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The Units of Time in Ancient and Medieval India

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The Units of Time in Ancient and Medieval India

Takao Hayashi

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INTRODUCTION

This is a preliminary survey of time units used or mentioned in ancient and medieval works written in Sanskrit and other Indian languages; the fields of the works surveyed are *jyautiṣa*, *paurāṇika*, *uttara-vaidika*, *āyurvedika*, *smārta*, *Bauddha*, and *Jaina* literatures, including Chinese translations of *Bauddha* works. No small portion of the data presented in the following sections has already been taken up and explained in the works mentioned at the end of this section, but I have newly collected the data from the original sources and arranged them in my own way according to my own interest.

My main interest lies in the great variety of the names of the units and of the conversion ratios between them that these texts exhibit. In these texts, they are mostly given in metrical languages. In this paper, I often put them together in a table, which is useful for showing the numerical structure of the given time units. The tabular presentation, however, excludes everything in the texts other than the names and ratios. I have therefore supplied other important information also from the texts, if any. For the *yuga-manvantara-kalpa* system described in the *purāṇas*, I often abandoned the tabular presentation because the mode of the description itself is interesting even if the resulting table would turn out to be the same. In such cases I have closely followed the text line-by-line in reproducing the given numerical relationships.

The sections that follow are arranged by Sanskrit alphabetical order of the titles of the works. The unit names are spelled out in the first column of each table but in the top row they are abbreviated to be fitted into the narrow space. The conversion ratios printed in bold face in the tables have actually been given in the texts; others have been obtained by calculation. I hope the two indices at the end of this paper will facilitate the use of this survey.

References For various studies of the measurement of time in India see: Balslev 1999, Chakravarty 1975, Chattopadyay 1992, Falk 2000, González-Reimann 2009,

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2010, Misra 1992, Ôhashi 1993: 168–96, 1994: 273–79, Pande 1992, S. R. Sarma 2008: 19–46, 125–75, Srinivasan 1979: 118–61, Subbarayappa and K. V. Sarma 1985: 49a–61a, and Thompson 2007: 203–36.

1 ANUYOGADVĀRASŪTRA

366

Sūtra 366 defines the smallest unit of time, *samaya*, with a metaphor. The following is a free digest of the sūtra. For a full English translation, see Hanaki 1970: 130.

> "Imagine a sturdy young man. Is the *samaya* equal to the time for him to tear a piece of cotton or silken cloth?"
>
> "No. One piece of cotton or silken cloth is produced by the integration (*samāgama*) of the assemblage (*samiti*) of groups (*samudaya*) of numerable number (*saṃkhejja*) of threads (*taṃtu*). The time when each thread is cut is different from each other."
>
> "Then, is the *samaya* equal to the time for him to cut a thread?"
>
> "No. One thread is produced by the integration of the assemblage of groups of numerable number of fibres (*pamha*, Skt. *pakṣman*). The time when each fibre is cut is different from each other."
>
> "Then, is the *samaya* equal to the time for him to cut a fibre?"
>
> "No. One fibre is produced by the integration of the assemblage of groups of infinite number (*aṇaṃta*) of molecular aggregates (*saṃghāta*). The time when each molecular aggregate is broken is different from each other. The *samaya* is smaller than that."

Cf. the *Gaṇitasārasaṃgraha* below, p. 13.

367

Sūtra 367 repeats exactly the same description, with minor phonetic changes, of the same time units with the same conversion ratios as in sūtra 24 of the *Jambūdvīpaprajñapti*. See p. 14 below.

368–81

The sūtras that follow (368–81) treat the time units that can be expressed only by similes (*ovamia*, Skt. *aupamika*) such as *paliovama* (*palya-upama*), *sāgarovama* (*sāgara-upama*), etc.

2 ABHIDHARMAKOŚA

The *Abhidharmakośa* with *bhāṣya* is also available in two Chinese translations, one entitled 阿毘達磨俱舍論 by 玄奘 (T1558) and the other 阿毘達磨俱舍釋論 by 眞諦 (T1559).

3.88B–89C

Verses 3.88b–89c (T1558.29.0062b13–16; T1559.29.0220a09–14) give the following relationships.

	玄奘	*kṣa*	*ta*	*la*	*mu*	*a*	*mā*	*saṃ*
kṣaṇa	刹那	1						
tatkṣaṇa	怛刹那	**120**	1					
lava	臘縛	7200	**60**	1				
muhūrta	牟呼栗多[a]	216000	1800	**30**	1			
ahorātra	晝夜	6480000	54000	900	**30**	1		
māsa	月					**30**	1	
saṃvatsara[b]	年					360	**12**	1

[a] 眞諦 transcribes *muhūrta* as 牟休多.

[b] The unit *saṃvatsara* includes 6 *ūnarātras* (omitted nights, where a 'night' means 'a day and night'), which are to be removed for obtaining a lunar year (354 nights).

This table is an extension of that of the *Abhidharmamahāvibhāṣāśāstra*, and verses 3.89d–93c, which immediately follow the above passage, describe the same *kalpa* system as in that work. See section 3 below.

3 ABHIDHARMAMAHĀVIBHĀṢĀŚĀSTRA

The *Abhidharmamahāvibhāṣāśāstra*, in the Chinese translation 阿毘達磨大毘婆沙論 by 玄奘 (T1545.27.0701b08–12), gives the following relationships.

	Skt.	*kṣa*	*ta*	*la*	*mu*	*a*
刹那	*kṣaṇa*	1				
怛刹那	*tatkṣaṇa*	**120**	1			
臘縛	*lava*	**7200**	**60**	1		
牟呼栗多	*muhūrta*	**216000**	1800	**30**	1	
晝夜	*ahorātra*	**6480000**	54000	900	**30**	1

Forty-five lines before this passage in the Chinese translation (T1545.27.0700c11–21), the *kalpa* system is described.

One cosmic cycle called *mahā-kalpa* (great *kalpa*, 大劫) consists of two *kalpas*, that is, *saṃvarta-kalpa* (*kalpa* for destruction) and *vivarta-kalpa* (*kalpa* for creation); and each *kalpa* is divided into two periods, that is, the period of destruction and the period of non-existence after the destruction in the former case and the period of creation and the period of existence after the creation in the latter case. Each period is said to consist of 20 *antaḥ-kalpas* (inward or medium *kalpas*, 中劫 or 中間劫) and consequently the *mahā-kalpa* consists of 80 *antaḥ-kalpas*, but no definition is given to the length of the *antaḥ-kalpa*. See the *Dīghanikāya* below for a definition.

mahā-kalpa	*saṃvarta-kalpa*	period of destruction (壞劫)	20 *antaḥ-kalpas*
		period of non-existence (空劫)	20 *antaḥ-kalpas*
	vivarta-kalpa	period of creation (成劫)	20 *antaḥ-kalpas*
		period of existence (住劫)	20 *antaḥ-kalpas*

The Sanskrit terms have been restored from the Chinese transliterations and translations. The words *saṃvartakalpa* and *kalpa* occur in Prakrit form, *saṃvaṭa-kapa* and *kapa*, respectively in the fourth and the fifth rock edicts of Aśoka (Sircar 1991: 20–23).

4 ABHIDHĀNACINTĀMAṆI

Verses 2.50–52a give the following definitions.

	ni	*kā*	*la*	*ka*	*le*	*kṣa*	*nā*	*mu*	*a*
nimeṣa	1								
kāṣṭhā	**18**	1							
lava	36	**2**	1						
kalā	540	30	**15**	1					
leśa	1080	60	30	**2**	1				
kṣaṇa	16200	900	450	30	**15**	1			
nāḍikā	97200	5400	2700	180	90	**6**	1		
muhūrta	194400	10800	5400	360	180	12	**2**	1	
ahorātra	5832000	324000	162000	10800	5400	360	60	**30**	1

Definitions of *pakṣa*, *māsa*, *ṛtu*, *ayana*, and *vatsara* interspersed in verses 2.61–72 and the *yuga-manvantara-kalpa* sysytem given in verses 2.73c–74 are the same as those of the *Nāmaliṅgānuśāsana*. See p. 24 below.

5 ARTHAŚĀSTRA

2.20.29–38 AND 43–63

PARAGRAPHS 2.20.29–38 and 43–63 give the following relationships.

2.20.29–38

	ṛtu	*la*	*ni*	*kā*	*ka*	*nā*	*mu*	*a*
tuṭa	1							
lava	**2**	1						
nimeṣa	4	**2**	1					
kāṣṭhā	20	10	**5**	1				
kalā	600	300	150	**30**	1			
nālikā	24000	12000	6000	1200	[a]**40**	1		
muhūrta	48000	24000	12000	2400	80	**2**	1	
ahorātra	1440000	720000	360000	72000	2400	60	**30**	1

[a] After this definition, paragraph 2.20.35 gives another definition by means of a water clock called *kumbha* or 'jar.'

> **सुवर्णमाषकाश्चत्वारश्चतुरङ्गुलायामाः कुम्भच्छिद्रमाढकमम्भसो वा नालिका।**
>
> Or, otherwise, *nālikā* is ⟨defined as the time duration in which⟩ one *āḍhaka* of water ⟨flows out of⟩ a hole of a jar; ⟨the size of the hole is tested by⟩ four *māṣakas* of gold ⟨wire⟩ having a length of four *aṅgulas*.

References On the two types of water clocks—outflowing type and sinking bowl type—used in India see Ôhashi 1993: 225–36, 1994: 273–79 and S. R. Sarma 2008: 125–75. Cf. Falk 2000: 117–19.

2.20.43–63

	a	*pa*	*mā*	*ṛ*	*a*	*va*
ahorātra	1					
pakṣa	**15**	1				
māsa	30	[a]**2**	1			
ṛtu	60	4	**2**	1		
ayana	180	12	6	**3**	1	
varṣa	360	24	12	6	**2**	1

[a] After this definition, paragraphs 2.20.47–53 define seven kinds of *māsa* or 'month':

Kinds of month	Number of days (*ahorātras*)
nākṣatra-māsa (sidereal month)	27
cāndra-māsa (lunar or synodic month)	$29\frac{1}{2}$
karma-māsa (working month)	30
saura-māsa (solar month)	$30\frac{1}{2}$
bala-māsa (military month)	32
aśvavāhā-māsa (horse-rider month)	35
hastivāhā-māsa (elephant-rider month)	40

2.20.64–66

Paragraphs 2.20.64–66 refer to a *yuga* consisting of five years with two intercalary months, which are inserted at the middle of the third year and at the end of the fifth. Cf. *Mahābhārata* and *Lokaprajñapti* below.

1.19.6–8

Paragraphs 1.19.6–8 describe the seasonal hour, which divides the day and the night into 8 parts (*bhāgas*) each. The divisions are made by means either of *nāḍikā* ('tube,' a water clock of the outflowing type) or by *chāyāpramāṇa* (shadow length). For the division by shadow lengths it says: 'Three *pauruṣīs*, one *pauruṣī*, four *aṅgulas*, and midday with lost shadow: these are the four eighth-parts of a day in the former ⟨half⟩. By the same ⟨lengths⟩, the latter ⟨half, too,⟩ is explained' (1.19.7–8). The word *pauruṣī* means 'of *puruṣa*,' i.e. '⟨the length⟩ of a man,' where 'man' stands for gnomon. The following table suggests that one *pauruṣī* is here equated to 12 *aṅgulas*. 義浄 in his 南海寄帰内法伝 (T2125.54.0219c08–15) refers to the 布路沙 (*puruṣa*), i.e. gnomon, of 四指 (four *aṅgulas*) employed in Buddhist monasteries of seventh-century India.

2.20.39

Paragraph 2.20.39 gives more detailed data of shadow lengths.

Time past (d=length of daylight)	$\frac{d}{18}$	$\frac{d}{14}$	$\frac{d}{8}$	$\frac{d}{6}$	$\frac{d}{4}$	$\frac{3d}{10}$	$\frac{3d}{8}$	$\frac{d}{2}$
Shadow length in *aṅgula*	96	72	36	24	12	8	4	0

In the following plot, Figure 1, the circled dots indicate the shadow length at the end of each one-eighth part (*aṣṭabhāga*) of the daylight except the last. The midday shadow is 'absent' (*abhāva*) in this scheme. It follows that this scheme is for the day when the sun's declination becomes equal to the latitude of the locality and that the latitude of the locality is less than the maximum declination of the sun (about 23.5 degrees).

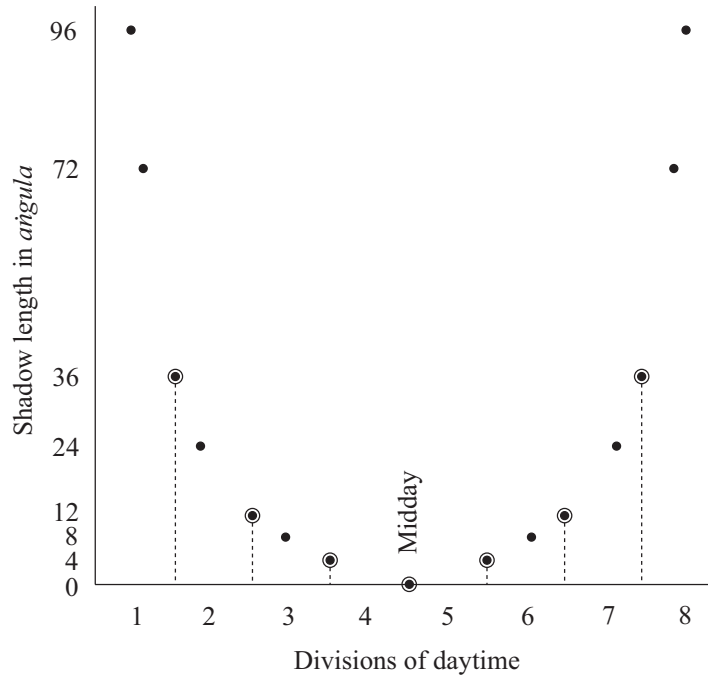

Figure 1: The shadow data in the *Arthaśāstra*.

Abraham (1981) points out that the above shadow data recorded in the *Arthaśāstra* follow the formula,

$$\frac{d}{2t} = \frac{s}{g} + 1,$$

where t is the time, s the shadow length, and g the length of the gnomon. He explains the origin of this formula by assuming the linear relationship between the shadow and the inverse of time with two constants, a and b,

$$\frac{d}{t} = a \cdot \frac{s}{g} + b.$$

By further assuming two particular cases, $(t, s) = (d/2, 0)$ and $(d/4, g)$, he obtains $a = b = 2$, which lead to the above formula. However, his conjecture is untenable not only because the formula in this form is not found in ancient India but also, more fundamentally, because the concept of 'the inverse of time' has not so far been attested in ancient India. The formulas actually prescribed by Indian authors for rough estimation of time are:

$$t = \frac{1/2}{s/g + 1} \text{ day} \quad \text{(BSS 12.52)},$$

$$t = \frac{g}{2(s+g)} \text{ day} \quad \text{(Tr 65, MS 15.118, SŚ 13.53)},$$

$$t = \frac{1}{2(s/g+1)} \text{ day} \quad \text{(GSS 9.8cd-9ab)},$$

where 'day' means the length of daylight. The abbreviations used here are: BSS = *Brāhmasphuṭasiddhānta*, Tr = *Triśatikā*, MS = *Mahāsiddhānta*, SŚ = *Siddhāntaśekhara*, and GSS = *Gaṇitasārasaṃgraha*. All these formulas are equivalent to the above formula and therefore the *Arthaśāstra*'s shadow data follow these formulas, too.

The second form of these, accepted at least by three authors, suggests that the origin of these formulas lies in the idea that the time (t) is inversely proportionate to the sum of the lengths of the gnomon (g) and the shadow (s) which constitute the two orthogonal sides of the right triangle produced by the eclipse of the sun ray. Even though the significance given to this particular inverse proportion in ancient India is yet to be investigated, this conjecture seems much more realistic than Abraham's one, which is based on the unwarranted concept of the inverse of time, as the inverse proportion was actually known in ancient India under the name 'inverse three-quantity operation' (*vyasta-trairāśika*, conventionally rendered as 'inverse rule of three'; see BSS 12.11ab, etc.).

