existing no monolithic rules for the insertion of the intercalary day after all (Aye, 2013). Presumably they thereby also would take into consideration the actual mean lunar year's length of not an insignificant 354.37 days as opposed to the given round number of 354 days (West, 2019; Irwin, 1909, pp. 7, 9), which was done by Aye in any case, as attested above.

Summary

The aim of this chapter has been to facilitate a comprehension of how to calculate the *pakkhā* and settle the seasons, independent of adventitious calendric assistance from smartphones & Co. To realize the aforementioned aims, it has, firstly, been revealed that the Buddhist calendar of Myanmar is an ancient one with several eras, the most important ones for our purposes being the Buddhist era (*buddhasakaraj*) and the *Chulasakarat*, with their inceptions in 543 BCE and 638 CE respectively.

It has, secondly, also been shown that the solar years as defined in the calendar – really being sidereal ones – consist of rounded 365,25 solar days and that 354 days in 12 months for the lunar years have been posited. The statement as to the alternating length of the months as 29 and 30 has been made to lubricate practical and simple computation of the *pakkhā*, knowing that every full moon falls on the 15th day of the lunar months and every new moon either on the 14th (in months of 29 days) or the 15th (in months of 30 days). The portrayal of how the season encompass the months – as has been mounted here – functioned as the basis for sapience regarding the establishment of the seasons. We have come to see that each season of the six-fold scheme encompasses two months and each of the three-fold scheme four. Lastly, by having subjected calendrical calculations to scrutiny and having presented them for consideration, the way to knowledge has been paved on how to easily determine the intercalation months and days for keeping the solar year in sync with the lunar. Thus, having provided guidelines for the remaining items to be understood (*pakkhā* and seasons), the aims of the present work are hoped to have been accomplished. What remains to be handed are some concluding deliberations, which are compassed with the subsequent section.

Conclusion

This simplified companion work set out to foster theoretical sapience in re to and practical compliance with the Buddha's decree regarding the *nakkhattāni* – or *nakkhattapadāni* – and cardinal directions, with particular emphasis set for wilderness-dwelling bhikkhus. The coequal design was to demonstrate, pertaining to all bhikkhus, how to calculate the *pakkhā* and determine the seasons independent of specific calendric assistance from extraneous modern technology (except perhaps a calculator, which could be easily dispensed with however); it is hoped that it has been successful in realizing these aims. What awaits treatment is merely an epilogue to this work. Firstly, a blend of the main points raised in this book with its implications is submitted before contemplating further research and then, finally, closing.

We have gotten a glimpse of the Buddhist scriptural conception regarding the *nakkhattāni* and cardinal directions by turning to ancient literature, having come to find out that many bhikkhus of old were in all likelihood skilled in navigation, knowing the time of the night and the *nakkhattaṃ* date, part and parcel of their exemplary upholding of their master's monastic rules. Buddhists, and bhikkhus in particular, were assuredly (or should have been) too involved with their own liberation (i.e. *nibbāna*); hence, the censuring of and proscribing engagement in sciences beyond of what is practically related and useful for that end, and hence the suggested simplified guide here presented. For the same reason did the earliest Buddhists not develop in astrology and astronomy but simply took over the Vedic ways of cyphering calendars, which are, regarding some principles, still operant in India today and issued for and used by the general populace for such matters as stating in which *nakṣatraṃ* the moon is on a given day. By implementing the actual *buddhavacanaṃ* ("the word of the Buddha"), here as legal directive to know the *nakkhattāni*, cardinal directions, *pakkhā* and seasons, a forest bhikkhu (every kind of bhikkhu in fact) now is capacitated, to some practical degree, to live independent of pre-calculated and manufactured calendars, somewhere in the wild or in a room in the innermost parts of Yangon city. Through the abecedarian astronomical knowledge, step-by-step to follow formulas and general descriptions provided here, assistance has been kindly offered.

It is inarguable that the texts of the Theravāda in the Pāḷi language, down to the earliest layers, portray and stress the ideal of punctiliousness in matters of monastic discipline (*vinaya*). The limited scope and mainly pragmatic outlook presented in this book is sufficient, I believe, to walk in that spirit of legal decorum. To explore the subject matter further I deem unnecessary, unless, perhaps, employed as a short-term skillful means for the individual being unable to proceed on the path through core-*dhamma* avenues. Therefore, plenty of material as it relates to the general Vedic calendar and further layers of Buddhists texts was not incorporated into the present treatise, not to mention still later developments in Indian calendrics. I personally am elated that I am now permitted to leave the issue aside, not wanting to say having perhaps even misspent about three months. No, it is well that, in attempting to fill a perceived gap in the field of the relevant literature, this gift to the community of bhikkhus (*saṅgho*) has been made. In the end, surely, travelers on the route to ultimate Buddhist beatitude should be *katakaranīyā* ("the ones who have done what had to be done") – namely, the ones who have effected fruition in arahant-ship. The subject matter here entertained is for that end surely of subservient weight, though it *has to have* its place allocated within the frame of *dhamma-vinaya*. In that sense, let there be *appamādo ca dhammesu* ("[continuous] diligence in [*buddha*-]*dhamma*").

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Tables

Table 1. *Synopsis Months and Seasons*

Name of Month (*māso*)	**Length**	**Seasons (six and three)**	
Citto (Tagu – တန်ခူး) – Mar.–Apr.	29/**30**	*vasanto* (spring)	*gimhāno* (summer)
Vesākho (Kason – ကဆုန်) – Apr.–May	30/**29**		
Jeṭṭho (Nayon – နယုန်) – May–June	29/**30**	*gimho* (hot)	
Āsāḷho (Waso – ဝါဆို) – June–July	30/**29**		
Sāvaṇaṃ (Wagaung – ဝါခေါင်) – July–Aug.	29/**30**	*vassāno* (rainy)	*vassāno* (rainy)
Poṭṭhapādo (Tawthalin – တော်သလင်း) – Aug.–Sept.	30/**29**		
Assayujo (Thadingyut – သီတင်းကျွတ်) – Sept.–Oct.	29/**30**	*sarado* (autumn)	
Kattikā (Tarzaungmon – တန်ဆောင်မုန်း) – Oct.–Nov.	30/**29**		
Māgasiro (Natdaw – နတ်တော်) – Nov.–Dec.	29/**30**	*hemanto* (winter)	*hemanto* (winter)
Phusso (Pyatho – ပြာသို) – Dec.–Jan.	30/**29**		
Māgho (Tabodwe – တပို့တွဲ) – Jan.–Feb.	29/**30**	*sisiro* (cool)	
Phagguno (Tabaung – တပေါင်း) – Feb.–Mar.	30/**29**		

Note: The **boldface** numerals indicating the length of the months correspond to the *puṇṇamānto* system, whereas the ones in plain typeface refer to the *amānto* scheme. When there is need for an intercalary day, it is always placed at the end of *Jeṭṭho*. Thus, on such occasions it (the month) has 30 days instead of its regular 29. The intercalary month is added invariably directly, in succession, as an appendix after *Āsāḷho*, which is then named "the second *Āsālho*." Intercalary days are just added in years with intercalary months (see Irwin, 1909, pp. 3, 9). One season of the threefold scheme comprises two seasons of the sixfold and/or four months, as is intelligible from the field's extensions. *Sources*: **(a)** *Abhidhānappadīpikā* (vv. 75–79) (n.d.) Sri Lanka Tripiṭaka Project (Ed.) Government of Ceylon. http://gretil.sub.uni-goettingen.de/gretil/2_pali/9_phil/lex/abhidh_u.htm. **(b)** Ānandajoti. (2013). *Pāḷivāramāsa-utū. Days, Months and Seasons in Pāḷi*. Retrieved from https://www.ancient-buddhist-texts.net/Reference/Days-Months-Seasons.htm. **(c)** Burmese Calendar (2018). In J. Gyllenbok, *Encyclopaedia of Historical Metrology, Weights, and Measures* (Vol. 1). Birkhäuser.