References Compare the list of shadow lengths in the *Śārdūlakarṇāvadāna* (p. 79 below). For detailed discussions on the gnomon used in India see Ôhashi 1993: 206–25, 1994: 168–96. For a comparative study of the gnomon of the *Arthaśāstra* and that of MUL.APIN see Falk 2000: 119–29.

6 ĀRYABHAṬĪYA

3.1–2B

Verses 3.1–2b give the following relationships.

	gu	*prā*	*vi*	*nā*	*di*	*mā*	*va*
gurvakṣara	1						
prāṇa	10	1					
vināḍikā (*ārkṣī*)	**60**	**6**	1				
nāḍī	3600	360	**60**	1			
divasa	216000	21600	3600	**60**	1		
māsa	6480000	648000	108000	1800	**30**	1	
varṣa	77760000	7776000	1296000	21600	360	**12**	1

Exactly the same table is given in *Sadratnamālā* 2.1. See Subbarayappa and K. V. Sarma 1985: 53a. For the measurement of time by means of *gurvakṣaras* ('heavy syllables') see S. R. Sarma 2008: 143–46.

The same author, Āryabhaṭa, in another of his works called *Āryabhaṭa-siddhānta*, briefly describes the sinking bowl type of water clock called *ghaṭikā* ('bowl') or *kapālaka* ('skull'). It is filled up with water in a period of 60 *palas* and sinks into water 60 times a day-and-night. See Ôhashi 1994: 274. This time-measuring device called *ghaṭikā*, therefore, measures one *nāḍī* of the above table.

3.2CD

Verse 3.2cd alludes to the divisions of arc beginning with a circle (*bha-gaṇa*) which are parallel to the above divisions of time. See *Brāhmasphuṭasiddhānta* and *Siddhāntaśiromaṇi* below. Bhaṭṭotpala in his commentary on the *Bṛhatsaṃhitā* (p. 23) and the younger Āryabhaṭa in his *Mahāsiddhānta* (1.6) also mention the same parallelism.

3.7–8

Verses 3.7–8 define higher units: 30 *mānuṣa-ravi-varṣas* (human solar years) = 1 *pitrya-varṣa* (ancestral year) , 12 *pitrya-varṣas* = 1 *divya-varṣa* (divine year), 12000 *divya-varṣas* = 1 *yuga* (conjunction cycle), and 1008 *yugas* = 1 *brāhma-divasa* (Day of Brahmā) .

1.5AB

Verse 1.5ab gives the relationships, 72 *yugas* = 1 *manvantara* (Manu's Period) and 14 *manvantaras* = 1 *ka-aha* (Day of Brahmā), and the latter half of the same verse uses the word *kalpa* in place of *ka-aha*.

These relationships can be put into one table as follows.

	mā	*pi*	*di*	*yu*	*ma*	*ka*
mānuṣa-ravi-varṣa	1					
pitrya-varṣa	**30**	1				
divya-varṣa	360	**12**	1			
yuga	4320000	144000	**12000**	1		
manvantara	311040000	10368000	864000	**72**	1	
kalpa/brāhmadivasa	4354560000	145152000	12096000	**1008**	**14**	1

3.9

Verse 3.9 divides the *yuga* into 4 equal parts of 1080000 years each (Fig. 2). The nomenclature is obviously influenced by the Jaina theory of cyclic time scale. See the *Jambūdvīpaprajñaptisūtra* below, p. 14.

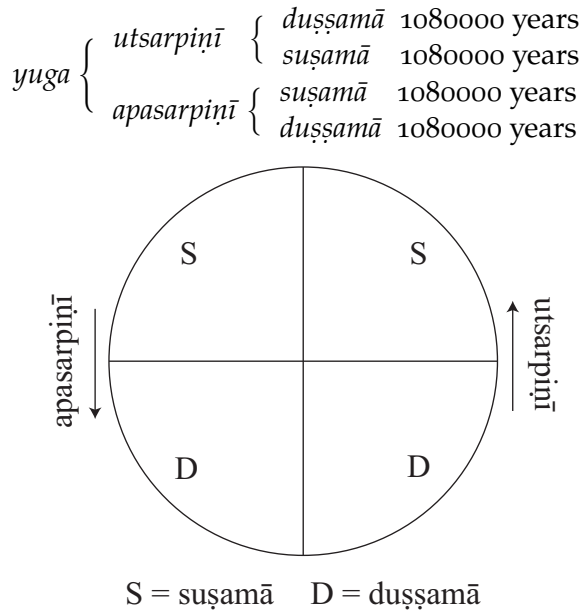

Figure 2: The *yuga* system in the *Āryabhaṭīya*.

4.16–17

Verses 4.16–17 refer to the day-and-night of the gods and of the ancestors based on the notion that the gods live on the North Pole and the ancestors on the far side of the moon.

> [16] The gods living in the north at the Meru mountain (i.e., at the North Pole) see one half of the Bhagola as revolving from left to right (or clockwise); the demons living in the south at the Baḍavāmukha (i.e., the South Pole), on the other hand, see the other half as revolving from right to left (or anti-clockwise). [17] The gods see the sun, after it has risen, for half a solar year; so is done by the demons too. The manes living on (the other side of) the moon see the sun for half a lunar month; the men here see it for half a civil day. (Translation by K. S. Shukla and K. V. Sarma (1976: 1.127); Bhagola = the sphere of constellations.)

7 ĀRYABHAṬĪYABHĀṢYA OF BHĀSKARA I

3.2

In his commentary on *Āryabhaṭīya* 3.2 (Āryabhaṭīya: 2.176), Bhāskara gives the following 'time division' (*kāla-vibhāga*) as an example of 'other kinds of time divisions.'

	nā	*mu*	*yā*	*ah*	*pa*	*mā*	*ṛ*	*ay*	*saṃ*	*yu*
nāḍikā	1									
muhūrta	**2**	1								
yāma			1							
ahorātra	60	[a]30	**4–4**	1						
pakṣa					1					
māsa					**2**	1				
ṛtu					4	**2**	1			
ayana					12	6	**3**	1		
saṃvatsara					24	**12**	**6**	2	1	
yuga					120	60	30	10	**5**	1

[a] This ratio is not mentioned in this context but is employed by Bhāskara in his solution of an example (Āryabhaṭīya: 2.118).

8 KŪRMAMAHĀPURĀṆA

5.6c–8

Verses 5.6c–8 of Pūrva-khaṇḍa give exactly the same table as *Viṣṇupurāṇa* 1.3.8–10b. See below. The next half verse (9ab) refers to the night and the day of gods:

rātri (night) of gods = *dakṣiṇāyana* (southward course of the sun),
dina (day) of gods = *uttarāyaṇa* (northward course of the sun).

9c–13

The next four and a half verses (9c–13) define the *caturyuga* in an unusual manner.

1 *caturyuga* = *kṛta-yuga* + *tretā-yuga* + etc. = 12000 *divya-varṣas* (divine years),
kṛta-yuga = 4000 divine years,
its *saṃdhyā* = *saṃdhyāṃśa* = 400 divine years,
tretā-, *dvāpara-*, *tiṣya-yugas* = 3000, 2000, 1000 divine years,
their respective *saṃdhyā* = *saṃdhyāṃśa* = 300, 200, 100 divine years,
sum of the three *saṃdhyāṃśas* other than that of *kṛta-yuga* = 600 divine years.

Here, *saṃdhyā* and *saṃdhyāṃśa* mean respectively 'joint' and 'part of joint' and are meant to be 'dawn' and 'dusk' of each period. The resulting table is of course

the usual one. See *Brahmavaivartapurāṇa*, p. 29 below.

14–19

The next verses (14–19) define the *manvantara*, *kalpa*, and *parārdha*:

1 *manvantara* = 71 *caturyugas*,
day of Brahmā = 14 *manus* = 1 *kalpa*,
⟨+ *antaras* (intervals)[a]⟩
day of Brahmā = night of Brahmā = 1 *kalpa* = 1000 *caturyugas*,
1 *vatsara* (year) of Brahmā = 360 *kalpas*[b],
1 *parārdha* = 100 *varṣas* of Brahmā[c]
⟨= life span of Brahmā⟩.

[a] This is probably implied by the following passage (16c–17b):

> मन्वन्तरेण चैकेन सर्वाण्येवान्तराणि वै ॥
> व्याख्यातानि न सन्देहः कल्पे कल्पे न चैव हि ।
>
> 'By one *manvantara* all the intervals have been explained. There is no doubt whatsoever ⟨about it⟩ in each *kalpa*.'

The total duration of these intervals is 6 *caturyugas*. See *Brāhmasphuṭasiddhānta* and *Manusmṛti* below. But some texts do not refer to these intervals at all. See *Mārkaṇḍeyapurāṇa* and *Viṣṇupurāṇa*.

[b] This is the reading of the text (18c–19b):

> त्रीणि कल्पशतानि स्युस् तथा षष्टिर्द्विजोत्तमाः ॥
> ब्रह्मणो वत्सरस्तज्ज्ञैः कथितो वै द्विजोत्तमाः ।

But it contradicts the immediately above line, from which we have the relationship, 1 day-and-night of Brahmā = 2 *kalpas*, and therefore, 1 *vatsara* (year) of Brahmā = 720 *kalpas*. See *Viṣṇudharmottarapurāṇa* and *Siddhāntaśiromaṇi*.

[c] This is the reading of Nagar and Jośī's edition. Gupta's edition has *parākhyaṃ* for *parārdhaṃ*, in which case one hundred years of Brahmā are 'called *para*,' not *parārdha*.

9 GAṆITAKAUMUDĪ

1.11c–12a

Verses 1.11c–12a give the following relationships.

	gha	*dyu*	*mā*	*va*
ghaṭikā	1			
dyuniśa	**60**	1		
māsa	1800	**30**	1	
varṣa	21600	360	**12**	1

10 GAṆITATILAKA

11–12b

Verses 11–12b give the following relationships.

	prā	*vi*	*gha*	*a*	*mā*	*saṃ*
prāṇa	1					
vināḍī	**6**	1				
ghaṭikā	360	**60**	1			
ahorātra	21600	3600	**60**	1		
māsa	648000	108000	1800	**30**	1	
saṃvatsara	7776000	1296000	21600	360	**12**	1

12cd

Verse 12cd that follows the above passage says:

> The remaining (time) units beginning with *pravālaka* are to be defined as those which are universally known.

This *pravālaka* seems to be a seasonal time unit like *prahara* and *yāma* though I cannot so far attest it in Indian literature.

11 GAṆITASĀRAKAUMUDĪ

Verse 1.11 gives the following relationships.

	pa	*gha*	*di*	*mā*	*va*
pala	1				
ghaḍiyā	**60**	1			
diṇarayaṇī	3600	**60**	1		
māsa	108000	1800	**30**	1	
varisa	1296000	21600	360	**12**	1

12 GAṆITASĀRASAṂGRAHA

1.32–35

Verses 1.32–35 give the following relationships.

Verses 32–34b

	sa	*ā*	*u*	*sto*	*la*	*gha*	*mu*	*di*
samaya	1							
āvali	[a]Inn	1						
ucchvāsa		[b]Cntd	1					
stoka			**7**	1				
lava			49	**7**	1			
ghaṭī			$1886\frac{1}{2}$	$269\frac{1}{2}$	$38\frac{1}{2}$	1		
muhūrta			3773	539	77	**2**	1	
dina			113190	16170	2310	60	**30**	1

[a] Inn = innumerable (*asaṃkhya*), [b] Cntd = counted (*saṃkhyāta*).

Verses 34c–35

	di	*pa*	*mā*	*ṛ*	*a*	*va*
dina	1					
pakṣa	**15**	1				
māsa	30	**2**	1			
ṛtu	60	4	**2**	1		
ayana	180	12	6	**3**	1	
vatsara	360	24	12	6	**2**	1

The *samaya* is defined as the time in which an atom (*aṇu*) passes over (*vyatikrāmati*) another atom. Cf. the *Anuyogadvārasūtra* above, p. 2.

13 JAMBŪDVĪPAPRAJÑAPTISŪTRA

24–25

Sūtras 24–25 (Vakṣaskāra 2) describe a cyclic time scale based on the two imaginary time units, *paliovama* (Skt. *palya-upama*, 'simile of granary') and *sāgarovama* (Skt. *sāgara-upama*, 'simile of ocean'), which can be defined only by similes.

	Names of periods (abbr.)		Duration	
osappiṇi ↓	*susamasusamā* (SS)	fortune-fortune	4kSu	↑ *ussappiṇi*
	susamā (S)	fortune	3kSu	
	susamadussamā (SD)	fortune-misfortune	2kSu	
	dussamasusamā (DS)	misfortune-fortune	1kSu–42000Y	
	dussamā (D)	misfortune	21000Y	
	dussamadussamā (DD)	misfortune-misfortune	21000Y	

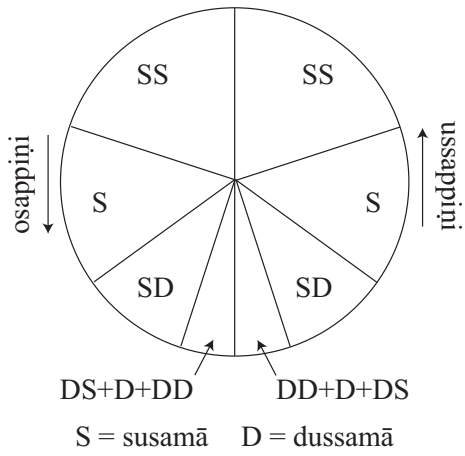

Figure 3: The cyclic time scale in the *Jambūdvīpaprajñaptisūtra*.

The abbreviations used in the last column of the table:

k = *koḍākoḍī* (a numeral) = $(10^7)^2 = 10^{14}$.
Y = year.
Su = *sāgarovama* = 10kPu = 10^{15}Pu, where
Pu = *paliovama*.

Hence follows: 1 *osappiṇi* = 1 *ussappiṇi* = 10kSu = 10^{30}Pu. One *osappiṇi* (*avasarpiṇī*, descending time) and one *ussapiṇi* (*utsarpiṇī*, ascending time) comprise one complete cycle that repeats itself forever. Note that, just like the constituent parts of the purāṇic *caturyuga*, the periods, SS, S , SD, and (DS+D+DD) make the ratios, 4 : 3 : 2 : 1. See Fig. 3.

The latter half of sūtra 24, which includes three verses, gives the relationships of time units from the smallest unit *samaya* to the largest countable unit *sīsapaheliā* (see *Anuyogadvārasūtra* above for a definition of *samaya*):

āvaliā (Skt. *āvalikā*) = integration (*samāgama*) of the assemblage (*samii*) of groups (*samudaya*) of innumerable number (*asaṃkhijja*) of *samayas*,
ūsāsa (Skt. *ucchvāsa*) = numerable number of *āvaliās*,
nīsāsa (Skt. *niḥśvāsa*) = numerable number of *āvaliās*.

The following table is given in the three verses.

	ū/nī	*pā*	*tho*	*la*	*mu*	*a*
ūsāsa/nīsāsa	1					
pāṇu (*prāṇa*)	**2**	1				
thova (*stoka*)	14	**7**	1			
lava	98	49	**7**	1		
muhutta (*muhūrta*)	7546	[a]**3773**	539	**77**	1	
ahoratta (*ahorātra*)	226380	113190	16170	2310	**30**	1

[a] This number is given in the third verse as follows:

> तिण्णि सहस्सा सत्त य सयाइं तेवत्तरिं च ऊसासा।
> एस मुहुत्तो भणिओ सव्वेहिं अणंतनाणीहिं॥
>
> Three thousand seven hundred and seventy-three *ūsāsas*: this is called *muhutta* by all omniscients.

The literal meaning of this verse would be '3773 *ūsāsas* = 1 *muhutta*' but this does not fit in this table. We have to understand that the word *ūsāsa* (expiration) in this verse is an abbreviated form of *ūsāsa-nīsāsa* (expiration and inspiration) or *pāṇu* (a breath).

After this comes a table for the units from *ahorātra* to *yuga*.

	ah	*pa*	*mā*	*u*	*ay*	*saṃ*	*ju*
ahoratta (*ahorātra*)	1						
pakkha (*pakṣa*)	**15**	1					
māsa	30	**2**	1				
uū (*ṛtu*)	60	4	**2**	1			
ayaṇa (*ayana*)	180	12	6	**3**	1		
saṃvacchara (*saṃvatsara*)	360	24	12	6	**2**	1	
juga (*yuga*)	1800	120	60	30	10	**5**	1

After this come the units of longer times: *puvvaṃga* = 8,400,000 *vassas* (Skt. *varṣas*, years), *puvva* = 8,400,000 *puvvaṃgas*. Similarly, *tuḍiaṃga*, *tuḍia*, *aḍaḍaṃga*, *aḍaḍa*, *avavaṃga*, *avava*, *hūhuaṃga*, *hūhua*, *uppalaṃga*, *uppala*, *paümaṃga*, *paüma*, *ṇaliṇaṃga*, *ṇaliṇa*, *atthaṇiuraṃga*, *atthaṇiura*, *ajuaṃga*, *ajua*, *najuaṃga*, *najua*, *pajuaṃga*, *pajua*, *cūliaṃga*, *cūlia*, *sīsapaheliaṃga*, and *sīsapaheliā* (= $8,400,000^{28}$ *vassas* or years).

Exactly the same description, with minor phonetic changes, of the time units beginning with *samaya* and ending with *sīsapaheliā* is repeated in sūtra 367 of the *Anuyogadvārasūtra*. See p. 2 above.

The relationship between the *sīsapaheliā* and the *ussappiṇi-osappiṇi* cycle is not clear to me.

14 JYOTIṢKARAṆḌAKA

7

Verse 7 refers to two kinds of classification of time (*kāla*):

$$kāla \begin{cases} aṇāgaya \text{ (future)} \\ atīta \text{ (past)} \\ vaṭṭamāṇa \text{ (present)} \end{cases} \qquad \begin{cases} saṃkhejja \text{ (numerable)} \\ asaṃkhejja \text{ (innumerable)} \\ aṇaṃta \text{ (infinite)} \end{cases}$$

8ab–10b

Verse 8ab defines the *samaya* as the most highly suppressed (*parama-niruddha*) time that cannot be divided (*avibhajja*). Verses 8c–10b give the following relations.

	sa	*us*/*nis*	*pā*	*tho*	*la*	*nā*
samaya	1					
ussāsa/*nissāsa*	*Inn	1				
pāṇa (*prāṇa*)		**2**	1			
thova (*stoka*)		14	**7**	1		
lava		98	49	**7**	1	
nāliyā (*nālikā*)		3773	$1886\frac{1}{2}$	$269\frac{1}{2}$	$38\frac{1}{2}$	1

*Inn = innumerable (*asaṃkhejja*).

The commentator Malayagiri inserts *āvalikā* between *samaya* and *ussāsa*/*nissāsa* (Skt. *ucchvāsa*/*niḥśvāsa*):

āvalikā = the lowest level of properly innumerable number (*jaghanya-yukta-asaṃkhyāta*) of *samaya*,
ussāsa/*nissāsa* = a numerable number (*saṃkhyeya*) of *āvalikā*.

Cf. *Anuyogadvārasūtra*, *Gaṇitasārasaṃgraha*, and *Jambūdvīpaprajñaptisūtra* above (pp. 2, 13, and 14).

11–15

Verses 11–15 describe a water-clock of the outflowing type called *nāliyā* ('tube') after which the time unit *nāliyā* was named. Verses 16–29 are concerned with weight units, steelyard, volume units, and the quality of water to be used for the water-clock.

30–32

Verses 30–32 define the time units greater than *nāliyā* after stating that the quantity of water necessary for the water-clock to measure one *nāliyā* is 2 *āḍhakas*.

	nā	*mu*	*a*	*pa*	*mā*	*saṃ*	Water for water-clock: volume in *āḍhaka*	Water for water-clock: weight in *pala*
nāliyā	1						**2**	100
muhutta	**2**	1					4	200
ahoratta[a]	**60**	30	1				120	[b]3
pakkha	900	450	**15**	1			1800	45
māsa	1800	900	**30**	**2**	1		3600	90
saṃvacchara	21600	10800	**360**	**24**	**12**	1	43200	1080

[a] Also called *diṇa* and *rāiṃdiya*. [b] In *bhāra* (= 2000 *palas*).

32

Verse 32 gives three qualifiers of this *saṃvacchara* (*saṃvatsara*): *kamma-* (*karma-*, 'working'), *sāvaṇa-* (*sāvana-*, 'civil'), and *uu-* (*ṛtu-*, 'seasonal').

The commentator Malayagiri supplies all the quantities of water (other than '2') both in volume (*meya*) and weight (*tolya*) listed in the last two columns of the above table.

34–36

Verses 34–36 defines four kinds of year (*saṃvacchara*):

1 *āicca-* (*āditya-*, solar)	=	6 *uus* (seasons),
1 *caṃda-* (*cāndra-*, lunar)	=	12 *puṇṇima-pariyaṭṭas* (repetitions of full-moon),
1 *nakkhatta-* (*nākṣatra-*, sidereal)	=	12 *nakkhatta-caṃda-jogas* (the interval beween two consecutive conjunctions of the moon and a lunar mansion),
1 *abhivaḍḍhiya-* (*abhivardhita-*, enlarged)	=	13 *caṃda-māsas* (lunar months).

The last one, the 'enlarged year,' means the year that has an intercalary month.

37–39

Verses 37–39 give the lengths of five kinds of month (*māsa*) in terms of *ahorātras* (day-and-nights or civil days):

$$
\begin{aligned}
1\ \textit{āicca-}\ (\textit{āditya-}, \text{solar}) &= 30\tfrac{1}{2},\\
1\ \textit{sāvaṇa-}\ (\textit{sāvana-}, \text{civil}) &= 30,\\
1\ \textit{caṃda-}\ (\textit{cāndra-}, \text{lunar}) &= 29\tfrac{32}{62},\\
1\ \textit{nakkhatta-}\ (\textit{nākṣatra-}, \text{sidereal}) &= 27\tfrac{21}{67},\\
1\ \textit{abhivaḍḍhiya-}\ (\textit{abhivardhita-}, \text{enlarged}) &= 31\tfrac{121}{124}.
\end{aligned}
$$

The last one, the 'enlarged month,' means an average (or mean) month when the 'enlarged year' is supposed to consist of 12 months, that is,

$$\frac{\left(29\frac{32}{62}\right)\cdot 13}{12} = 31\frac{121}{124}$$

56 and 58–59

Verses 56 and 58–59 gives the basic parameters of the five year *yuga*:

$$
\begin{aligned}
1\ \textit{juga} &= 5\ \textit{āicca-saṃvaccharas}\ (\text{solar years})\\
&= 1860\ \textit{tihis}\ (\textit{tithis}, \text{lunar days}),\\
&= 1830\ \textit{ahorattas}\ (\textit{ahorātras}, \text{day-and-nights}),\\
&= 60\ \textit{āicca-māsas}\ (\text{solar months}),\\
&= 61\ \textit{uu-māsas}\ (\text{seasonal or civil months}),\\
&= 62\ \textit{caṃda-māsas}\ (\text{lunar or synodic months}),\\
&= 67\ \textit{nakkhatta-māsas}\ (\text{sidereal months}),\\
&= 57\ \textit{abhivaḍḍha-māsas}\ (\textit{abhivardhita-māsas}, \text{enlarged months}) + 7\\
&\quad \textit{rāiṃdiyas}\ (\textit{rātridinas}, \text{night-and-days}) + 11\tfrac{23}{62}\ \textit{muhuttas}\ (\textit{muhūrtas}).
\end{aligned}
$$

62–72, 73–90

Verses 62–72 define the longer time units from *puvva* to *sīsapaheliā*, and verses 73–90 the cyclic time scale *ussappiṇi-osappiṇi* based on the two imaginary time units, *paliovama* and *sāgarovama*. Cf. *Jambūdvīpaprajñaptisūtra* above (p. 14).

15 TANTRASAṂGRAHA

1.2

Verse 1.2 defines *sāvana-* and *ārkṣa-dina* (civil- and sidereal-day):

$$
\begin{aligned}
\textit{sāvana-dina} &= \text{one revolution of the sun}\ (\textit{ravi})\\
\textit{ārkṣa-dina} &= \text{one revolution of the sphere of stars}\ (\textit{bha-gola})
\end{aligned}
$$

3–4

The next two verses (3–4) give the following table, which is part of the table of the *Āryabhaṭīya* (see p. 8 above).

	gu	*prā*	*vi*	*nā*	*di*
gurvakṣara	1				
prāṇa	**10**	1			
vināḍikā	60	6	1		
nāḍī	3600	360	**60**	1	
dina (*ārkṣa-*)	216000	**21600**	3600	**60**	1

16 TRIŚATIKĀ

See *Pāṭīgaṇita* below, p. 28.

17 大唐西域記

T2087.51.0875C 17–20

大唐西域記 of 玄奘, in T2087.51.0875c17–19, gives the following relationships.

	Skt.	*kṣa*	*ta*	*la*	*mu*	*pra*	*ah*
刹那	*kṣaṇa*	1					
怛刹那	*tatkṣaṇa*	**120**	1				
臘縛	*lava*	7200	**60**	1			
牟呼栗多	*muhūrta*	216000	1800	**30**	1		
時	*prahara*?	1080000	9000	150	**5**	1	
日夜	*ahorātra*	6480000	54000	900	30	**3–3**	1

In this table, the day and the night are each divided into three seasonal hours (時) but the next line (20) refers also to another method called vulgar (俗) which divides the day and the night each into four seasonal hours (時), where one hour consists of four parts (分).

	分	時	日夜
分	1		
時	**4**	1	
日夜	32	**4–4**	1

21–23

In the next lines (21–23) 玄奘 says that one month (月) consists of two parts: the first part called black (黒分) has 14 or 15 days and the second part called white (白分) 15 days. Months are therefore of two kinds, small (小) and large (大).

T2087.51.0875C23–0876A01

Then, in T2087.51.0875c23–0876a01, he gives the following relationships:

	Skt.	*mā*	*ṛ*	*ay*	*va*
月	*māsa*	1			
時	*ṛtu*	2	1		
行	*ayana*	**6**	3	1	
歲	*varṣa*	12	**6**	**2**	1

In this table he accepts the common division of one year into six seasons (六時): 漸熱, 盛熱, 雨時, 茂時, 漸寒, and 盛寒. In the next lines (01–13), however, he refers also to two other systems of seasons. One of them divides one year into three seasons (三時): 熱時, 雨時, and 寒時; the other into four seasons (四時): 春 (spring), 夏 (summer), 秋 (autumn), and 冬 (winter). For the latter see the *Suvarṇaprabhāsasūtra* below, p. 89.

T2125.54.0219C18–15

義浄 in his 南海寄帰内法伝 (T2125.54.0219c18–15), in addition to these three kinds of seasonal divisions, refers also to the Buddhist monastic calendar that divides one year into five unequal 'seasons' (時), that is, 冬時 (winter season) = 4 months from 16th day of the 9th month to 15th day of the 1st month; 春時 (spring season) = 4 months from 16th day of the 1st month to 15th day of the 5th month; 雨時 (rainy season) = 1 month from 16th day of the 5th month to 15th day of the 6th month; 終時 (closing season) = 16th day of the 6th month (only one day); 長時 (long season) = 3 months (less 1 day) from 17th day of the 6th month to 15th day of the 9th month.

18 DĪGHANIKĀYA

T0001.01.0146A10–11 AND 0147B05–06

The *Dīghanikāya*, in Chinese translation T0001.01.0146a10–11 and 0147b05–06, gives the following relationships.

	Pali/Skt.	*kha*/*kṣa*	*la*	*mu*	*u*	*ra*
念	*khaṇa*/*kṣaṇa*	1				
羅耶	*laya*/*laya*	**60**	1			
摩睺多	*muhutta*/*muhūrta*	1800	**30**	1		
優婆摩	*upamā*/*upamā*	180000	3000	**100**	1	
⟨晝夜⟩	*rattidiva*/*rātridivasa*				?	1

This part of the *Dīghanikāya* is available only in the Chinese translation (apart from modern secondary translations from it), where the part is called 世記経. The Pali/Skt. terms in the above table have been restored from the Chinese transliterations and translations. The word *kṣaṇa* is sometimes rendered as 念. See Hirakawa 1973: 141.

About 20 pages before the above passage in the *Taishō Tripiṭaka* edition (vol. 1, pp. 125c29–126a12), 大劫 (*mahā-kalpa*) and 中劫 (*antaḥ-kalpa*) are defined as follows. Let N be the number of 胡麻 (*tilas*, sesame seeds) contained in a basket whose capacity is 64 斛 (for which see below). Then,

$$\begin{aligned} 100N \text{ years} &< 1 \text{ life span of the creatures of } \mathrm{H}_1, \\ 20 \text{ life spans of the creatures of } \mathrm{H}_i &= 1 \text{ life span of the creatures of } \\ &\quad \mathrm{H}_{i+1} (i = 1, 2, \dots, 9), \\ 20 \text{ life spans of the creatures of } \mathrm{H}_{10} &= 1 \text{ 中劫 } \textit{antaḥ-kalpa}, \\ 20 \text{ 中劫 } \textit{antaḥ-kalpas} &= 1 \text{大劫 } \textit{mahā-kalpa}, \end{aligned}$$

where $\mathrm{H}_i (i = 1, 2, \dots, 10)$ denote the ten hells listed in the following table. I owe Matsumura 2005: 42 for the identifications of the Pali/Sanskrit terms.

	H_1	H_2	H_3	H_4	H_5
世記経	厚雲	無雲	呵呵	奈何	羊鳴
Pali	*abbuda*	*nirabbuda*	*ababa*	*ahaha*	*aṭaṭa*
Skt.	*arbuda*	*nirarbuda*	*hahava*	*huhuva*	*aṭaṭa*
	H_6	H_7	H_8	H_9	H_{10}
世記経	須乾提	優鉢羅	拘物頭	分陀利	鉢頭摩
Pali	*sogandhika*	*uppalaka*	*kumuda*	*puṇḍarī ka*	*paduma*
Skt.	*sugandhika*	*utpala*	*kumuda*	*puṇḍarī ka*	*padma*

Therefore, one *mahā-kalpa* is greater than

$$20^{10} \times 100N = 1,024,000,000,000,000N \text{ years.}$$

The Chinese word 斛 stands for a Chinese volume unit but here it seems to be used, irrespective of its actual quantity, for translating the Skt/Pali term *khāraka*

(usually known as *khāra* or *khārī*) used for volume measure from old times. This is known from two parallel passages in the 起世経 (T0024) and 起世本因経 (T0025). In the 起世経 (T0024.01.0329b12), the volume of the sesame seeds is said to be 20斛 and this 斛 is referred to as that of Kosala (憍薩羅國斛量). Moreover, in the 起世本因経 (T0025.01.0384b09), the same quantity is said to be '20 *khārakas* of Kosala' (譬如憍薩羅國中二十佉囉迦). The reason why the volume of the sesame seeds is 64 斛 in the 世記経 but 20 斛 in these passages is not clear.

19 NATVĀŚIVAM

The *Natvāśivam* is an anonymous Gujarātī commentary on the *paribhāṣā* section (weights and measures) of Śrīdhara's *Triśatikā*. It begins with an invocatory verse, starting '*natvā śivaṃ*...' ('Having bowed down to Śiva, ...'). For the manuscripts (H1, H2, O1, O2) used here see the "Primary Sources" (p. 98 below).