Table 2. *The 27 Nakṣatrāni*

27 *Nakkhattāni* (*Nakṣatrāni*)	**Star Cluster and Prominent Star (*Yogatārā*)**	**Corresp. Sidereal Degrees—Pāḷi (Sanskrit; Latin) Zodiac**
1. *Assayuja* (*Aśvinī*) (3)	**(1)** HD 12929 (Hamal, 13-Ari, α-Ari,); **(2)** HD 11636 (β-Ari, 6-Ari, Sheratan)	Mesa (Meṣa; Aries) 0°—13°20
2. *Bharaṇī* (1)	**(1)** HD 16908 (35-Ari); **(2)** HD 17361 (39-Ari); **(3)** HD 17573 (c-Ari, 41-Ari)	Mesa (Meṣa; Aries) 13°20—26°40
3. *Kattikā* (*Kṛittikā*) (6)	**(1)** HD 23850 (Atlas, 27-Tau); **(2)** HD 23302 (Electra, 17-Tau); **(3)** HD 23408 (Maia, 20-Tau); **(4)** HD 23862 (Pleione, 28-Tau); **(5)** HD 23338 (Taygeta, 19-Tau, q-Tau) **(6)** HD 23630 (Alcyone, 25-Tau, η-Tau)	Mesa (Meṣa; Aries) 26°40—Usabha (Vṛṣabha; Taurus) 10°
4. *Rohiṇī* (1)	**(1)** HD 29139 (Aldebaran, 87-Tau, α-Tau)	Usabha (Vṛṣabha; Taurus) 10°—23°20
5. *Magasiraṁ* (*Mṛgaśirā*) (3)	**(1)** HD 36822 (37-Ori, ϕ^1-Ori); **(2)** HD 37160 (ϕ^2-Ori, 40-Ori); **(3)** HD 35468 (Bellatrix, 24-Ori, γ-Ori)	Usabha (Vṛṣabha; Taurus) 23°20—Methuna (Mithuna; Gemini) 6°40
6. *Addā* (*Ārdrā*) (1)	**(1)** HD 47105 (Alhena, 24-Gem, γ-Gem)	Methuna (Mithuna; Gemini) 6°40—20°00
7. *Punabbasu* (*Punarvasu*) (2)	**(1)** HD 60179 (Castor, 66-Gem, α-Gem); **(2)** HD 62509 (Pollux, 78-Gem, β-Gem)	Methuna (Mithuna; Gemini) 20°00—Kakkata (Karkaṭa; Cancer) 3°20
8. *Phusso* (*Puṣya*) (1)	**(1)** HD 74442 (Asellus Australis, 47-Cnc, δ-Cnc)	Kakkata (Karkaṭa; Cancer) 3°20—16°40
9. *Asilesā* (*Āśleṣā*) (6)	**(1)** HD 74280 **(**η-Hya, 7-Hya); **(2**) HD 73471 (5-Hya, σ-Hya,); **(3)** HD 73262 (4-Hya, δ-Hya); **(4)** HD 74874 (11-Hya, ε-Hya); **(5)** HD 79469 **(**22-Hya, θ-Hya); **(6)** HD 76294 (16-Hya, ζ-Hya)	Kakkata (Karkaṭa; Cancer) 16°40—30°00
10. *Maghā* (6)	**(1)** HD 84441 (17-Leo, ε-Leo); **(2)** HD 5503 (Rasalas, 24-Leo, μ-Leo); **(3)** HD 91316 (47-Leo, ρ-Leo); **(4)** HD 89484 (Algieba, 41-Leo, γ^1-Leo); **(5)** HD 87737 (η-Leo, 30-Leo); **(6)** HD 87901 (Regulus, 32-Leo, α-Leo)	Sīha (Siṃha; Leo) 0°—13°20
11. *Pubbaphaggunī* (*Pūrvāphalgunī*) (2)	**(1)** HD 97633 (Chertan, 70-Leo, θ-Leo); **(2)** HD 97603 (Zosma, 68-Leo, δ-Leo)	Sīha (Siṃha; Leo) 13°20—26°40
12. *Uttaraphaggunī* (*Uttarāphalgunī*) (2)	**(1)** HD 102509 (93-Leo); **(2)** HD 102647 (Denebola, 94-Leo, β-Leo)	Sīha (Siṃha; Leo) 26°40—Kaññā (Kaṇyā; Virgo) 10°00
13. *Hattha* (*Hasta*) (5)	**(1)** HD 105452 (Alchiba, 1-Crv, α-Crv); **(2**) HD 109379 (Kraz, 9-Crv, β-Crv); **(3)** HD 106625 (Gienah, 4-Crv, γ-Crv); **(4)** HD 105707 (Minkar, 2-Crv, ε-Crv); **(5)** HD 108767 (Algorab, 7-Crv, δ-Crv)	Kaññā (Kaṇyā; Virgo) 10°00—23°20

Table 2. *The 27 Nakṣatrāni*

27 *Nakkhattāni* (*Nakṣatrāni*)	**Star Cluster and Prominent Star (*Yogatārā*)**	**Corresp. Sidereal Degrees—Pāḷi (Sanskrit; Latin) Zodiac**
14. *Cittā* (*Citrā*) (1)	**(1)** HD 116658 (Spica, 67-Vir, α-Vir)	Kaññā (Kaṇyā; Virgo) 23°20—Tulā (Libra) 6°40
15. *Sāti* (*Svāti*) (1)	**(1)** HD 124897 (Arcturus, 16-Boo, α-Boo)	Tulā (Libra) 6°40—20°00
16. *Visākhā* (*Viśākhā*) (2)	**(1)** HD 135742 (Zubeneschamali, 27-Lib, β-Lib); **(2)** HD 130841 (Zubenelgenubi, 9-Lib, α²-Lib)	Tulā (Libra) 20°00—Vicchikā (Vṛṣcika; Scorpio) 3°20
17. *Anurādhā* (4)	**(1)** HD 144218 (Acrab, 8-Sco, β²-Sco); **(2)** HD 143018 **(**6-Sco, π-Sco); **(3)** HD 142669 (Iklil, 5-Sco, ρ-Sco); **(4)** HD 143275 (Dschubba, 7-Sco, δ-Sco)	Vicchikā (Vṛṣcika; Scorpio) 3°20—16°40
18. *Jeṭṭhā* (*Jyeṣṭhā*) (1)	**(1)** HD 148478 (Antares, 21-Sco, α-Sco)	Vicchikā (Vṛṣcika; Scorpio) 16°40—30°00
19. *Mūla* (*Mūla*) (7)	**(1)** HD 152334 (ζ²-Sco); **(2)** HD 155203 (η-Sco); HD **(3)** HD 159532 (Sargas, θ-Sco); **(4)** HD 161471 (ι¹-Sco); **(5)** HD 160578 (κ-Sco); **(6)** HD 158408 (Lesath, 34-Sco, υ-Sco); **(7)** HD 158926 (Shaula, 35-Sco, λ-Sco)	Dhanu (Dhanus; Sagittarius) 0°—13°20
20. *Pubbāsāḷha* (*Pūrvāṣāḍhā*) (4)	**(1)** HD 165135 (Alnasl, 10-Sgr, γ²-Sgr); **(2)** HD 169022 (Kaus Australis, 20-Sgr, ε-Sgr); **(3)** HD 167618 (Sephdar, η-Sgr); **(4)** HD 168454 (Kaus Media, 19-Sgr, δ-Sgr)	Dhanu (Dhanus; Sagittarius) 13°20—26°40
21. *Uttarāsāḷha* (*Uttarāṣāḍhā*) (4)	**(1)** HD 173300 (27-Sgr, ϕ-Sgr); **(2)** HD 177716 (40-Sgr, τ-Sgr); **(3)** HD 176687 (Ascella, 38-Sgr, ζ-Sgr); **(4)** HD 175191 (Nunki, 34-Sgr, σ-Sgr)	Dhanu (Dhanus; Sagittarius) 26°40—Makara/Capricornus 10°00
22. *Savaṇa* (*Śravaṇa*) (3)	**(1)** HD 188512 (Alshain, 60-Aql, β-Aql); **(2)** HD 186791 (Tarazed, 50-Aql, γ-Aql); **(3)** HD 187642 (Altair, 53-Aql, α-Aql); **(3a)** HD 196524 (Rotanev, 6-Del, β-Del)	Makara (Capricornus) 10°00—23°20
23 *Dhaniṭṭhā* (*Dhaniṣṭhā*) (5)	**(1)** HD 196867 (Sualocin, 9-Del, α-Del); **(2)** HD 197964 (12-Del, γ²-Del); **(3)** HD 197461 (11-Del δ-Del); **(4)** HD 195810 (2-Del, ε-Del); **(5)** HD 196524 (Rotanev, 6-Del, β-Del); **(5a)** HD 204867 (Sadalsuud, 22-Aqr, β-Aqr)	Makara (Capricornus) 23°20—Kumbha (Aquarius) 6°40
24. *Satabhisaja* (*Śatabhiṣaj*) (1)	**(1**) HD 216386 (73-Aqr, λ-Aqr); **(1a)** HD 216956 (Fomalhaut, 24-PsA, α-PsA)	Kumbha (Aquarius) 6°40—20°00
25. *Pubbabhaddapadā* (*Purvabhādrapadā*) (2)	**(1)** HD 218045 (Markab, 54-Peg, α-Peg); **(2)** HD 217906 (Scheat, 53-Peg, β-Peg)	Kumbha (Aquarius) 20°00—Mīna/Pisces 3°20

Table 2. *The 27 Nakṣatrāni*

27 *Nakkhattāni* (*Nakṣatrāni*)	**Star Cluster and Prominent Star (*Yogatārā*)**	**Corresp. Sidereal Degrees—Pāḷi (Sanskrit; Latin) Zodiac**
26. *Uttarabhaddapadā* (*Uttarabhādrapadā*) (2)	**(1)** HD 886 (Algenib, 88-Peg, γ-Peg); **(2)** HD 358 (Alpheratz, 21-And, α-And)	Mīna (Pisces) 3°20—16°40
27. *Revatī*	**(1)** HD 7344 (86-Psc, ζ-Psc)	Mīna (Pisces) 16°40—30°00

Note: Abbreviations: And – Andromedae; Aql – Aquilae; Aqr – Aquarii; Ari – Arietis; And – Andromedae; Boo – Boötis; Cnc – Cancri; Crv – Corvi; Del – Delphini; Gem – Geminorum; Hya – Hydrae; Leo – Leonis; Lib – Librae; Ori – Orionis; Peg – Pegasi; Psc – Piscium; Sco – Sorpii; Sgr – Sagittarii; Tau – Tauri; Vir – Virginis. The *yogatārāḥ* are the last-mentioned stars in the middle column. Germane to the *Mūla-nakkhattaṃ* (no. 19) Abhyankar (1991, p. 3) gives only ζ-Sco and ι-Sco but there are two stars in each case (ζ^1-Sco, ζ^2-Sco and ι^1-Sco, ι^2-Sco) compartmentalized under the simple designations of ζ-Sco and ι-Sco. I opted for ζ^2-Sco and ι^1-Sco respectively, though both stars are practically on the same position. A similar situation of two stars each (γ^1-Sgr, γ^2-Sgr and γ^1-Del, γ^2-Del) for a further unspecified single name is found in re to γ-Sgr and γ-Del. I opted for γ^2-Sgr (*Pubbāsāḷha-nakkhatta*, no. 20) and γ^2-Del (*Dhaniṭṭhā-nakkhatta*, no. 23) respectively since these are the brighter stars, as is the case with the stars of the previous sentence. Both selected stars again practically on the same coordinates as their alternatives. For *Dhaniṣṭhā-nakṣatraṃ* of the Vedic heritage are traditionally five stars assigned but, unfortunately, I could determine and single out merely four of them. Abhyankar (p. 3) states six. Among stars HD 196180 (ζ-Del, 4-Del) and HD 195810 (2-Del, ε-Del) of Abhyankar a choice was felt due since those two were not among the four that stand assuredly. Ensuingly incorporated was star HD 195810, again due to its being the brighter star. Abhyankar (p. 8) contains a discussion on the identification of the *yogatārāḥ* of *Śravaṇa-nakṣatraṃ* and concludes that HD 196524 (Rotanev, 6-Del, β-Del) should be the preferred choice. For *Dhaniṣṭhā-nakṣatraṃ* he identifies HD 204867 (Sadalsuud, 22-Aqr, β-Aqr), without prior deliberation. I included the traditional list totals of three and five but provided his amendments too which are marked as 3a and 5a apiece. On the same page he identifies HD 204867 (Sadalsuud, 22-Aqr, β-Aqr) as the *yogatārāḥ* of *Dhaniṣṭhā-nakṣatraṃ* instead of the traditional star HD 196524 (Rotanev, 6-Del, β-Del) — here too I left the original numbering and extended the list in the same manner as mentioned in the previous sentence. *Sources*:
(a) *A Note on the Asterisms Forming the Nakṣatra-s* (2017). Retrieved December 28, 2019. https://manasataramgini.wordpress.com/2017/07/01/a-note-on-the-asterisms-forming-the-nak%E1%B9%A3atra-s/. **(b)** Abhyankar, K. D. (1991). Misidentification of Some Indian Nakṣatras. *Indian Journal of History of Science*, *26*(1), 1–10.

Figures

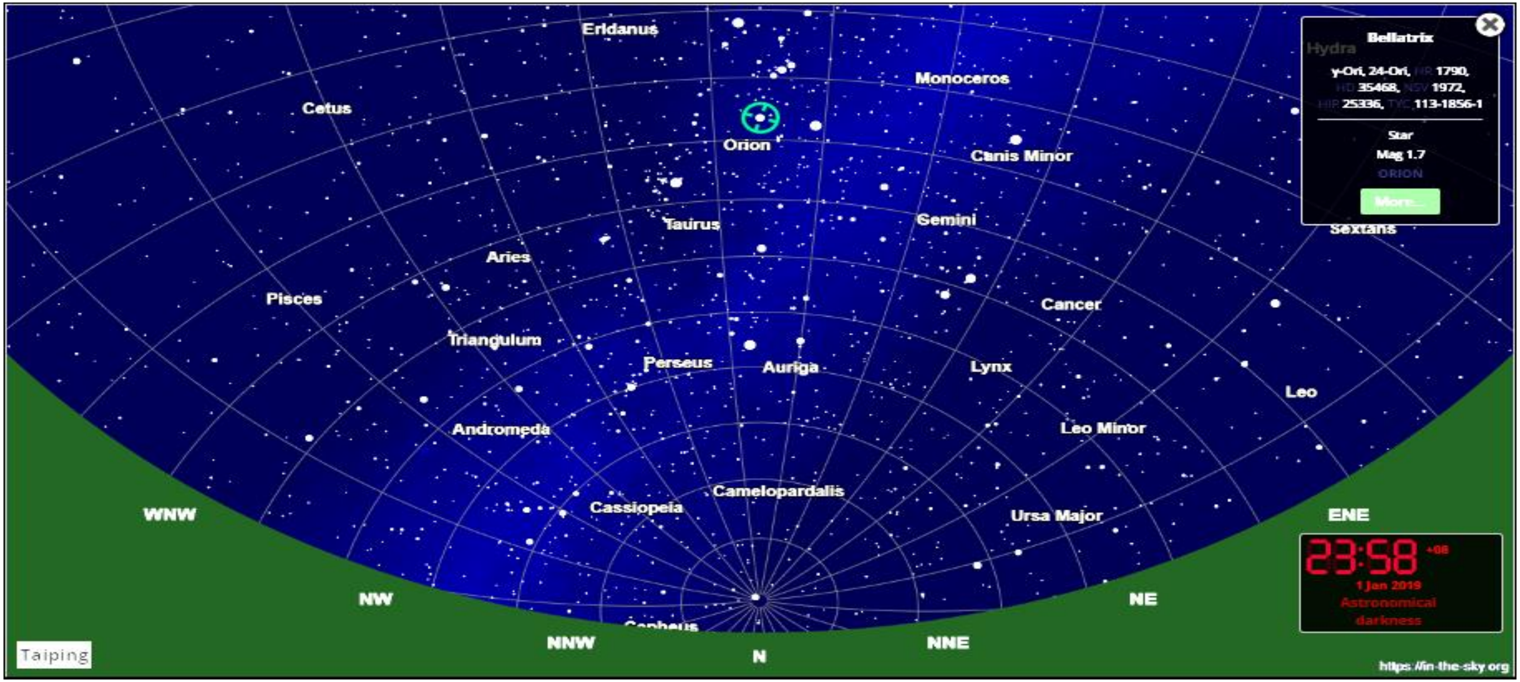

Figure 5. *Magasiraṁ-nakkhattaṃ* without Constellation Figures in RA/Dec Grid. Star does not move relative to the grid. The coordinates of right ascension and declination are fixed on the imaginary celestial sphere (though appear to move with the stars). *Source*: Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