These manuscripts (H1.6a, H2.33b, O1.7a, O2.11b) first add the three units, *unmīlana* (or *nimeṣa*), *prāṇa*, and *vināḍikā* to the table of *Triśatikā* (see *Pāṭīgaṇita*, p. 28 below, where *ghaṭī* = *nāḍī*).

Type A

	u	*prā*	*vi*	*nā*	*a*
unmīlana	1				
prāṇa	**20**	1			
vināḍikā	120	**6**	1		
nāḍī	7200	360	**60**	1	
aharniśa	432000	21600	3600	**60**	1

Then, they rewrite the same table with different names. The name *pāṇīvala* used in place of *vināḍikā* is very rare.

Type B

	ni	*prā*	*pā*	*gha*	*a*
nimeṣa	1				
prāṇa	**20**	1			
pāṇīvala	120	**6**	1		
ghaḍī	7200	360	**60**	1	
ahorātra	432000	21600	3600	**60**	1

Three of the manuscripts (H1.6a, H2.34a, O2.11b) extend the table up to the *varasa* (i.e., *varṣa*) or the year, which is the highest unit in the table of the *Triśatikā*. The units, *parva* (Skt. *parvan*) and *ādityavāra* ('Sunday'), introduced in this table are quite rare.

	a	*par*	*ā*	*pak*	*mā*	*ṛ*	*va*
ahorātra	1						
parva (*parvan*)	6	1					
ādityavāra	$7\frac{1}{2}$	$1\frac{1}{4}$	1				
pakṣa	**15**	$2\frac{1}{2}$	2	1			
māsa	30	5	4	**2**	1		
ṛtu	60	10	8	4	**2**	1	
varasa (*varṣa*)	**360**	**60**	**48**	**24**	**12**	**6**	1

Two of them (H2.34a, O2.11b) also give the number of the smaller units of Type B that comprise one *varasa*.

	nimeṣa	*prāṇa*	*pāṇīvala*	*ghaḍī*	*ahorātra*
varasa	**155520000**	**7776000**	**1296000**	**216000**	**360**

These manuscripts (H1.6a, H2.34a, O1.7b, O2.11b) also give a *caturyuga-manvantara-kalpa* system, which is an amalgamation of the *Manusmṛti*'s *yuga* system and the *Ārybhaṭīya*'s *kalpa* system.

	va	*ka*	*dvā*	*tre*	*kṛ*	*caü*	*ma*	*ka*
varasa	1							
kaliyuga	**432000**	1						
dvāparayuga	**864000**	2	1					
tretāyuga	**1296000**	3	3/2	1				
kṛtayuga	**1728000**	4	2	4/3	1			
caükaḍī	43200000	**10**	5	10/3	5/2	1		
manvantara	311040000	720	360	240	180	**72**	1	
kalpa	4354560000	10080	5040	3360	2525	1008	**14**	1

20 NĀMALIṄGĀNUŚĀSANA

1.3.11–13

Verses 1.3.11–13 define the units from *nimeṣa* to *vatsara* (year).

	ni	*kā*	*ka*	*kṣa*	*mu*	*ah*	*pa*	*mā*	*ṛ*	*ay*	*va*
nimeṣa	1										
kāṣṭhā	**18**	1									
kalā	540	**30**	1								
kṣaṇa	16200	900	**30**	1							
muhūrta	194400	10800	360	**12**	1						
ahorātra	5832000	324000	10800	360	**30**	1					
pakṣa[a]						**15**	1				
māsa[b]						30	**2**	1			
ṛtu						60	4	**2**	1		
ayana[c]						180	12	6	**3**	1	
vatsara						360	24	12	6	**2**	1

[a] They are called *pūrva-aparau* (the former and the latter) or *śukla-kṛṣṇau* (white and black).

[b] They begin with Māgha.

[c] The sun takes the northward and the southward course in each *ayana*.

The first half of this table is quoted in Gaṇeśa's commentary on Līlāvatī: v. 1, p. 11 (up to verse 12a) and in MS Benares BHU B4394 Supplement §3 (up to verse 12b) (see p. 45 below).

14–20

Verse 14ab defines the *viṣuvat* and *viṣuva* as the day when the daytime and the night-time have the same length (*samarātriṃdive kāle*). Verses 14c–19 enumerate the names of the months (*māsas*) and of the seasons (*ṛtus*). Verse 20ab states that the six *ṛtus* begin with Mārgaśīrṣa. Verse 20cd gives synonyms of *vatsara*: *saṃvatsara*, *abda*, *hāyana*, *śarat*, and *samā*.

21–22b

Verses 21–22b contain elements of the *yuga-manvantara-kalpa* system similar to that of the *Manusmṛti*.

1 *māsa* = 1 *paitra-ahorātra* (ancestral day-and-night),
1 *varṣa* = 1 *daivata-ahorātra* (divine day-and-night),
1 *manvantara* = 71 *divya-yugas* (divine *yugas*),
2 *nṛ-kalpas* (human *kalpas*) = 2000 *daiva-yugas* (divine *yugas*).

The commentator Kṣīrasvāmin on verse 21 gives the relationships,

1 *divya-varṣa* (divine year) = 360 *divya-ahorātras* (divine day-and-nights),
1 *divya-yuga* (divine *yuga*) = 12000 *divya-varṣas* (divine years)
= 1 *laukika-caturyuga* (worldly 'four *yugas*'),
1 day of Brahmā = 1 night of Brahmā
= 1000 *daiva-yugas*,

and then cites three verses from *Manusmṛti* 1.69–71 (p. 48 below).

21 NĀRADĪYAMAHĀPURĀṆA

5.21–24C

Verses 5.21–24c of the Pūrva-khaṇḍa give the following relationships.

	ni	*kā*	*ka*	*kṣa*	*gha*	*mu*	*di*	*pa*	*mā*	*ṛ*	*ay*	*ab*
nimeṣa	1											
kāṣṭhā	**15**	1										
kalā	450	**30**	1									
kṣaṇa	13500	900	**30**	1								
ghaṭikā	81000	5400	180	**6**	1							
muhūrta	162000	10800	360	12	**2**	1						
dina	4860000	324000	10800	360	60	**30**	1					
pakṣa							**15**	1				
māsa							**30**	**2**	1			
ṛtu							60	4	**2**	1		
ayana							180	12	6	**3**	1	
abda							360	24	12	6	**2**	1

5.24D–31

Verses 5.24d–31 give the following relationships.

1 *divya-dina* (divine day-and-night) = 1 *abda*,
1 *paitra-dina* (ancestral day-and-night) = 1 *māsa*,
1 *daivata-yuga* (divine *yuga*) = 12000 *divya-varṣas* (divine year),
1 *manvantara* = 71 *divya-yugas* (divine *yugas*),
2 *nṛ-kalpas* (human *kalpas*) = 2000 *daiva-yugas* (divine *yugas*),
1 day of Brahmā = ⟨1 night of Brahmā⟩ = 1000 *caturyugas*,
1 *māsa* (month) of Brahmā = 30 day-and-nights of Brahmā,
1 *vatsara* (year) of Brahmā = 12 *māsas* of Brahmā,
1 day of Viṣṇu = 1 night of Viṣṇu = 2 × *parārdha* (half of *para*).

The *parārdha* in the last line is not defined here but is said to be 100 years of Brahmā in the *Kūrmamahāpurāṇa* (see p. 11 above) and therefore equals 72000 *kalpas*; in mathematics it is usually used as a numeral for 10^{17}.

22 PAÑCASIDDHĀNTIKĀ

The *Pañcasiddhāntikā* does not explicitly give a table of time units but does employ the following time units (Pañcasiddhāntikā: pt. 2, p. 129).

	vi	*nā*	*mu*	*a*
vināḍī	1			
nāḍī	**60**	1		
muhūrta	120	**2**	1	
ahorātra/dyuniś	3600	60	**30**	1

The *Pañcasiddhāntikā* also refers to two kinds of *yuga* with regard to the sun and the moon: verse 1.15 ascribes the *yuga* of 2850 years (*varṣas*) to the *Romakasiddhānta*, while verse 12.1 mentions the *yuga* of 5 years. For other kinds of *yuga* reconstructable, see Pañcasiddhāntikā: pt. 2, p. 151.

13.27abc, 38bcd

Verse 13.27abc says that 'for those who dwell on the top of the North Pole (i.e., for the gods) the sun, having risen once, is visible for six months beginning with Meṣa.' Verse 13.38bcd says that 'those who dwell on the moon (i.e., the ancestors) see the sun for half a *pakṣa* on either side of the disappearance of the moon; otherwise there is no light.' (trans. by Pingree).

23 PADĀRTHADHARMASAṂGRAHA

Praśastapāda in his Padārthadharmasaṅgraha (commonly called *Praśastapādabhāṣya*, see edition p. 63) enumerates the following time units without conversion ratios:

kṣaṇa,	*muhūrta*,	*ṛtu*,	*manvantara*,
lava,	*yāma*,	*ayana*,	*pralaya*,
nimeṣa,	*ahorātra*,	*saṃvatsara*,	*mahā-pralaya*.
kāṣṭhā,	*ardhamāsa*,	*yuga*,	
kalā,	*māsa*,	*kalpa*,	

Śrīdhara in his *Nyāyakandalī* on this passage gives conversion ratios for the

first three units (Padārthadharmasaṅgraha: 65):

	kṣa	*la*	*ni*
kṣaṇa	1		
lava	**2**	1	
nimeṣa	**4**	2	1

Śrīdhara defines the *nimeṣa* as the motion of eyelash.

अक्षिपक्ष्मकर्मोपलक्षितकालो निमेषः।

24 PARĀŚARA

Parāśara's passage on time units is cited by Bhaṭṭotpala in his commentary on the Bṛhatsaṃhitā: 23.

	ni	*tru*	*la*	*kṣa*	*kā*	*ka*	*nā*	*mu*	*di*
nimeṣa[a]	1								
truṭi	**2**	1							
lava	4	**2**	1						
kṣaṇa	8	4	**2**	1					
kāṣṭhā	80	40	20	**10**	1				
kalā	800	400	200	100	**10**	1			
nāḍikā	8000	4000	2000	1000	100	**10**	1		
muhūrta	16000	8000	4000	2000	200	20	**2**	1	
dina	480000	240000	120000	60000	6000	600	60	**30**	1

[a] The *nimeṣa* is defined as 'the time during which an altered letter (or syllable) is uttered' (*yāvatā kālena vikṛtam akṣaram uccāryate sa nimeṣaḥ*). Cf. *Lokaprakāśa*, p. 58 below.

25 PĀṬĪGAṆITA

Pāṭīgaṇita 13 (= *Triśatikā*, paribhāṣā 8) prescribes the following relationships.

	gha	*a*	*mā*	*va*
ghaṭī	1			
ahorātra	**60**	1		
māsa	1800	**30**	1	
varṣa	21600	360	**12**	1

The anonymous commentator on the Pāṭīgaṇita refers to the units *caṣaka* and *yuga*: he points out that,

no worldly procedures (*loka-vyavahāra*, i.e., commercial transactions, etc.) are made with subtle measures (*sūkṣma-māna*) beginning with *caṣaka* and gross measures (*sthūla-māna*) beginning with *yuga*. (Pāṭīgaṇita: 6)

26 BAKHSHĀLĪ MANUSCRIPT

The following table is based on Table 12.1 of Hayashi's edition of The Bakhshālī Manuscript.

	vi	*li*	*ca*	*gha*	*mu*	*di*	*mā*	*va*
viliptā	1							
liptā	**60**	1						
caṣaka	3600	**60**	1					
ghaṭikā	216000	3600	**60**	1				
muhūrta	432000	7200	120	**2**	1			
dina	12960000	216000	3600	60	[a]⟨**30**⟩	1		
māsa	388800000	6480000	108000	1800	900	**30**	1	
varṣa	4665600000	77760000	1296000	21600	10800	360	**12**	1

[a] This ratio has been restored from the fragments of the solution to a problem on X 18.

27 BRAHMAVAIVARTAPURĀṆA

The *Brahmavaivartapurāṇa* mentions time units at three different occasions.

PRAKṚTI-KHAṆḌA 7.70–75

First, in Chapter 7 of Prakṛti-khaṇḍa, verses 70–71a refer to: 7 *vāras* (weekdays), 16 *tithis* (lunar days, not 15!), 12 *māsas* (months), 6 *ṛtus* (seasons), 2 *pakṣas* (fortnights), and 2 *ayanas* (half years). Verse 71bcd defines: 4 *praharas* each for day and night, and 30 *dinas* (days) = 1 *māsa* (month). Verse 72a refers to 5 kinds of *varṣa* (year) and 72cd to the cyclic nature of the 'four-fold *yuga*' (*yuga-catuṣṭaya*). Verses 73–75 give the following relationships.

1 human year = 1 divine day-and-night,
[hence, 360 human years = 1 divine year,]
360 human *yugas* = 1 divine *yuga*,
1 *manvantara* = 71 divine *yugas* = 1 life span of Indra,
1 day-and-night of Brahmā = 28 Indras (i.e., *manvantaras*),
108 years (*varṣas*) ⟨of Brahmā⟩ = 1 life span of Brahmā.

PRAKṚTI-KHAṆḌA 54.27–30B

Second, in Chapter 54 of the same khaṇḍa, verses 29–30b give the following relationships.

	da	*mu*	*yā*	*vā*	*pa*	*mā*	*va*
daṇḍa[a]	1						
muhūrta	**2**	1					
yāma[b]		**4**	1				
vāsara	60	30	**8**	1			
pakṣa				**15**	1		
māsa				30	**2**	1	
varṣa				360	24	**12**	1

[a] Use of the word *daṇḍa* (stick) for a time unit is very rare. Here it denotes half the *muhūrta*, which is usually named *nāḍikā* or *ghaṭikā*. The preceding verses (27c–28) describe the bowl (*pātra*) used for measuring one *daṇḍa* as follows:

> पात्रं षड्पलसंभूतं गभीरं चतुरङ्गुलम् ॥ २७ ॥
> स्वर्णमाषकृतच्छिद्रं दण्डैश्च चतुरङ्गुलैः ।
> यावज्जलप्लुतं पात्रं तत्कालं दण्डमेव च ॥ २८ ॥
>
> 'A bowl is made from six *palas* ⟨of a certain kind of metal (probably copper; see *Bhāgavatapurāṇa* below)⟩. ⟨Its⟩ depth is four *aṅgulas*. It has a hole ⟨at its bottom⟩ made by means of one *māṣa* of gold ⟨in the form of⟩ stick of four *aṅgulas* (that is to say, the size of the hole is tested by using a stick of four *aṅgulas* made of one *māṣa* of gold). The time for which the bowl is filled with water is the *daṇḍa*.'

See S. R. Sarma 2008: 145–75 for the sinking-bowl type of water clock described in astronomical works.

[b] The ratio of *yāma* to *muhūrta* is given here as 4 : 1, but the former must have been a seasonal (variable) time unit like *prahara* defined in verse 7.71bc. See above.

PRAKṚTI-KHAṆḌA 54.30C–32B

Verses 30c–32b of the same chapter define the ancestral and divine day-and-night.

1 human month = 1 ancestral day-and-night, where the day is *kṛṣṇa-pakṣa* and the night is *śukla-pakṣa*
1 human year = 1 divine day-and-night, where the day is *uttarāyaṇa* and the night is *dakṣiṇāyana*.

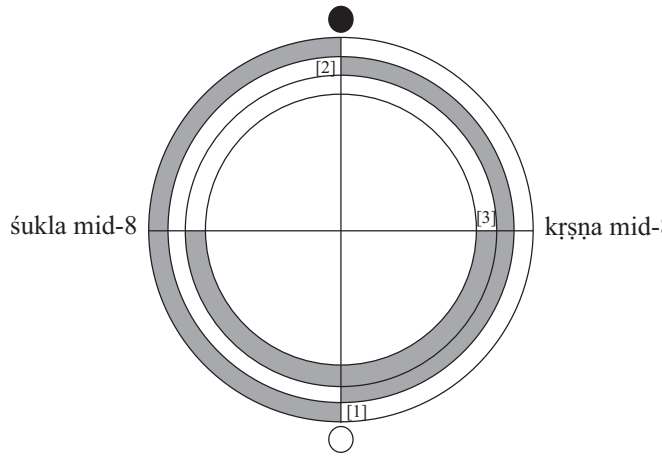

Figure 4: The night and the day for the ancestors.

In the works surveyed, we find three kinds of definition of the ancestral and divine day-and-night.

For the ancestors (*see Figure 4*),

[1] Day = *kṛṣṇa-pakṣa*, i.e., full moon to new moon, and night = *śukla-pakṣa*, i.e., new moon to full moon: *Manusmṛti* 1.66 ≈ *Vāyupurāṇa* 57.9 = *Brahmāṇḍapurāṇa* 1.29.8c–9b = *Mahābhārata* 12.224.15 = *Matsyapurāṇa* 142.6; *Brahmavaivartapurāṇa*, Prakṛti-khaṇḍa 54.30c–31b; Kṣīrasvāmin on *Nāmaliṅgānuśāsana* 1.3.21.

[2] Day = *śukla-pakṣa*, i.e., new moon to full moon, and night = *kṛṣṇa-pakṣa*, i.e., full moon to new moon: *Brahmavaivartapurāṇa*, Kṛṣṇajanma-khaṇḍa 96.83.

[3] Day = mid 8th day of *kṛṣṇa-pakṣa* to mid 8th day of *śukla-pakṣa*, and night = mid 8th day of *śukla-pakṣa* to mid 8th day of *kṛṣṇa-pakṣa*: *Viṣṇudharmottarapurāṇa* 1.73.14–16b and 2.168 (fol. 295ab); *Ārybhaṭīya* 4.17cd (implicit) and Sūryadeva on it (explicit); *Pañcasiddhāntikā* 13.38bcd; *Brāhmasphuṭasiddhānta* 21.8cd (implicit) and Pṛthūdaka on it (explicit).

Note that the *Brahmavaivartapurāṇa* has the two mutually contradicting definitions, [1] and [2].

For the gods (*see Figure 5*),

[1] Day = *uttarāyaṇa* or the sun's northward course, i.e., 0 point of Makara to 0 point of Karkaṭa, and night = *dakṣiṇāyana* or the sun's southward course, i.e., 0 point of Karkaṭa to 0 point of Makara: *Manusmṛti* 1.67 ≈

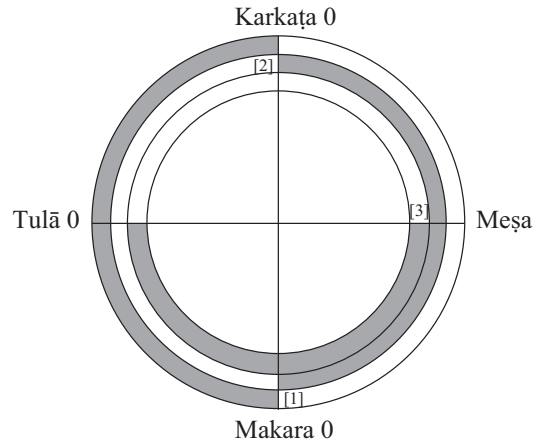

Figure 5: The night and the day for the gods.

Vāyupurāṇa 57.13 = *Brahmāṇḍapurāṇa* 1.29.13c–14b = *Mahābhārata* 12.224.16 ≈ *Matsyapurāṇa* 142.10; *Viṣṇusmṛti* 20.1–3; *Brahmavaivartapurāṇa*, Prakṛti-khaṇḍa 54.31c–32b and Kṛṣṇajanma-khaṇḍa 96.84; *Viṣṇupurāṇa* 1.3.10cd; *Nāradīyamahāpurāṇa* 5.25ab; Kṣīrasvāmin on *Nāmaliṅgānuśāsana* 1.3.21.

[2] Day = *dakṣiṇāyana* or the sun's southward course, i.e., 0 point of Karkaṭa to 0 point of Makara, and night = *uttarāyaṇa* or the sun's northward course, i.e., 0 point of Makara to 0 point of Karkaṭa: *Kūrmamahāpurāṇa* 5.6c–8.

[3] Day = the sun's northern course, i.e., 0 point of Meṣa to 0 point of Tulā, and night = the sun's southern course, i.e., 0 point of Tulā to 0 point of Meṣa: *Viṣṇudharmottarapurāṇa* 1.73.12c–13 and 2.168 (fol. 295ab); *Ārybhaṭīya* 4.16ab + 17ab (implicit) and Sūryadeva on it (explicit); *Pañcasiddhāntikā* 13.27abc; *Brāhmasphuṭasiddhānta* 21.7ab + 8ab.

The third definition [3] in both cases seems to have been invented after the Indian astronomers adapted the Purāṇic cosmography with the flat Earth (*bhūmi*) and the world axis Meru where the gods live to a spherical astronomy which retains Meru at the North Pole of the round Earth (*bhū-gola*).

PRAKṚTI-KHAṆḌA 54.32C–40

Verses 32c–40 of the same chapter define the *caturyuga*.

1 *caturyuga* = 12000 divine years,
1 *kṛta-yuga* = 4000 divine years,
1 *tretā-yuga* = 3000 divine years,

1 *dvāpara-yuga* = 2000 divine years,
1 *kali-yuga* = 1000 divine years,
saṃdhyās (S) and *saṃdhyāṃśas* (SA) = 2000 divine years in total,
1 *caturyuga* = 4320000 human years,
1 *kṛta-yuga* (including S and SA) = 1728000 human years,
1 *tretā-yuga* (including S and SA) = 1296000 human years,
1 *dvāpara-yuga* (including S and SA) = 864000 human years,
1 *kali-yuga* (including S and SA) = 432000 human years.

These relationships may be put into one table.

1 *caturyuga*

	divine years		human years		ratio
saṃdhyā	400		144000		
kṛta-yuga	4000	4800	1440000	1728000	4
saṃdhyāṃśa	400		144000		
saṃdhyā	300		108000		
tretā-yuga	3000	3600	1080000	1296000	3
saṃdhyāṃśa	300		108000		
saṃdhyā	200		72000		
dvāpara-yuga	2000	2400	720000	864000	2
saṃdhyāṃśa	200		72000		
saṃdhyā	100		36000		
kali-yuga	1000	1200	360000	432000	1
saṃdhyāṃśa	100		36000		
Total		12000		4320000	

KṚṢṆAJANMA-KHAṆḌA 96.48–56, 58C, AND 62C

Third, in Chapter 96 of Kṛṣṇajanma-khaṇḍa, verse 48 states that the time (*kāla*) originates from *parama-aṇu* or the ultimate particle and verses 49–56, 58c, and 62c give the following relationships.

Verses 49–51

	pa	*a*	*tra*	*tru*	*ve*	*lav*	*ni*	*kṣa*	*kā*	*lagh*
paramāṇu	1									
aṇu	**2**	1								
trasareṇu	6	**3**	1							
truṭi	18	9	**3**	1						
vedha	1800	900	300	**100**	1					
lava	5400	2700	900	300	**3**	1				
nimeṣa	16200	8100	2700	900	9	**3**	1			
kṣaṇa				2700	27	9	**3**	1		
kāṣṭhā				13500	135	45	15	**5**	1	
laghu				135000	1350	450	150	50	[a]**10**	1

[a] 15 in the *Bhāgavatapurāṇa*. See p. 41 below.

Verses 52–56, 58c, and 62c

	lagh	*da*	*mu*	*pra*	*ti*	*pa*	*mā*	*ṛ*	*ay*	*ab*
laghu	1									
daṇḍa[a]	**15**	1								
muhūrta	30	**2**	1							
prahara				1						
tithi		**60**	30	**4–4**	1					
pakṣa					**15**	1				
māsa					30	**2**	1			
ṛtu					60	4	**2**	1		
ayana					180	12	6	3	1	
abda					360	24	**12**	**6**	**2**	1

[a] Verses 52–53b give two kinds of definition of the *daṇḍa* as follows.

> लघुपञ्चदशं दण्डस्तत्प्रमाणं निशामय।
> द्वादशार्धपलोन्मानं चतुर्भिश्चतुरङ्गुलैः ॥ ५२ ॥
> स्वर्णमाषैः कृतच्छिद्रं यावत्प्रस्थजलप्लुतम्।
>
> Fifteen *laghus* constitute one *daṇḍa*. Listen to ⟨my words on⟩ its quantity (i.e., duration). ⟨The bowl for water measuring one *daṇḍa*⟩ weighs half of twelve *palas* and has a hole ⟨at its bottom⟩ made by means of four *māṣas* of gold of four *aṅgulas*. The time during which ⟨the bowl is⟩ filled with one *prastha* of water ⟨is the *daṇḍa*⟩.

The description of the bowl in verses 52c–53b resembles the one given in verses 54.27c–28 of Prakṛti-khaṇḍa cited above. Exactly the same verse (*dvādaśārdha*…) occurs in *Bhāgavatapurāṇa* 3.11.9, where the bowl is used for measuring the *nāḍikā*.

The above table beginning with *paramāṇu*, except *daṇḍa* and *tithi*, is the same

as the table of *Bhāgavatapurāṇa* 3.11.4–12. See below under that work for *paramāṇu*, *aṇu*, *trasareṇu*, and *prahara*.

KṚṢṆAJANMA-KHAṆḌA 57–82

Verses 57–58b of the same chapter list the five kinds of *varṣa*, i.e., *saṃvatsara*, *pravatsara*, *ilāvatsara*, *anuvatsara*, and *vatsara*. Verses 58d–63 give the names of 12 *māsas*, 6 *ṛtus* and 2 *ayanas* together with their relationships. Verse 64 refers to the annual cycle of the increase and decrease of the day and the night. Verses 65–66a define the *śukla-* and *kṛṣṇa-pakṣas*. Verses 66b–68b count 15 *tithis*: *pratipadā*, *dvitīyā*, ..., *caturdaśī*, and *kuhū* (i.e., *amāvasyā*). Verses 68c–73b enumerate the names of the 28 *nakṣatras*; verse 73cd mentions that the *śruti* counts only 27 of those; and verses 74–76 explain the reason why Abhijit was introduced as a 28th. Verses 78–81a enumerate the names of 25 *yogas* and verses 81b–82 the names of 11 *karaṇas*.

KṚṢṆAJANMA-KHAṆḌA 83–86B

Verses 83–86b of the same chapter give the following relationships.

1 human *māsa* = 1 ancestral day-and-night, where the day is *śukla-pakṣa* and the night is *kṛṣṇa-pakṣa*, [this contradicts verses 54.30c–40 of Prakṛti-khaṇḍa cited above];

1 human *vatsara* = 1 divine day-and-night, where the day is *uttarāyaṇa* and the night is *dakṣiṇāyana*;

1 *manvantara* = 71 *divya-yugas*,

1 life span of Manu = 25560[a] ⟨human *yugas*⟩ = 1 life span of Indra.

[a] I emended the text (86b), **तथा पञ्चशतं परम्** to **षष्टिः पञ्चशतं परम्**. Without the emendation, the text means 25500, which nothing seems to support. The number, 25560, is obtained from 71 × 360 by using the relationship, 1 divine *yuga* = 360 human *yugas*, which is stated in verse 7.73 of Prakṛti-khaṇḍa. See p. 29 above.

KṚṢṆAJANMA-KHAṆḌA 86C–88

Verses 86c–88 of the same chapter say that, since no motion of the sun exists in the Brahma-loka, the residents know the day and the night through the fall of Indra (*śakra-pāta*), and give the following relationships.

Just as 1 human *pala* = 2 *daṇḍas*, so

1 Brahmā's *pala* = 1 fall of Indra,

1 Brahmā's *māsa* = 30 Brahmā's *dinas*,

1 Brahmā's *abda* = 12 Brahmā's *māsas*,
1 life span of Brahmā = 100 Brahmā's *abdas*.

KṚṢṆAJANMA-KHAṆḌA 89–93

Verses 89–93 of the same chapter say that, since there is no motion of the sun, moon, planets and zodiac in the Viṣṇu-loka, the residents know the time from

1 Viṣṇu's *pala* = 1 *nimeṣa* (twinkling) of Viṣṇu;

and that the day comes when the world is lit by Viṣṇu's brightness (*tejas*) and the night comes when he goes back to his palace.

KṚṢṆAJANMA-KHAṆḌA 94–96B

Verses 94–96b say that, for the residents of the seven nether worlds (*pātālas*), the day is known from the shining jewel on the hood of the serpents, the evening by lighted fire, and the night by the overwhelming darkness. They know the time by means of a copper pot (*tāmrī*) used as a water clock.

KṚṢṆAJANMA-KHAṆḌA 96C–106

Finally, for the seven nether worlds, verses 96c–106 repeat the same *caturyuga* system as above in a slightly modified fashion.

	yugas	dvn yrs	hmn yrs
1 *caturyuga*	*kṛta-yuga*	4000 + 800	1728000
	tretā-yuga	3000 + 600	1296000
	dvāpara-yuga	2000 + 400	864000
	kali-yuga	1000 + 200	432000
	Total	12000	[a]4320000

[a] I emended the text (106a), लक्षैर्द्विचत्वारिंशद्भिः to लक्षैस्त्रिचत्वारिंशद्भिः.

28 BRAHMASIDDHĀNTA

1.12c–15a

For the time shorter than one day (i.e., a day and night) *Brahmasiddhānta* 1.12c–14b give two alternative (*yadvā*) tables.

System 1 (verses 12c–13b)

	ni	*kā*	*ka*	*kṣa*	*nā*
nimeṣa	1				
kāṣṭhā	**18**	1			
kalā	540	**30**	1		
kṣaṇa	16200	900	**30**	1	
nāḍī	97200	5400	180	**6**	1

System 2 (verses 13c–14b)

	gu	*prā*	*vi*	*gha*
gurvakṣara	1			
prāṇa	**10**	1		
vināḍī	60	**6**	1	
ghaṭikā	3600	360	**60**	1

Verse 14c mentions *śvāsa* as a synonym of *prāṇa*. Verse 15a gives the relation, 60 *nāḍīs* = 1 *ahorātra*. The common usage suggests that *ghaṭikā* and *nāḍī* are synonymous with each other and this is confirmed by the relation, 60 *vināḍīs* = 1 *ghaṭikā*, in System 2. But, Systems 1 and 2 of the *Siddhāntaśiromaṇi* and of the *Siddhāntaśekhara* (see below) suggest that here the *ahorātra* of System 1 is a civil day and that of System 2 is a sidereal day.

15b–44

The units higher than *ahorātra*, that is, *māsa*, *ṛtu* (= 2 *māsas*), etc. up to *kalpa*, with the same conversion ratios as defined in the *Sūryasiddhānta* (see below) are also given in verses 15b–44.

29 BRAHMĀṆḌAPURĀṆA

The *Brahmāṇḍapurāṇa* (BAP) has a number of passages in common with the *Vāyupurāṇa* (VP). The verses are exactly the same in many places (sometimes with minor variants). I only give here their concordance. For the details of the topics see the *Vāyupurāṇa* below, p. 61.