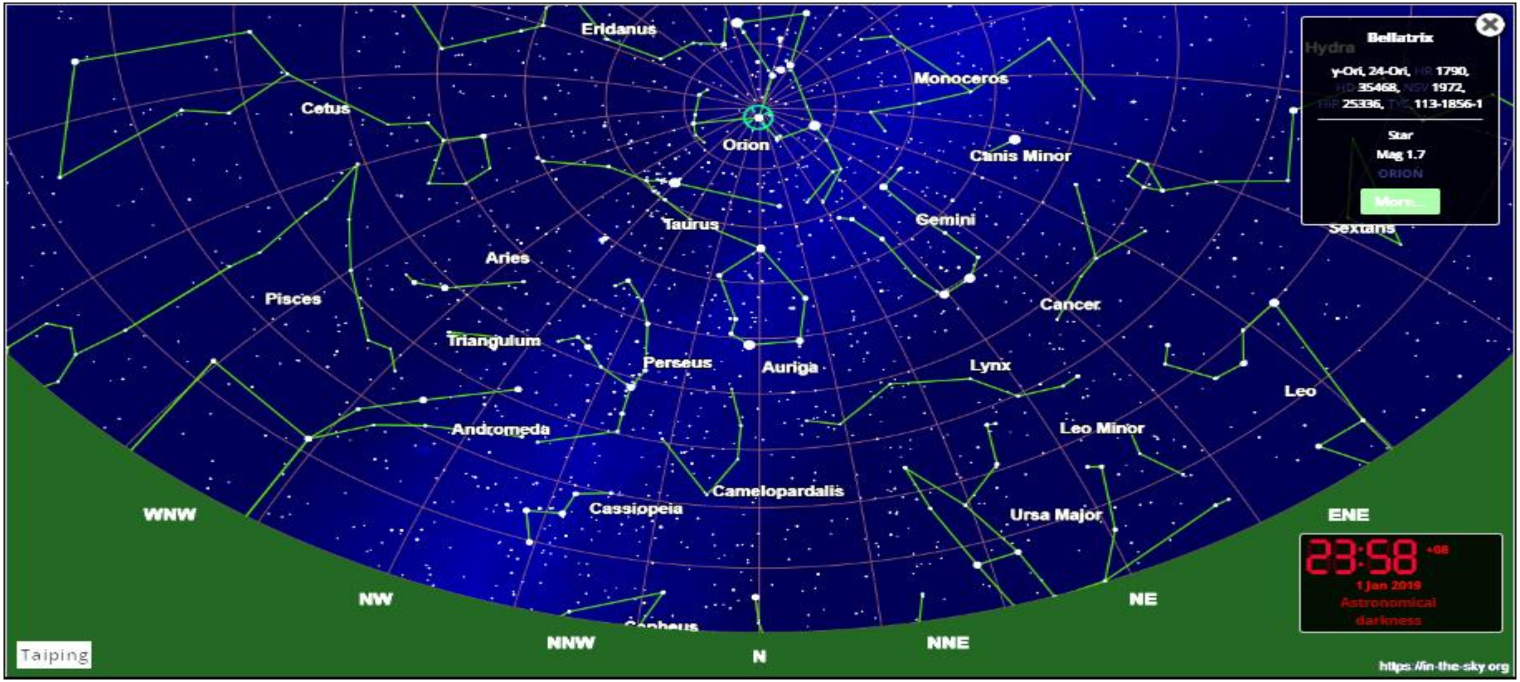

Figure 6. Magasiraṁ-nakkhattaṃ with Constellation Figures in Alt/Az Grid. Star does move relative to the grid. Altitude and azimuth are relative to the observer's position, the cardinal directions and the horizon (appearing stationary and stars moving through). *Source*: Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

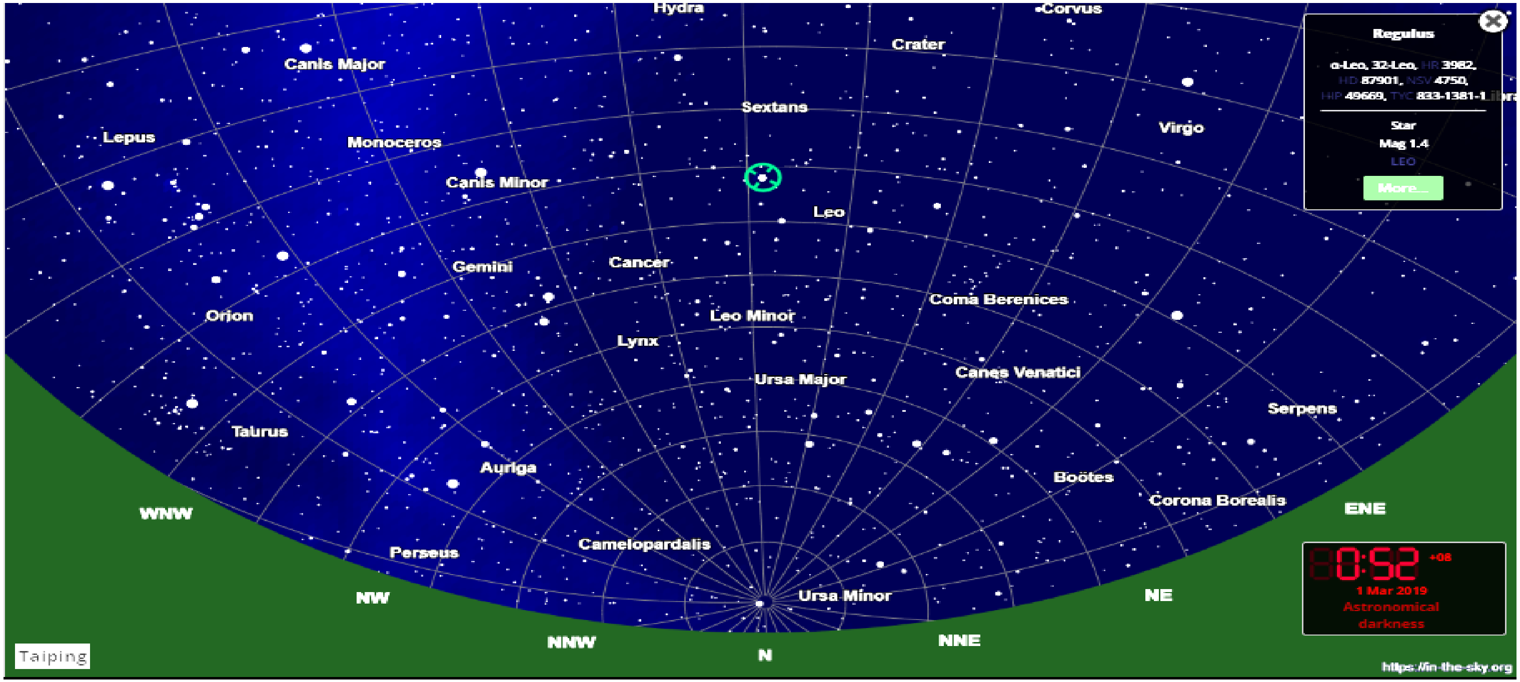

Figure 7. Maghā-nakkhattaṃ without Constellation Figures in RA/Dec Grid. Star does not move relative to the grid. The coordinates of right ascension and declination are fixed on the imaginary celestial sphere (though appear to move with the stars). *Source*: Ford, D. (2019). Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

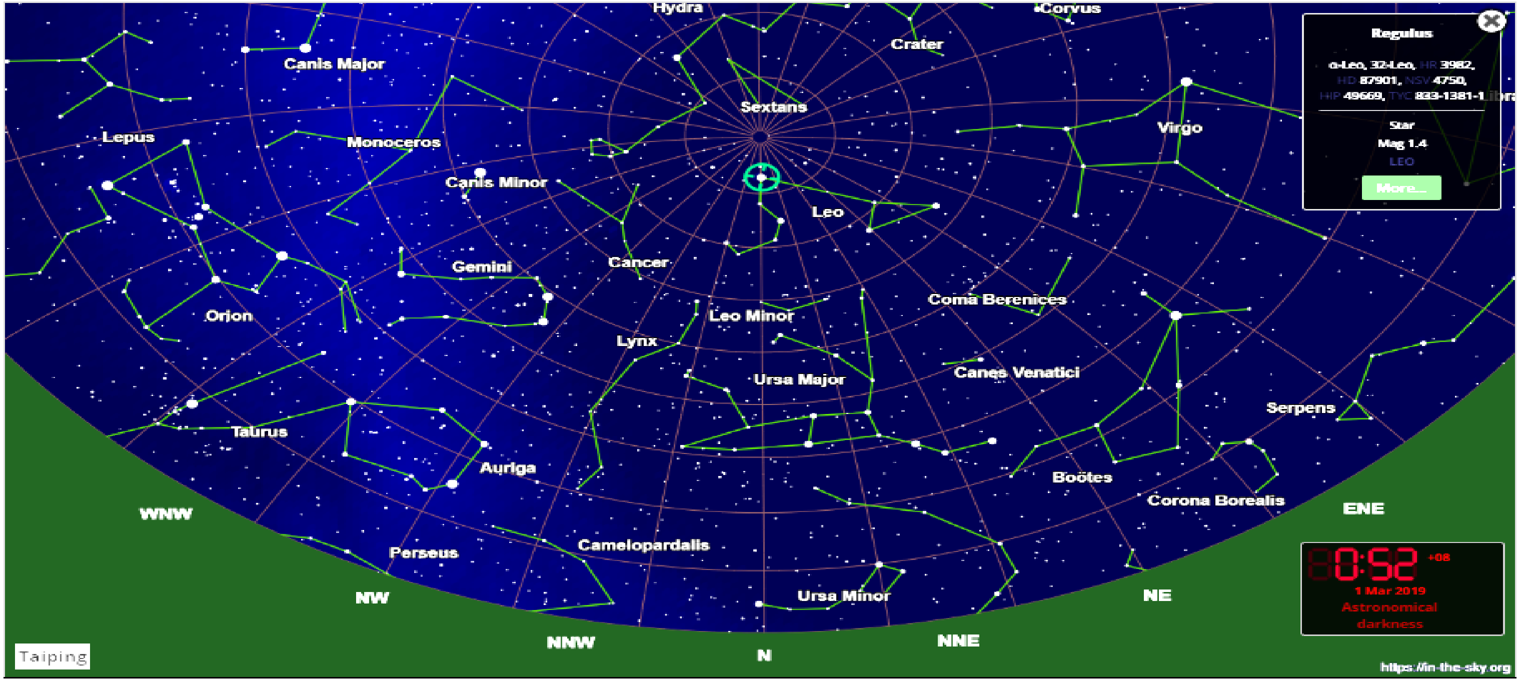

Figure 8. *Maghā-nakkhattaṃ* with Constellation Figures in Alt/Az Grid. Star does move relative to the grid. Altitude and azimuth are relative to the observer's position, the cardinal directions and the horizon (appearing stationary and stars moving through). *Source*: Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

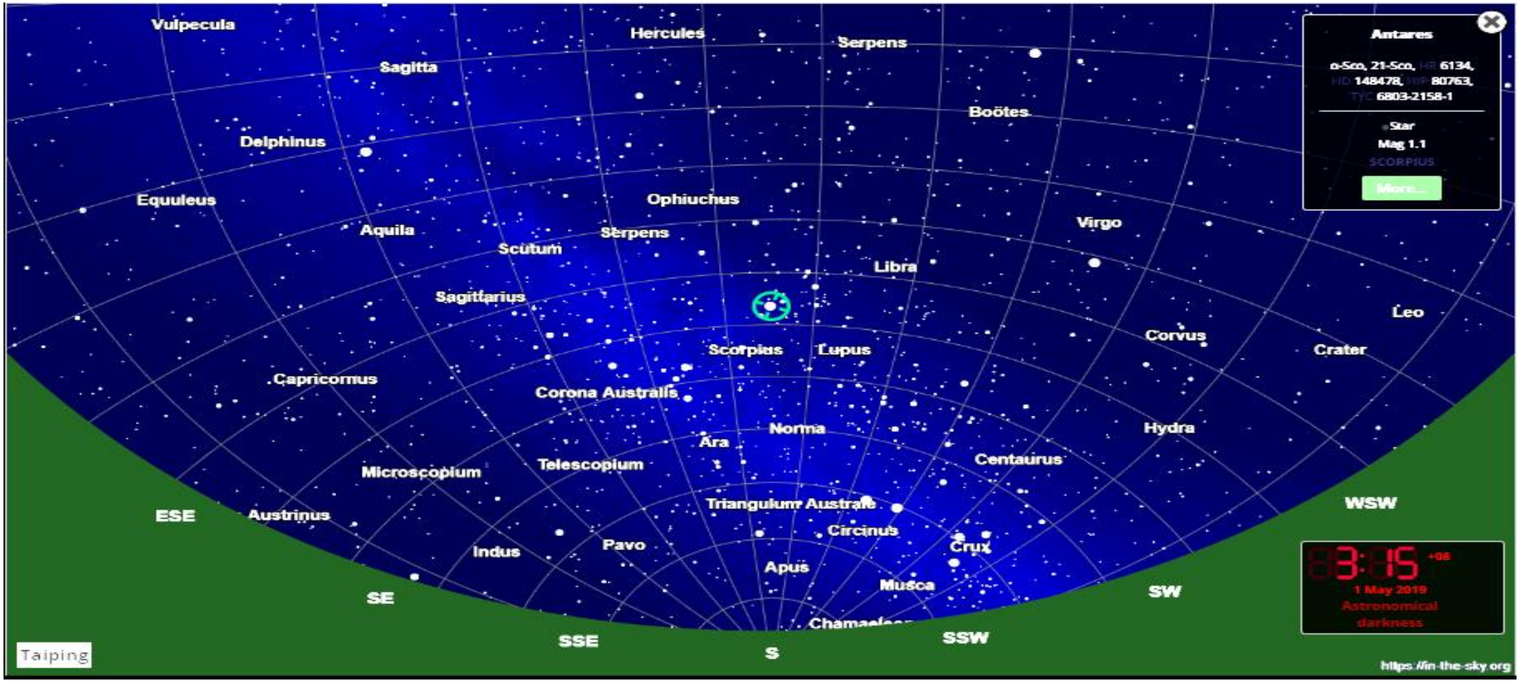

Figure 9. *Jeṭṭhā-nakkhattaṃ* without Constellation Figures in RA/Dec Grid. Star does not move relative to the grid. The coordinates of right ascension and declination are fixed on the imaginary celestial sphere (though appear to move with the stars). *Source*: Ford, D. (2019). Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