BAP	VP	Topics
1.13.113c–14b	31.26	Five kinds of time divisors, *ahan* to *ayana*.
114c–16b	27–28	Five-year *yuga*.
147cd	49ab	Five-year *yuga*.
1.21.116 (=29.6)	50.169 (=57.7)	Time units from *nimeṣa* to *rātryahaṇī*.
117–18b	170	Increase and decrease of day and night.
118c–22	171–75b	Five divisions of the day time, *prātar* etc.
123–24	176–77	Increase and decrease of day and night.
125–26b	178	Time units from *ahan* to *saura-varṣa*.
126c–30b	179–82	On the *varāṃśa* (?, *carāṃśa* in VP).
130c–32	183–84	Five-year *yuga*.
133–36[a]	185–88	Parameters of the five-year *yuga*.
137	189	Four kinds of time measurement, solar, etc.
1.29.5cd	57.6cd	Def. of *nimeṣa*.
6 (=21.116)	7 (=50.169)	Time units from *nimeṣa* to *rātryahaṇī*.
7–8b[b]	8	Sun's causality of the day and the night.
8c–12b[c]	9–11	Time for ancestors.
12c–16	12–16	Time for gods.
17–18	17–18	Saptarṣi year and Dhruva year.[d]
19–21[e]	19–20	Relation between human and divine years.
22	21	Narration: 'This was told by the sages (*ṣis*).'
23–29[f]	22–28	Def. of the *yuga* system in divine years.
30–31c,[g] 34d–36[h]	29–32	Def. of the *yuga* system in human years.
37–39	33–35	Def. of *manvantara*.

[a] BAP 1.21.133a reads *triṃśacchataṃ* instead of *viṃśaṃ śataṃ* of VP 50.185a. If we accept this ratio, 130 *parvans* = 1 *yuga*, the table would be as follows. Compare the third table of the *Vāyupurāṇa* below, p. 61.

	ah	*pa*	*s-mā*	*s-ṛ*	*s-ay*	*va*	*yu*
ahorātra	1						
parvan	$14\frac{1}{13}$	1					
saura-māsa	**30**$\langle\frac{1}{2}\rangle$	$2\frac{1}{6}$	1				
saura-ṛtu	**61**	$4\frac{1}{3}$	2	1			
saura-ayana	**183**	13	6	3	1		
varṣa	366	26	12	6	2	1	
yuga	**1830**	**130**	**60**	**30**	**10**	5	1

[b] BAP 1.29.7d reads **मानुषलौकिकौ** instead of **मानुषदैविके** of VP 57.8b. Obviously the former is incorrect.

[c] BAP 1.29.12 reads **दश चैवाधिका** instead of **चत्वारश्चाधिका** of VP 57.11c. The reading of BAP equates 100 human years with 3 ancestral years plus 10 ancestral months, but this equation is wrong.

[d] VP 50.18d reads **क्रौञ्च** instead of **ध्रुव** of BAP 1.29.18d.

[e] BAP 1.29.19a reads **षड्विंशति** instead of **षड्विंशत्तु** of VP 57.19a. The reading of BAP, 26000 human years, is wrong.

[f] BAP 1.29.26c reads **एकन्यायेन** instead of **एकापायेन** of VP 57.24c.

[g] BAP 1.29.31d–34c do not occur in VP. These verses give the lengths of the *tretā-*, *dvāpara-*, and *kali-yugas* in human years: 1080000, 720000, and 360000.

[h] BAP 1.29.35cd reads **नियुतान्येव षड्विंशान्निरसानि युगानि वै** instead of **नियुतान्येकषड्विंशन्निरंशानि तु तानि वै** of VP 57.32ab. Both are incorrect. This line should be: **नियुतान्येव षड्विंशन्निरंशानि तु तानि वै**. See under *Vāyupurāṇa*, p. 61.

30 BRĀHMASPHUṬASIDDHĀNTA

1.5–6

Verses 1.5–6a give the following relationships.

	prā	*vi*	*gha*	*di*	*mā*	*va*
prāṇa	1					
vināḍikā (*ārkṣī*)	**6**	1				
ghaṭikā	360	**60**	1			
divasa	21600	3600	**60**	1		
māsa	648000	108000	1800	**30**	1	
varṣa	7776000	1296000	21600	360	**12**	1

According to verse 1.6bcd, these time divisions except *prāṇa* correspond to the divisions of the spherical linear space (i.e., arc) as follows.

Time	day	Space (arc)	degree
vināḍikā	0;0,1	*vikalā*	0;0,1
ghaṭikā	0;1	*liptā*	0;1
divasa	1	*aṃśa*	1
māsa	30	*rāśi*	30
varṣa	360	*bha-gaṇa*	360

1.7–8

Verses 1.7–8 define the *caturyuga* ('the four *yugas*'):

$$\begin{aligned} 1\ \textit{caturyuga} &= 4320000\ \textit{ravi-varṣas}\ (\text{solar years}) \\ &= \textit{kaliyuga} + \textit{dvāparayuga} + \textit{tretāyuga} + \textit{kṛtayuga}, \end{aligned}$$

where

$$\begin{aligned} 1\ \textit{kaliyuga} &= \tfrac{1}{10}\ \text{of}\ \textit{caturyuga}, \\ 1\ \textit{dvāparayuga} &= \tfrac{2}{10}\ \text{of}\ \textit{caturyuga}, \\ 1\ \textit{tretāyuga} &= \tfrac{3}{10}\ \text{of}\ \textit{caturyuga}, \\ 1\ \textit{kṛtauyga} &= \tfrac{4}{10}\ \text{of}\ \textit{caturyuga}. \end{aligned}$$

1.10

Verse 1.10 defines the *kalpa*:

$$\begin{aligned} 1\ \textit{manu} &= 71\ \textit{caturyugas}, \\ 1\ \textit{kalpa} &= 14\ \textit{manus} + 15\ \textit{saṃdhis}. \end{aligned}$$

The *saṃdhi* ('joint') connects two consecutive *manus* and is placed also at the beginning and the end of the *kalpa*; its length is equal to the *kṛtayuga*. Therefore,

$$1\ \textit{kalpa} = 1000\ \textit{caturyugas}.$$

This *caturyuga-manu-kalpa* system is exactly the same as that of the *Sūrya-siddhānta* (see p. 91 below).

1.11

Verse 1.11 refers to the people 'who do not want *saṃdhi* for the interstices; their *kalpa* consists of 994 *caturyugas*.' Presumably Brahmagupta is here referring to

some *purāṇas*. The *Matsyapurāṇa*, for example, gives the relationships, '1 *kalpa* = 14 *manvantaras*' and '1 *manvantara* = 71 *caturyugas*', without mentioning the *saṃdhi*. See below. Some other *purāṇas*, however, add the relationship, '1 *kalpa* = 1000 *caturyugas*', without mentioning the *saṃdhi*, in which case the additional term, '+ 15 *saṃdhis*,' in the definition of the *kalpa* may have been understood. See, for example, the *Bhāgavatapurāṇa* and *Mārkaṇḍeyapurāṇa* below (pp. 41, 56).

21.7ab + 8

Verses 21.7ab + 8ab say that the gods, who live on Meru (21.3), 'always see the northern half of the ecliptic beginning with Meṣa going to the right' (7ab) and therefore 'see the sun which has risen once for half a solar year' (8ab). Verse 21.8cd says that the ancestors who live on the moon see the sun for half a lunar month. The *Brāhmasphuṭasiddhānta* itself does not specify the beginning and end of the day and of the night but the commentator Pṛthūdaka defines the day of the ancestors as follows: 'From half of the eighth ⟨tithi⟩ of *kṛṣṇa-pakṣa* to half of the eighth ⟨tithi⟩ of *śukla-pakṣa* the ancestors see ⟨the sun⟩.'

31 BHAṬṬOTPALA

1.19, 7.2 and 7.12

Bhaṭṭotpala on *Bṛhajjātaka* 1.19, 7.2 and 7.12 refers to the following relationships. The use of *caṣaka* instead of *pala* is noteworthy.

	ca	*gha*	*di*	*mā*	*va*
caṣaka	1				
ghaṭikā	**60**	1			
dina	3600	**60**	1		
māsa	108000	1800	**30**	1	
varṣa	1296000	21600	360	**12**	1

32 BHĀGAVATAPURĀṆA

3.11.4–12

Verses 3.11.4–12 give the following relationships.

Verses 4–7

	pa	*a*	*tra*	*tru*	*ve*	*lav*	*ni*	*kṣa*	*kā*	*lagh*
paramāṇu	1									
aṇu	**2**	1								
trasareṇu	6	**3**	1							
truṭi	18	9	**3**	1						
vedha	1800	900	300	**100**	1					
lava	5400	2700	900	300	**3**	1				
nimeṣa	16200	8100	2700	900	9	**3**	1			
kṣaṇa				2700	27	9	**3**	1		
kāṣṭhā				13500	135	45	15	**5**	1	
laghu				202500	2025	675	225	75	**15**	1

Verses 8–12

	lagh	*nā*	*mu*	*pra*	*ah*	*pa*	*mā*	*ṛ*	*ay*	*va*
laghu	1									
nāḍikā[a]	**15**	1								
muhūrta	30	**2**	1							
prahara	**6 or 7**			1						
ahan		60	30	**4–4**	1					
pakṣa					**15**	1				
māsa					30	**2**	1			
ṛtu					60	4	**2**	1		
ayana					180	12	**6**	3	1	
vatsara					360	24	**12**	6	**2**	1

[a] The bowl for measuring the *nāḍikā* is described in verse 9, which is identical with verses 96.52c–53b of Kṛṣṇajanma-khaṇḍa of the *Brahmavaivarta-purāṇa*, although the unit is there called *daṇḍa*. See above.

> द्वादशार्धपलोन्मानं चतुर्भिश्चतुरङ्गुलैः।
> स्वर्णमाषैः कृतच्छिद्रं यावत्प्रस्थजलप्लुतम्॥९॥
>
> ⟨The bowl for water measuring one *nāḍikā*⟩ weighs half of twelve *palas* and has a hole ⟨at its bottom⟩ made by means of four *māṣas* of gold of four *aṅgulas*. The time during which ⟨the bowl is⟩ filled with one *prastha* of water ⟨is the *nāḍikā*⟩.

This table is interesting in two senses. First, it starts with the three units named *paramāṇu*, *aṇu*, and *trasareṇu*, which are usually used for linear measures. Second, it includes the seasonal hour *prahara* in addition to the fixed time units.

The word *paramāṇu* literally means the 'ultimate particle' but here it is a time unit defined as follows (verse 4ab):

> स कालः परमाणुर्वै यो भुङ्क्ते परमाणुताम्।४ab।

'The time that enjoys the state of being a *parama-aṇu*, ⟨as it were⟩, is indeed *paramāṇu*.'

The commentator Śrīdhara Svāmin comments on this passage as follows: 'The duration of time in which the sun passes over the space (*deśa*) of one *paramāṇu* ⟨on the ecliptic⟩ is the *paramāṇu*' (*sūryo yāvatā paramāṇudeśam atikrāmati tāvān kālaḥ paramāṇuḥ*). Cf. the definition of *samaya* in the *Gaṇitasārasaṃgraha* above, p. 13.

The unit *prahara* is also called a *yāma*. According to verse 8, one *prahara* consists of 6 or 7 *nāḍikās* depending on the seasons. According to the commentator, the 'four *praharas*' for each of the day and the night exclude two *muhūrtas* for the dawn (*saṃdhyā*) and the dusk (*saṃdhyāṃśa*).

संध्यांशमुहूर्तद्वयं विनेति ज्ञातव्यम्।

'It should be known that this excludes two *muhūrtas* of the dawn and of the dusk.'

Therefore, in winter for example, the distribution of the 60 *nāḍikās* of a day is as follows (see Figure 6).

Day	6 *nāḍikās*/*prahara* × 4 *praharas*	24	*nāḍikās*
Dusk	2 *nāḍikās*/*muhūrta* × 2 *muhūrtas*	4	*nāḍikās*
Night	7 *nāḍikās*/*prahara* × 4 *praharas*	28	*nāḍikās*
Dawn	2 *nāḍikās*/*muhūrta* × 2 *muhūrtas*	4	*nāḍikās*
	Total	60	*nāḍikās*

Verses 3.11.11b and 11d–12a give the relationships:

$$\begin{aligned} 1\ \textit{māsa} &= 1 \text{ ancestral } \textit{aharniśa} \text{ (day and night)},\\ 1\ \textit{vatsara} &= 1 \text{ divine } \textit{ahanī} \text{ (day and night)}. \end{aligned}$$

3.11.14, 18–20

Verse 3.11.14 refers to the five kinds of year; *saṃvatsara* etc.

Verses 3.11.18–20 give the definition of *caturyuga*. It consists of *kṛta-*, *tretā*, *dvāpara-*, and *kali-yugas*. Let $i = 4, 3, 2, 1$ for the four *yugas*, respectively. Then,

$$\begin{aligned} \textit{saṃdhyā} \text{ of } \textit{kṛta-yuga} \text{ etc.} &= 100 \times i,\\ \textit{kṛta-yuga} \text{ etc.} &= 1000 \times i,\\ \textit{saṃdhyāṃśa} \text{ of } \textit{kṛta-yuga} \text{ etc.} &= 100 \times i. \end{aligned}$$

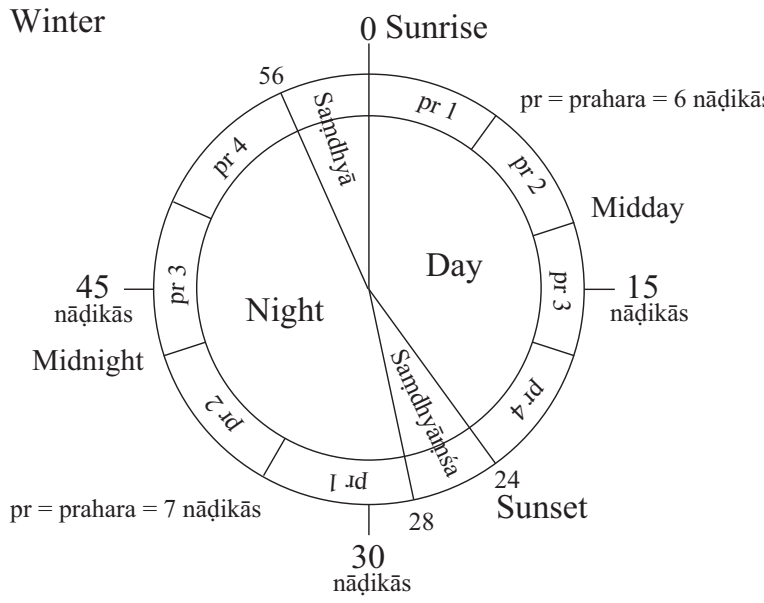

Figure 6: Relationship of the *nāḍikās* and the *praharas* of a day in winter.

Cf. the table for the *caturyuga* under the *Brahmavaivartapurāṇa*, p. 29.

3.11.22–23

Verses 3.11.22–23 give the relationships:

$$\begin{aligned} \text{1 day of Brahmā} = \text{1 night of Brahmā} &= 1000\ \textit{yugas} = 1\ \textit{kalpa} = 14\ \textit{manus}, \\ 1\ \textit{manu} &= 71\ \langle \textit{caturyugas} \rangle. \end{aligned}$$

12.4.2

Verse 12.4.2 repeats the relationships:

$$1000\ \textit{caturyugas} = \text{1 day of Brahmā} = 1\ \textit{kalpa} = 14\ \textit{manus}.$$

33 BHU B4394

The following table is given in §3 of the Supplement to the MS Benares BHU B4394 of Rāmacandra's *Kautukalīlāvatī*.

	ni	*tru*	*la*	*kṣa*	*kā*	*ka*	*mu*	*a*
nimeṣa	1							
truṭi	**2**	1						
lava	4	**2**	1					
kṣaṇa	8	4	**2**	1				
kāṣṭhā	80	40	20	**10**	1			
kalā	2400	1200	600	300	**30**	1		
muhūrta	72000	36000	18000	9000	900	**30**	1	
ahorātra	2160000	1080000	540000	270000	27000	900	**30**	1

34 MAÑJUŚRĪMŪLAKALPA

The *Mañjuśrīmūlakalpa* refers to three systems of time units in paṭalavisara 24. In the following tables, G and V indicate respectively the editions of Gaṇapatiśāstri and of Vaidya. A Chinese translation entitled 大方廣菩薩藏文殊師利根本儀軌經 (T1191) is available.