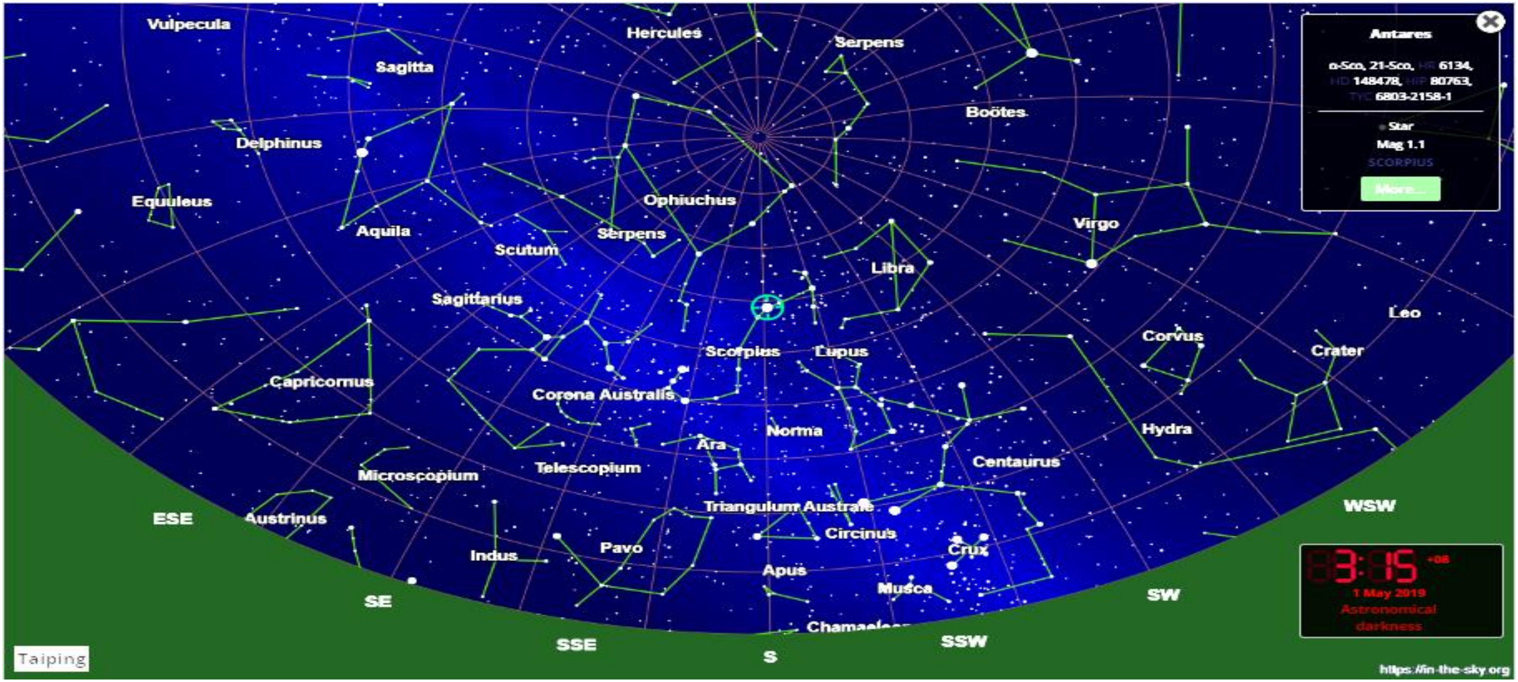

Figure 10. Jeṭṭhā-nakkhattaṃ with Constellation Figures in Alt/Az Grid. Star does move relative to the grid. Altitude and azimuth are relative to the observer's position, the cardinal directions and the horizon (appearing stationary and stars moving through). *Source*: Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

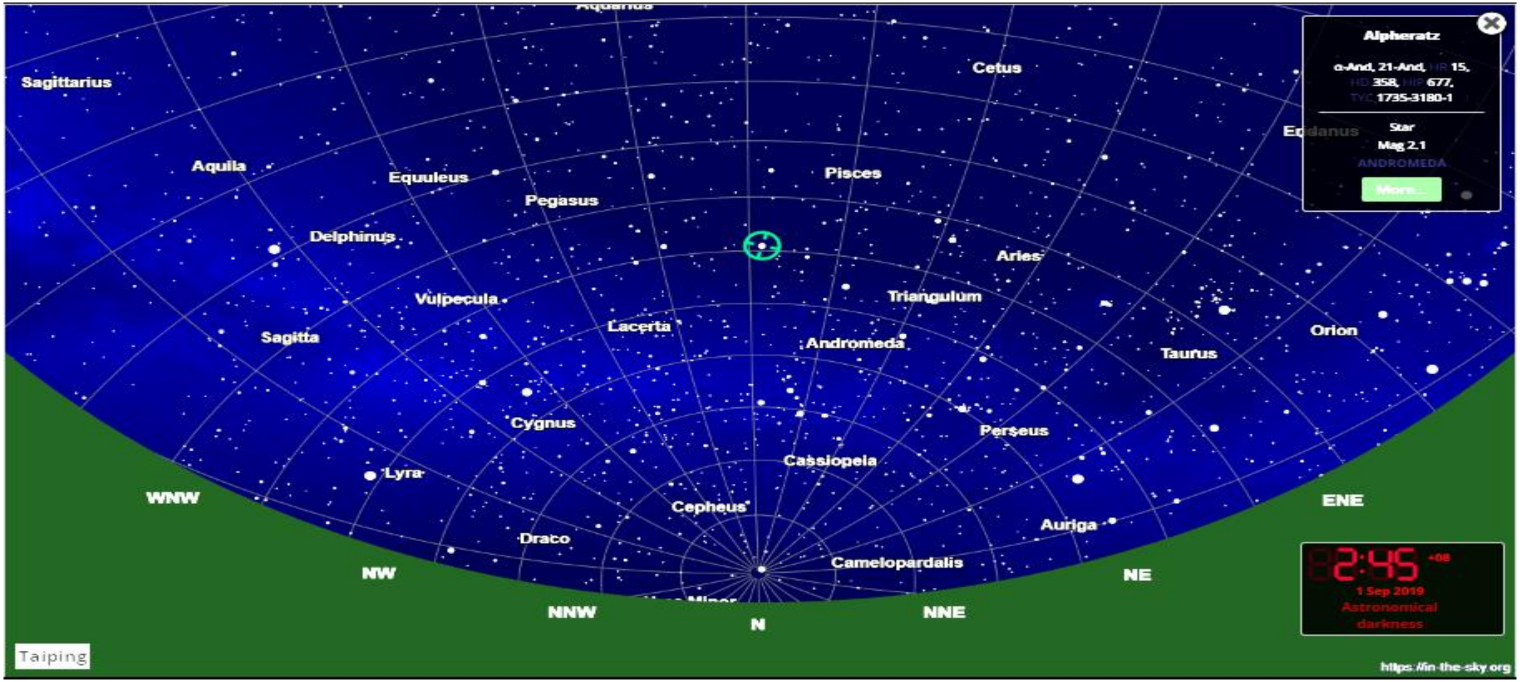

Figure 11. *Uttarabhaddapadā-nakkhattaṃ* without Constellation Figures in RA/Dec Grid. Star does not move relative to the grid. The coordinates of right ascension and declination are fixed on the imaginary celestial sphere (though appear to move with the stars). *Source*: Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

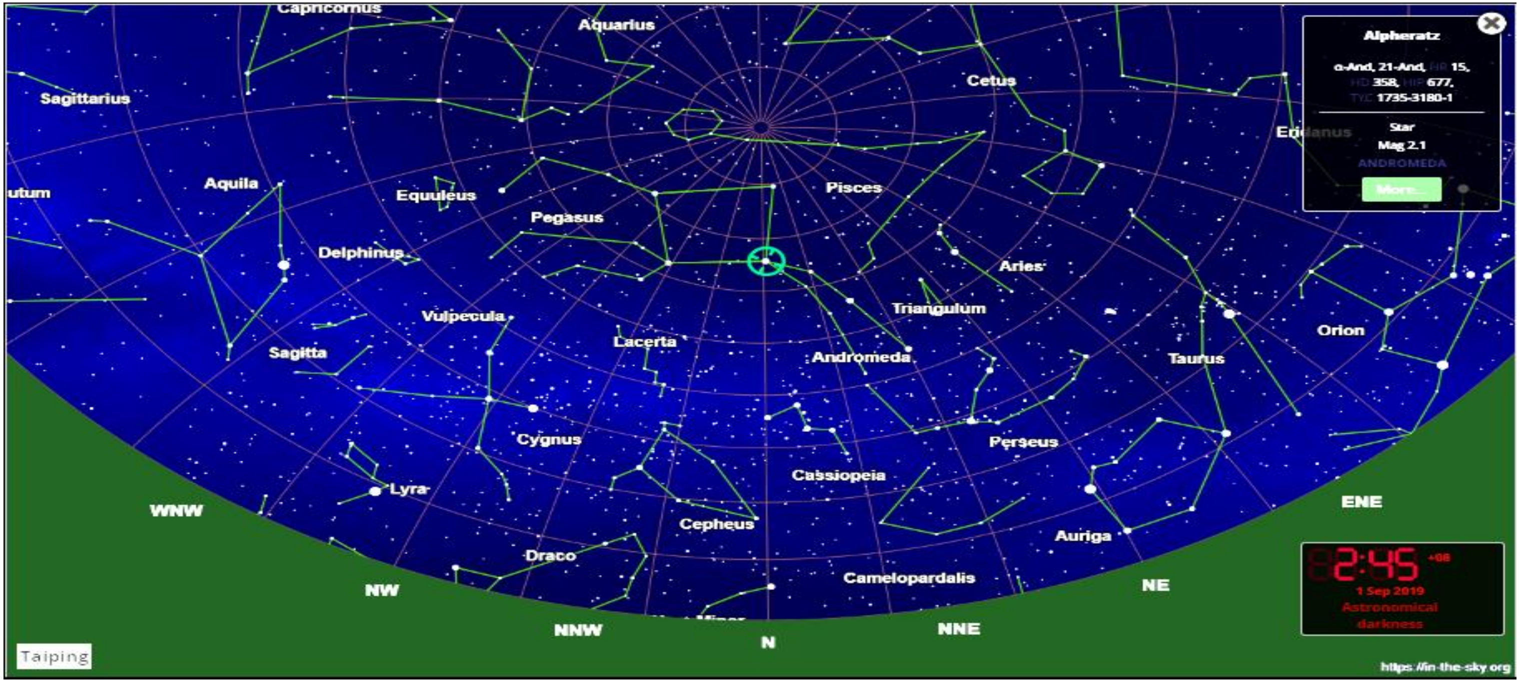

Figure 12. *Uttarabhaddapadā-nakkhattaṃ* with Constellation Figures in Alt/Az Grid. Star does move relative to the grid. Altitude and azimuth are relative to the observer's position, the cardinal directions and the horizon (appearing stationary and stars moving through. *Source*: Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

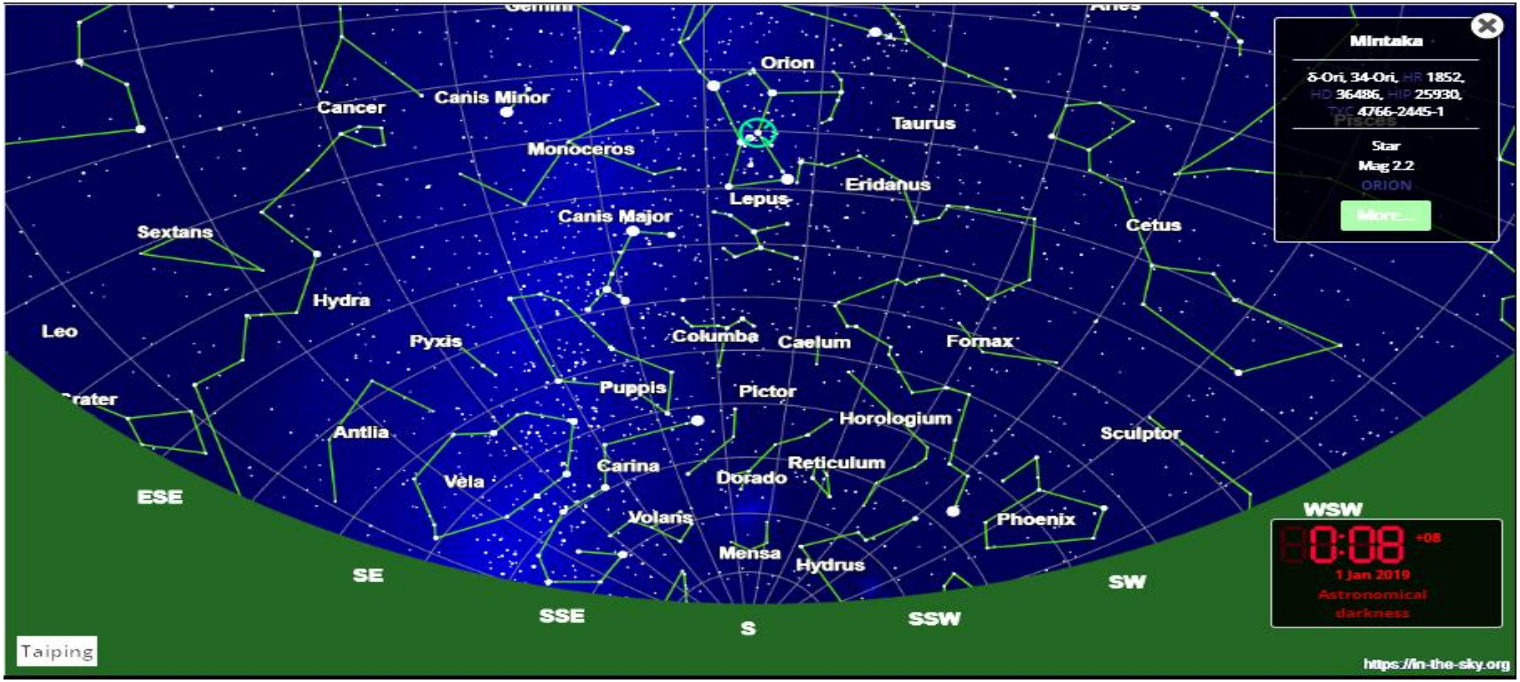

Figure 13. Mintaka displayed in its zenith and on the celestial equator facing due south, with constellation figures in RA/Dec grid. Star does not move relative to the grid. The coordinates of right ascension and declination are fixed on the imaginary celestial sphere (though appear to move with the stars). *Source*: Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