System 1 (G, pp. 279–80; V, p, 218, vv. 192–3; T1191.20.0886b28–c02)

	Chin.	*ac*	*nā*	*gha*	*pra*	*di/rā*		*ah*
acchaṭā [a]	弾指	1						
nāḍikā	初分時	**100**	1					
ghaṭī	中分時	400	**4**	1				
prahara	移分時	1600	16	**4**	1			
divasa/rātri	日[b]	6400	64	16	**4**	1		
ahorātra	晝夜	12800	128	32	[c]**8**	[c]**2**		1

[a] This is a Buddhist Sanskrit word. See *acchaṭā* in Edgerton 1953: 7a. Cf. Pali *accharā* (Rhys Davids and Stede 1921–1925: 9). Both words, like the corresponding Chinese word 弾指, mean 'snapping fingers.' There is another word with the same meaning: *sphoṭana* or *aṅguli-sphoṭana* (*-poṭhana* in Pali). This naming is curious because this unit is equal to 6.75 seconds.

[b] The Chinese translation does not refer to the *rātri* or 夜.

[c] The Sanskrit original defines the *ahorātra* by 8 *praharas*, while the Chinese translation by 2 日 (*divasas*).

Another table is given immediately after the above table in both the Sanskrit original and the Chinese translation but they are slightly different from each other. Noteworthy is that the table in the Chinese translation (System 2b) uses the decimal system of conversion ratios.

System 2a (G, p. 280; V, p. 218, vv. 194–95)

	u/tā	*kṣa*	*mu*	*pra*
unmeṣanimeṣa/tāla	1			
kṣaṇa	**10**	1		
muhūrta	100	**10**	1	
prahara	400	40	**4**	1

System 2b (T1191.20.0886c02–05)

	入息	滅	刹那	須臾	晝夜
入息 (*niśvāsa*)	1				
滅 (*laya*)	**10**	1			
刹那 (*kṣaṇa*)	100	**10**	1		
須臾 (*muhūrta*)	100	100	**10**	1	
晝夜 (*ahorātra*)	10000	10000	1000	**100**	1

The first two Sanskrit terms, *niśvāsa* and *laya*, are tentative restorations. After several verses from this table (G, p. 280; V, p. 218, verses 198–200b; T1191.20.0886c08–10), another table for higher units is given as follows.

	Chin.	*di*	*pa*	*mā*	*va*	*ma*
divasa	日(晝夜)	1				
pakṣa	半月	**15**	1			
māsa	月	30	**2**	1		
varṣa	年	360	24	**12**	1	
mahā-varṣa	大年				**12**	1

The last unit in this table, *mahā-varṣa* ('great year'), is peculiar to this work. The same table without *mahā-varṣa* is given also a few pages earlier in the same chapter (G, p. 273; V, p. 213, verses 116–17). The corresponding Chinese translation (T1191.20.0885c03–06) too excludes 大年 (for *mahā-varṣa*) but adds the relationship, 六 or 三時＝一年, which seems to be a translation of '6 or 3 *ṛtus* = 1 *varṣa*.' For the 12-year cycle by Jupiter see Viṣṇudharmottarapurāṇa: v. 2, ch. 168 (p. 69 below).

35 MATSYAPURĀṆA

142.1–23

MATSYAPURĀṆA 142.1–23 correspond to *Vāyupurāṇa* 57.1–28: many of these verses are almost the same with each other, although the former (MP) seems to be more corrupted than the latter (VP). The following are major differences found in these verses.

- Instead of **चत्वारश्चाधिका मासाः** of VP 57.11e, MP 142.8e reads **दश च द्यधिका मासा**. This means that 100 human years = 3 ancestral years + 12 months, which is wrong.
- Instead of **दश चैव तथाहानि** of VP 57.15c, MP 142.11e reads **तथैव सह संख्यातो**. This means that 100 human years = 3 divine months, which is wrong.
- Instead of **क्रौञ्चः संवत्सरः** (Heron Year) of VP 57.18d, MP 142.14d reads **ध्रुवसंवत्सरः** (Polaris Year), although both verses give the same number.
- Like VP 57.19–20, MP 142.15 deals with the relationship between human and divine years but the latter misses two verse lines, i.e., 19ef-20ab of the former. Accordingly, MP 142.15 gives the relationship, 36000 + 60000 ⟨= 96000⟩ human years = 1000 divine years, which does not make sense.

142.24–28

Like VP 57.29–32, MP 142.24–28 define the *yuga* system in terms of human years but in different expressions.

$$\begin{aligned}
1\ \textit{kṛta-yuga} &= (10 + 2 + 5) \cdot 10^5 + 28 \cdot 10^3 \ \langle = 1728000 \rangle \text{ human years,} \\
1\ \textit{tretā-yuga} &= 1 \cdot 10^6 + 2 \cdot 10^5 + 96 \cdot 10^3 \ \langle = 1296000 \rangle \text{ human years,} \\
1\ \textit{dvāpara-yuga} &= 8 \cdot 10^3 \cdot 10^2 + 64 \cdot 10^3 \ \langle = 864000 \rangle \text{ human years,} \\
1\ \textit{kali-yuga} &= 4 \cdot 10^5 + 32 \cdot 10^3 \ \langle = 432000 \rangle \text{ human years,}
\end{aligned}$$

where the numbers of years include the *saṃdhyā* and *saṃdhyāṃśa* for each period. The decimal expressions with indexes, 10^2, 10^3, 10^5, 10^6, and 10^7 in this and the following lists stand respectively for the Sanskrit numerals, *śata*, *sahasra*, *niyuta*, *prayuta*, and *koṭi* used in the verses.

142.29–36B

Like VP 57.33–35, MP 142.29–32 define the *manvantara* in terms of human years but in different expressions.

$$1\ \textit{manvantara} = 71\ \textit{caturyugas} =$$

$31 \cdot 10^7 + 10 \cdot 10^2 \cdot 10^3 + 32 \cdot 10^3 + 8 \cdot 10^2 + 80$ ⟨ = 311032880 ⟩ human years + 6 months.

This is incorrect. The VP gives the correct value, 306720000 human years.

MP 142.33–35 define the *manvantara* in terms of divine years also:

$$1 \textit{ manvantara} = 71 \textit{ caturyugas} = n \cdot 10^3 \cdot 10^2 + 40 \cdot 10^3 \text{ divine years,}$$

where $n = 8$ can be easily restored by emending the text (33c), *sahasrāṇāṃ śatāny āhuḥ* to *sahasrāṇāṃ śatāny aṣṭau*. But further corrections of the text are necessary in order to arrive at the correct number, 852000 divine years, which occurs in the *Mārkaṇḍeyapurāṇa* (see below). The *Vāyupurāṇa* does not have verses for this number, although a half verse (34cd) of this passage coincides with VP 57.36cd.

MP 142.36ab defines the *kalpa*:

$$1 \textit{ kalpa} = 14 \textit{ manvantaras},$$

which is missing in the corresponding section of the VP.

36 MANUSMṚTI

1.64

Verse 1.64 gives the following relationships.

	ni	*kā*	*ka*	*mu*	*a*
nimeṣa	1				
kāṣṭhā	**18**	1			
kalā	540	**30**	1		
muhūrta	16200	900	**30**	1	
ahorātra	486000	27000	900	**30**	1

1.65–67

Verse 1.65 mentions that the sun divides the day and the night for both men and gods: the day for action and the night for sleep.

Verses 1.66–67 define the day and the night for ancestors and for the gods.

1 *pitrya-rātryahanī* (ancestral night-and-day) = 1 *māsa* (month), where the day is *kṛṣṇa-pakṣa* and the night is *śukla-pakṣa*,

1 *daiva-rātryahaṇī* (divine night-and-day) = 1 *varṣa* (year), where the day is *udagayana* and the night is *dakṣiṇāyana*.

1.69–71

Verses 1.69–71 define the *daivika-yuga* (divine *yuga*) as follows.

kṛta-yuga = 4000 *varṣas*,
its *saṃdhyā* = *saṃdhyāṃśa* = 400 *varṣas*,
tretā-yuga etc. diminish 1000 *varṣas* each and
their *saṃdhyā* and *saṃdhyāṃśa* 100 *varṣas* each, and therefore
1 *caturyuga* = *kṛta-* + *tretā-* + *dvāpara-* + *kali-yugas*
= 12000 *varṣas*
= 1 *daivika-yuga* (*yuga* of gods).

1.72, 79

Verse 1.72 defines 'Day of Brahmā' and 'Night of Brahmā':

1 *brahma-aha* = 1 *brahma-rātri* = 1000 *daivika-yugas*.

Verse 1.79 defines *manvantara* (Manu's Period):

1 *manvantara* = 71 *daivika-yugas*.

1.61–63

Verses 1.61–63 list the names of only the first seven Manus (Svāyambhuva, Svārociṣa, Auttami, Tāmasa, Raivata, Cākṣuṣa, and Vivasvat-suta or Vaivasvata), and there is no reference to the relationship between the *manvantara* and the Day of Brahmā (usually called *kalpa*, which does not occur in this work), but there is no doubt that the *Manusmṛti* also admitted 14 Manus in a *kalpa* because the integer number 71 in the above equation can only be obtained by dividing 1000 by 14 (1000/14 = 71.4 ...), although it is not certain if it included 15 *sandhis* also as has been suggested by the *Brāhmasphuṭasiddhānta* and *Sūryasiddhānta*,

1 *brahma-aha* = 14 *manvantaras* + 15 *saṃdhis*,

where a *saṃdhi* comprises the same number of *varṣas* (years) as a *kṛtayuga* together with its own *saṃdhyā* and *saṃdhyāṃśa*, that is, 4800 *daivika-varṣas*.

37 MAHĀBHĀRATA

The *Mahābhārata* enumerates the names of time units at several places without conversion ratios; a table with them is given only once. It is interesting that intercalary months and days to be added to 13 lunar years are calculated according to the 5-year *yuga* system in the Virāṭa Parvan. (In this section, variants are cited from the Poona edition.)

VERSES 1.21.13C–14D

Kadrū, in her prayers to Indra, equates the god with many things including time units:

> You are our best refuge, O best of gods, you are the lord, ...,/13b/ you are the *muhūrta*, ..., you are the *dina*,//14// you are the best holder of wealth (i.e., the earth) accompanied by the mountains and forests, ...

The following time units are included here.

muhūrta,	*śukla* and *bahula* ⟨*pakṣa*⟩,	*saṃvatsara* (year),
tithi,	*kalā*,	*ṛtu* (season),
lava,	*kāṣṭhā*,	*rajanī* (night), and
kṣaṇa,	*truṭi*,	*dina* (day),

VERSES 2.11.27–28

The following time units are included in a list of all kinds of existence personified who attend Brahmā in the Assembly Hall (*sabhā*).

kṣaṇa,	*ardhamāsa* (half month),	which make a
lava,	*māsa* (month),	*yuga*,[a] and
muhūrta,	*ṛtu* (season), six of which	*ahorātra* is four kinds.[b]
divārātri (day-and-night),	make a *saṃvatsara* (year), five of	

[a] This refers to the 5-year *yuga*. See under verses 4.47.1–5 below.

[b] This seems to imply the day-and-nights of men, of ancestors, of gods, and of Brahmā.

VERSE 3.3.22–23A

The following time units are included in a list of 108 names of Sūrya.

kṛta,	*kalā*,	*māsa*,
tretā,	*kāṣṭhā*,	*ṛtu*, and
dvāpara,	*muhūrta*,	*saṃvatsara*.
kali,[a]	*pakṣa*,	

[a] These are the names of the four *yugas* and defined in verses 12.224.18c–20 (see below), but the word *caturyuga* does not occur in the *Mahābhārata*.

VERSES 4.47.1–5

Against the doubts whether Arjuna's appearance in a battle field broke Pāndavas' oath about the thirteenth year of their exile, Bhīṣma says:

> O Dear One, *kalāḥ*,[a] *muhūrtāḥ*, and *dināni* (days) are employed (or joined) ⟨to measure time⟩; *ardhamāsāḥ*, *māsāḥ*, *nakṣatrāṇi*, and *grahāḥ* too; //1// and *tavaḥ* and *saṃvatsarāḥ* are also used. By this time division, the wheel of time (*kāla-cakra*) proceeds.//2// But, due to the excess (*atireka*) of these (time units) over time and to the deviation (*vyatikrama*) of the heavenly bodies ⟨from the uniform motions⟩, two months are additionally born in every fifth year (*pañcame pañcame varṣe*).//3// For them, ⟨therefore, who have just finished their exile of thirteen years,⟩ the additional ⟨time⟩ for the thirteen years is five months and twelve nights, I think.//4// Everything promised[b] by them has been done so exactly. Having confirmed this, Bībhatsu (i.e., Arjuna) came.//5// (Therefore the Pāndavas did not break the oath for the thirteenth year of their exile.)
>
> [a] *kalāś ca tāta* among the variants is accepted here instead of *kalāṃśās tāta* in the text.
> [b] *pratiśrutaṃ* among the variants is accepted here instead of *pariśrutaṃ* in the text.

Verses 1–2 in this passage refers to the 'wheel of time,' which 'proceeds' with the division of time into various units. The units mentioned here are:

kalā,	*ardhamāsa* (half month),	*saṃvatsara* (year).
muhūrta,	*māsa* (month),	
dina (day),	*ṛtu* (season), and	

The *nakṣatra* (lunar mansion) and *graha* (planet) mentioned in verse 1 are of course not time units but are important means for measuring time.

Verses 3–4 calculate the additional months and nights (i.e., night-and-days) for the 13 years of the exile according to the 5-year *yuga* system (cf. *Arthaśāstra* above and *Lokaprajñapti* below). In the calendar based on the the 5-year *yuga*, 2 months or 60 nights (= 30 × 2) were added to 5 lunar years or 1770 nights (= 354 × 5) in order to adjust the latter to the 5 solar years of one *yuga* or 1830 nights (= 366×5); therefore, the ratio of the number of the additional nights to the former number (summand) is 60 : 1770 = 2 : 59. The number of the additional nights $A(n)$ for n nights may have been calculated by means of Trairāśika (Three Quantity Operation), that is, $59 : 2 = n : A(n)$, or $A(n) = \frac{2n}{59}$. Since 13 lunar years = 4602 nights, we have $A(4602) = 156$ nights or 5 months and 6 nights, which may be confirmed by the difference between the numbers of the nights in 13 solar

years and in 13 lunar years, that is, $366 \times 13 - -354 \times 13 = 4758 - -4602 = 156$ nights. However, verse 4 says that 'the additional ⟨time⟩ for the thirteen years is five months and twelve nights' (**तेषामभ्यधिका मासाः पञ्च द्वादश च क्षपाः**).

The translators, Ganguli (1884–1894: bk 4, sec. LII), Dutt (1988: 512), and Garbutt (2006: 329) do not comment on this passage. Debroy (2010–2014: footnotes 129 & 130) gives his comments, which however do not help us understand the passage because they are based on modern calendrical knowledge. But van Buitenen (1973–1978: 3–4, intro.) rightly suggests the possibility that Bhīṣma counted 12 nights, which are required for adjusting one lunar year of 354 nights to one solar year of 366 nights, for only the half year after the fifth intercalary month inserted. This is plausible as it is probable that the shortest time span for intercalation was taken to be one year.

Another, less plausible, explanation may be that Bhīṣma redundantly computed additional nights also for the additional nights already obtained by the Trairāśika, $A(4602) = 156 (= a_1)$, and possibly for the successive results too.

$$A(a_1) = 5\frac{17}{59}\ (= a_2), \quad A(a_2) = \frac{624}{3481}\ (= a_3), \ \cdots$$

The sum of the first two terms (a_1 and a_2) is $161\frac{17}{59}$ nights. The next a_3 is less than $\frac{1}{5}$ and each of the succeeding terms is $\frac{2}{59}$ of the preceding one; therefore the sum of them is very small and ignorable (actually we have $a_1 + a_2 + a_3 + \cdots = 161\frac{27}{57}$, but we cannot expect that the calculators of the *Mahābhārata* could obtain the sum of the infinite geometric progression). Hence, it may be that, the nearest upper integer of the sum was taken by Bhīṣma to be 162 nights or 'five months and twelve nights.'