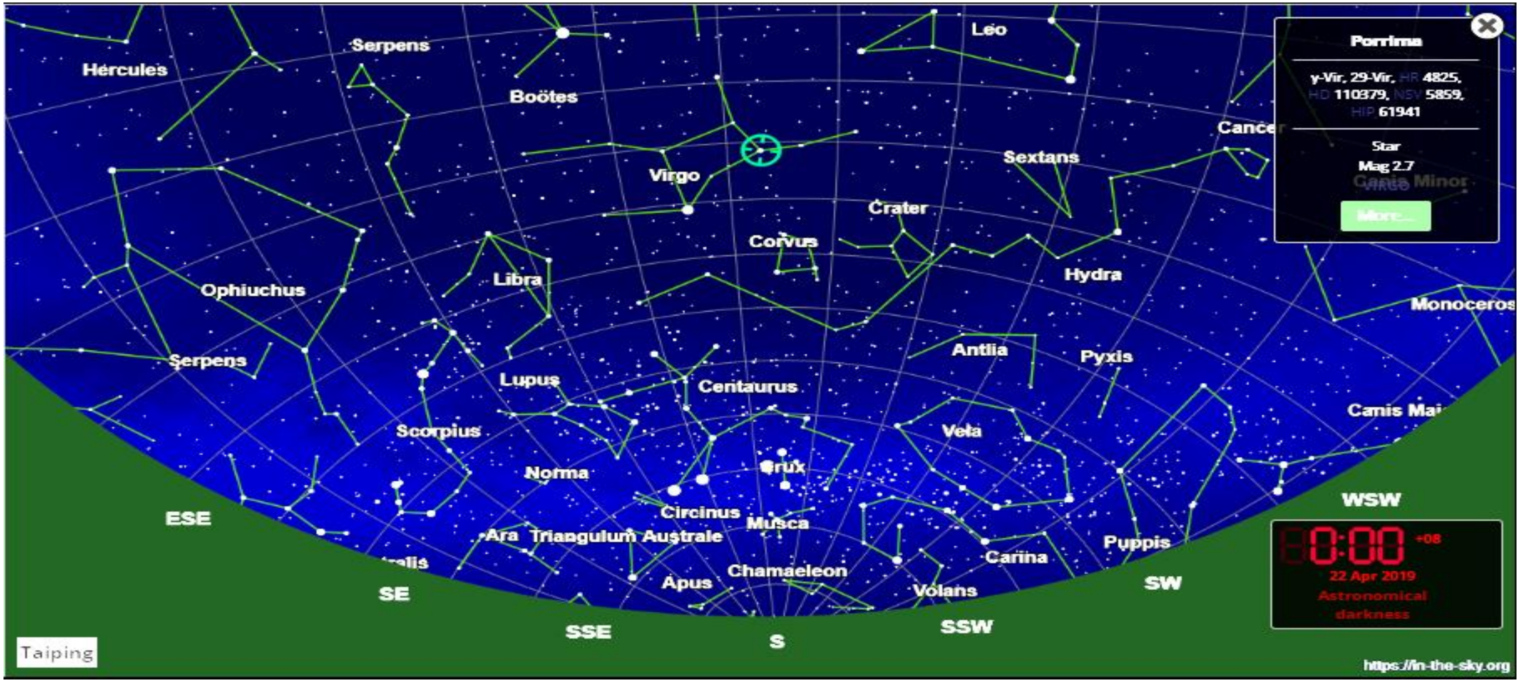

Figure 14. Porrima displayed in its zenith and on the celestial equator facing due south, with constellation figures in RA/Dec grid. Star does not move relative to the grid. The coordinates of right ascension and declination are fixed on the imaginary celestial sphere (though appear to move with the stars). *Source*: Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

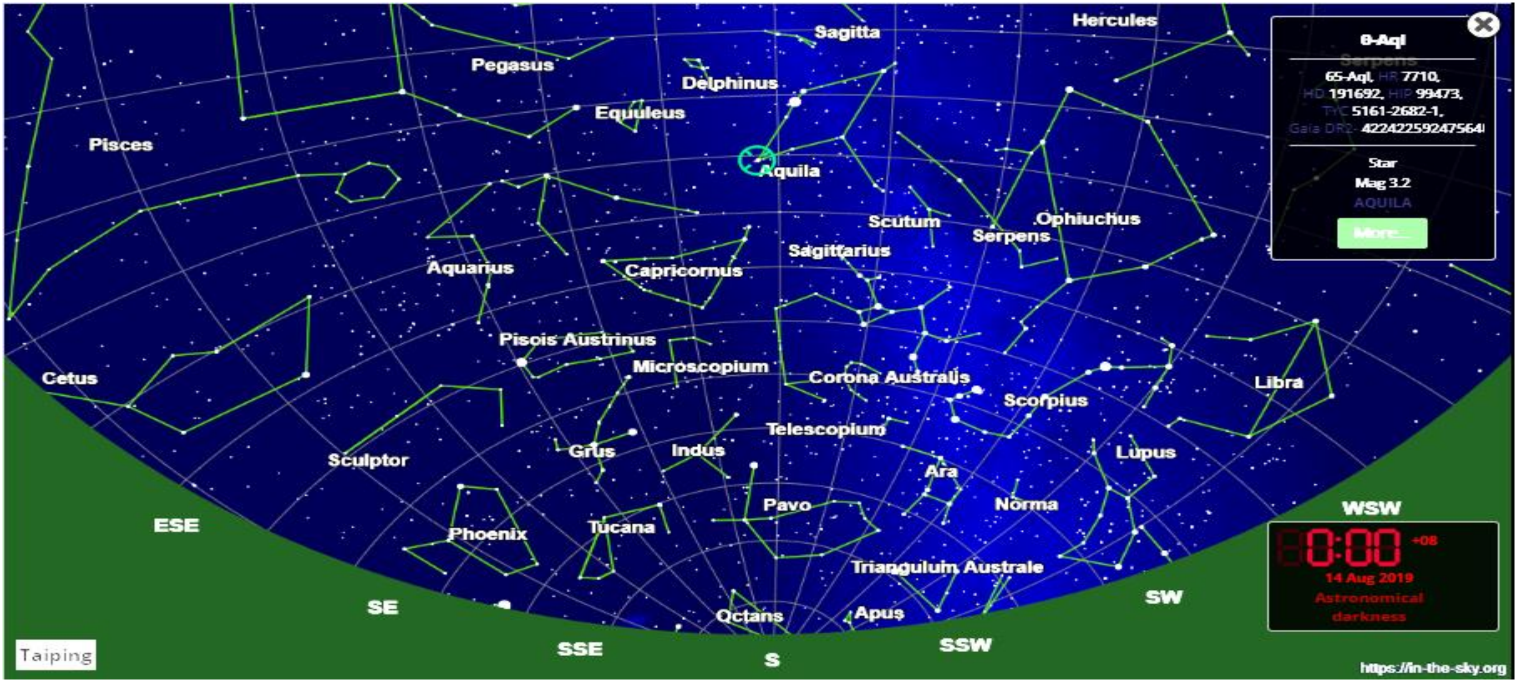

Figure 15. Tseen Foo displayed in its zenith and on the celestial equator facing due south, with constellation figures in RA/Dec grid. Star does not move relative to the grid. The coordinates of right ascension and declination are fixed on the imaginary celestial sphere (though appear to move with the stars). *Source*: Ford, D. (2019). The In-The-Sky.org Planetarium. Retrieved December 28, 2019. https://in-the-sky.org/skymap.php.

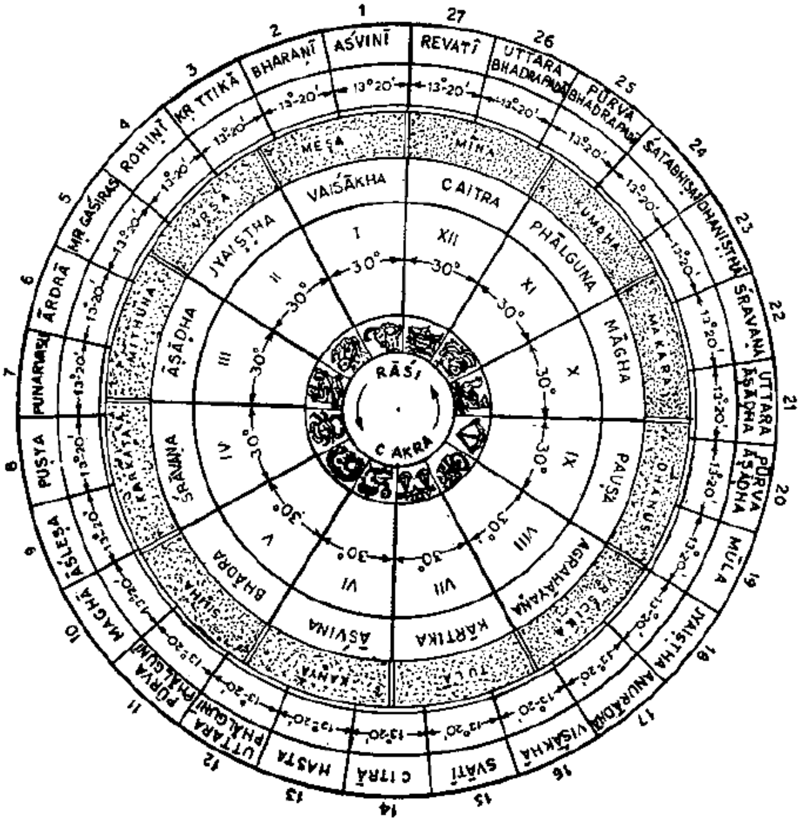

Figure 16. The 27 *Nakṣatrāṇi* in the Zodiac. *Source*: Chatterjee, S.K., & Chakravarty, A.K. (1985). Indian Calendar from Post-Vedic Period to AD 1900. *Indian Journal of History of Science*, *20*(1-4), 252-307.