VERSE 12.135.20

The following time units are enumerated in an allegory of three fishes for teaching that one who wants to make success should act with due attention to the time and space.

kalā,	*nāḍī*,	*māsa*,
kāṣṭhā,	*kṣaṇa*,	*ṛtu*,
muhūrta,	*lava*,	*tulya*[a], and
dina,	*pakṣa*,	*saṃvatsara*.

[a] Variants for *tulyāḥ*: *tulyaḥ*, *kalpaḥ*, *tathā*, *kālaḥ*.

CHAPTER 12.224

Chapter 224 of book 12 begins Vyāsa's discourse on the cosmic worlds and peoples's duties, i.e., on the *purāṇic* topics, in reply to the question of his

son Śuka. Naturally, it shows resemblance with *purāṇas*, especially with the *Brahmāṇḍapurāṇa* (BAP) and *Vāyupurāṇa* (VP) and also with the *Manusmṛti* (MS).

VERSES 12.224.12–13

Verses 12–13 of this chapter (12ab = BAP 1.29.6ab = VP 50.169ab = VP 57.7ab) define the units from *nimeṣa* to *saṃvatsara*:

	ni	*kā*	*ka*	*mu*	*ah*	*mā*	*ay*	*saṃ*
nimeṣa	1							
kāṣṭhā	**15**	1						
kalā	450	**30**	1					
muhūrta	406350	903	[a] **30** $\frac{\mathbf{1}}{\mathbf{10}}$	1				
ahorātra	12190500	27090	903	**30**	1			
māsa				900	**30**	1		
ayana				5400	180	6	1	
saṃvatsara				10800	360	**12**	**2**	1

[a] See *Vedāṅgajyotiṣa* below, which has: $20\frac{1}{10}$ *kalās* = 1 *muhūrta*.

VERSES 12.224.14–16

The next three verses (14–16), which are almost identical with MS 1.65–67, BAP 1.29.7c–9b and 13c–14b, and VP 57.8–9 and 13, state that the sun causes the day and the night not only for men but also for ancestors and gods and that

1 *māsa* (month) = 1 *rātryahanī* (night-and-day) for ancestors,
⟨for men⟩ where the day is *kṛṣṇa-pakṣa* and the night is *śukla-pakṣa*,
1 *varṣa* (year) = 1 *rātryahanī* (night-and-day) for gods,
⟨for men⟩ where the day is *udagayana* and the night is *dakṣiṇāyana*.

VERSES 12.224.18C–20

Verses 18c–20 of the same chapter, of which 19 and 20 are identical with MS 1.69–70, define the four *yugas*:

1 *kṛta-yuga* = 4000 *varṣas*,
and its *saṃdhyā* = *saṃdhyāṃśa* = 400 *varṣas*,
other *yugas* decrease by 1000 *varṣas* in order and
their *saṃdhyā* and *saṃdhyāṃśa* by 100 *varṣas*.

VERSES 12.224.28–29A

Verses 28–29a of the same chapter:

12000 ⟨divine years⟩ = 1 *yuga*,
1000 *yugas* = Day of Brahmā = Night of Brahmā.

The word *kalpa* in the sense 'the Day of Brahmā' does not occur in the *Mahābhārata*. González-Reimann (2009: 416) points out the possibility that the *mahākalpa* mentioned in 12.323.1 is 'synonymous with the *mahāyuga*,' i.e., the *yuga* in the above equation.

VERSES 13.14.22–23

The following time units are included in a list of the objects to which Jambavatī prays for Vasudeva's peaceful travel.

manvantara,[a]	*kṣapā*,	*nimeṣa*, and
...,	*kṣaṇa*,	*yuga*.
ṛtu,	*lava*,	
vatsara,	*muhūrta*,	

[a] The word *manvantara* occurs also in verses 12.337.41 and 52.

VERSES 13.15.18C–19B

The following time units personified are included in a list of admirers of Mahādeva.

māsa,	*rātri*,	*muhūrta*,
ardhamāsa,	*saṃvatsara*,	*nimeṣa*, and
ṛtu,	*kṣaṇa*,	*yuga*.

VERSES 13.143.30

Viṣṇu, under the name Viṣvaksena, is equated with various kinds of things, gods, etc. including the following time units.

saṃvatsara,	*kalā*,	*lava*, and
ṛtu,	*kāṣṭhā*,	*kṣaṇa*.
ardhamāsa,	*mātrā*[a],	
ahorātra,	*muhūrta*,	

[a] Variants for *mātrā*: *maṃtrā*, *kāṣṭhā*.

SUMMARY

To sum up, the following unit names, including synonyms, are referred to in the *Mahābhārata*. Those with asterisks are given conversion ratios to other units.

ayana,* *ardhamāsa* (half month), *ahorātra** (day-and-night), *ṛtu** (season), *kalā*,* *kali-yuga*,* *kāṣṭhā*,* *kṛta-yuga*,* *kṣaṇa*, *kṣapā* (night), *tithi*, *tulya*(?), *truṭi*, *tretā-yuga*,* *dina* (day), *divārātri* (day-and-night), *dvāpara-yuga*,* *nāḍī*, *nimeṣa*,* *pakṣa*, *bahula⟨-pakṣa⟩*, *manvantara*, *mātrā*, *māsa** (month), *muhūrta*,* *yuga*,* *rajanī* (night), *rātri* (night), *rātryahanī* (night-and-day), *lava*, *vatsara* (year), *varṣa** (year), *śukla⟨-pakṣa⟩*, *saṃdhyā*,* *saṃdhyāṃśa*,* *saṃvatsara** (year).

38 MAHĀSAṄGHIKAVINAYA

The *Mahāsaṅghikavinaya*, in Chinese translation 摩訶僧祇律, T1425.22.0360a12–16, gives the following relationships.

	Skt.	*kṣa*	*ni*	*ac*	*la*	*mu*	*ah*
念	*kṣaṇa*	1					
瞬	*nimeṣa*	**20**	1				
弾指	*acchaṭā*	400	**20**	1			
羅豫	*laya*	8000	400	**20**	1		
須臾	*muhūrta*	160000	8000	400	**20**	1	
日夜	*ahorātra*	4800000	240000	12000	600	**30**	1

The Sanskrit/Pali original is not extant. The Sanskrit terms in the above table have been restored from the Chinese translations and transliterations. For *acchaṭā* see System 1 of the *Mañjuśrīmūlakalpa* above, p. 45.

39 MAHĀSANNIPĀTASŪTRA

The *Mahāsannipātasūtra*, in Chinese translation 大方等大集経, T0397.13.0276a25–27, gives the following relationships.

	Skt.	*kṣa*	*ka*	*mu*	*a*
刹那	*kṣaṇa*	1			
迦羅	*kalā*	**1600**	1		
摸呼律多	*muhūrta*	96000	**60**	1	
日夜	*ahorātra*	2880000	1800	**30**	1

The Sanskrit original is not extant. The Sanskrit terms in the above table have been restored from the Chinese translation and transliterations.

The words, 中劫 (*antaḥ-kalpa*), 壞劫 (*saṃvarta-kalpa*), 成劫 (*vivarta-kalpa*), and 大劫 (*mahā-kalpa*), are also employed in this text, but their definitions are not found.

40 MĀRKAṆḌEYAPURĀṆA

46.23–38b

Verses 46.23–25b give exactly the same table of time units as that of *Viṣṇupurāṇa* 1.3.8–10b. See below.

Verse 46.25cd mentions the relation,

1 *varṣa* (year) = 1 *daiva-ahorātra* (divine day-and-night),

and the next five and a half verses (46.26–31b) define the *caturyuga* in the same way as *Manusmṛti* 1.69–71 do. Finally, verses 46.31c–38b give the relationships:

1 day of Brahmā = 1000 *caturyugas*
= 14 *manus* (or *manvantaras*),
1 *manvantara* = 71 *caturyugas*
= 306720000 *mānuṣa-abdas* (human years)
= 800000[a] + 52000 ⟨= 852000⟩ *divya-varṣas* (divine years).

[a] I emended the text (37b), युतम् to शतम्; otherwise the text would mean 8000 instead of 800000.

41 YAVANAJĀTAKA

79.28–29

Verses 79.28–29 give the following relationships. See Mak 2013.

	ni	*pa*	*ku*	*li*	*ka*	*nā*	*mu*	*dyu*
nimiṣa	1							
pala	$41\frac{27}{61}$	1						
kuḍava	$129\frac{31}{61}$	$\mathbf{3\frac{1}{8}}$	1					
liptā	$131\frac{2}{3}$	$3\frac{17}{96}$	$1\frac{1}{60}$	1				
kalā	**790**	$19\frac{1}{16}$	$6\frac{1}{10}$	6	1			
nāḍikā	7900	$190\frac{5}{8}$	**61**	**60**	**10**	1		
muhūrta	15800	$381\frac{1}{4}$	122	120	20	**2**	1	
dyuniśā	474000	$11437\frac{1}{2}$	3660	3600	600	**60**	[a]**30**	1

[a] This ratio is mentioned in verse 7.

The conversion ratios with various fractions in this table show that the three units, *pala*, *kuḍava*, and *liptā*, are heterogeneous to this table. The *pala* and *kuḍava* are originally liquid measures and *liptā*, which originates from Greek λεπτόν, is usually used, synonymously with *kalā*, for a minute of arc in Indian astronomy. The *Bakhshālī Manuscript* too uses *liptā* for a time unit but it is equal to one sixtieth of the *liptā* of the *Yavanajātaka*.

79.3, 6–9

Verse 3 refers to a *yuga* of 165 *samās* (years) and verses 6–9 give the relations,

1 *yuga* = 61230 *tithis* (lunar days),
1 *yuga* = 60272 *dinarātra* (day-and-nights),
1 *yuga* = 58231 *candra-udayas* (risings of the moon),
1 *yuga* = 60272 + 165 ⟨= 60437⟩ *bhagaṇa-udayas* (risings of asterism),
1 *yuga* = 1980 *arka-māsas* (solar months),
1 *yuga* = 1980 + 61 ⟨= 2041⟩ *indu-māsas* (lunar or synodic months),
1 *yuga* = 2206 *samāsa-māsas* (sidereal months).

79.5

Verse 5 refers to the relations: 1 *tithi* = 63/64 *dina* (day) and, conversely, 1 *dyu* or *ahan* (day) = 64/63 *tithis*.

42 LOKAPRAKĀŚA

VERSES 1–4

Verses 1–4 (Lokaprakāśa: pp. 74–75) give the following relationships, which are introduced by the phrase, *atha kālakalanā kathyate* ('Now, the counting of time is told').

	ni	*tu*	*la*	⋯	*ca*	*gha*	*mu*	*ah*	*pa*	*mā*	*ṛ*	*ay*	*saṃ*
nimiṣa[a]	1												
tuṭi(*kā*)	**2**	1											
lava	4	**2**	1										
…[b]													
caṣaka					1								
ghaṭikā					**60**	1							
muhūrta					120	**2**	1						
ahorātra					3600	60	**30**	1					
pakṣa								**15**	1				
māsa								30	**2**	1			
ṛtu								60	4	**2**	1		
ayana								180	12	6	**3**	1	
saṃvatsara								360	24	12	6	**2**	1

[a] The *nimiṣa* is 'defined as so much ⟨duration of time⟩ for uttering ⟨one of the short⟩ letters (i.e., syllables) beginning with *a*' (**आद्यक्षरं समुच्चार्य तावच्च निमिषः स्मृतः**).
[b] The units between *lava* and *caṣaka* are missing.

VERSES 5–10B

Verses 5–10b (Lokaprakāśa: p. 75) give the following relationships.

1 *saṃvatsara* = 1 *sura-divasa* (day of gods) according to a *Churikā*,
1 *saṃvatsara* = 1 *divya-ahorātra* (divine day-and-night) for Indra etc.,
[The difference between *sura-* and *divya-* is not clear.]
1 *kali-yuga* = 432000 *saṃvatsaras*,
1 *dvāpara-yuga* = 2 × *kali-yuga* ⟨= 864000 *saṃvatsaras*⟩,
1 *tretā-yuga* = 3 × *kali-yuga* ⟨= 1296000 *saṃvatsaras*⟩,
1 *kṛta-yuga* = 4 × *kali-yuga* ⟨= 1728000 *saṃvatsaras*⟩,
⟨1 *caturyuga* = *kali-dvāpara-tretā-kṛta-yugas*
= 43200001 *saṃvatsaras*⟩,

1 *manvantara* = 71 *caturyugas* = 1 *dina* (day) of Brahmā,

and after the day of Brahmā come, in order, the days of Viṣṇu, of Keśava, of Rudra, of Maheśvara, of Sadāśiva, and of Māyā (probably of the same length). Obviously, the 'day of Brahmā' defined here is different from that of *purāṇas*, which is equated with 14 *manvantaras*.

43 LOKAPRAJÑAPTI

T1644.32.0196B01–03

The Sanskrit original *Lokaprajñapti* does not exist except for a few fragmental folios of manuscripts. But its Chinese translation, 佛説立世阿毘曇論 (Taishō Tripiṭaka, no. 1644), and its Pali version, *Lokapaññatti* (Denis 1977), are available. The Chinese translation, T1644.32.0196b01–03, gives the following relationships.

Chinese tr.	Pali tr.	Skt.	la	mu	rā
羅婆		*lava*	1		
牟休多	*muhutta*	*muhūrta*	**30**	1	
日夜	*rattidiva*	*rātridivasa*	900	**30**	1

The Pali words *muhutta* and *rattidiva* in this table are from Denis' edition (Lokaprajñapti: 57), which does not give any name to one thirtieth of the *muhutta*. The Sanskrit terms except *lava* have been restored from the Pali names, and *lava* from the Chinese transliteration 羅婆.

T1644.32.0196C01–03 AND 07–19

Another passage describes the 5-year *yuga* with 2 intercalary months (T1644.32.0196c01–03 and 07–19; Lokaprajñapti: 58–9). Cf. *Arthaśāstra* and *Mahābhārata* above and *Vedāṅgajyotiṣa* below, pp. 5, 49, 75.

44 VAṬEŚVARASIDDHĀNTA

1.1.7–8

Verses 1.1.7–8 expand the table of the *Āryabhaṭīya* by incorporating traditional time units with new definitions.

Verses 7–8a

	tru	*la*	*ni*	*gu*	*kā*	*as*
truṭi	1					
lava	**100**	1				
nimeṣa	10000	**100**	1			
gurvakṣara	45000	450	$4\frac{1}{2}$	1		
kāṣṭhā	180000	1800	18	**4**	1	
asu	450000	4500	45	10	$2\frac{1}{2}$	1

Verse 8bcd

	as	*pa*	*gha*	*di*	*mā*	*ab*
asu	1					
pala	**6**	1				
ghaṭikā	360	**60**	1			
dina	21600	3600	**60**	1		
māsa	648000	108000	1800	**30**	1	
abda	7776000	1296000	21600	360	**12**	1

The *truṭi* is defined as the time for cutting lotus petal (*kamala-dalana-tulyaḥ kālaḥ*). The term *gurvakṣara* means 'heavy letter' or a syllable of two morae.

1.1.9

The next verse (1.1.9) gives the following relationships.

1 *yuga* = 4320000 *arka-varṣas* (solar years),
1 *manu* = 72 *yugas*,
1 *kalpa* = 14 *manus* (= 1008 *yugas*; cf. *Āryabhaṭīya*),
1 day-and-night of Brahmā = 2 *kalpas*,
1 life span (*āyus*) of Brahmā = 100 *sva-varṣas* ('His own years')

The term *sva-varṣa* ('His own year') in the last relationship is not defined here but has been reconstructed by Subbarayappa and K. V. Sarma 1985: 53 as:

1 *varṣa* (= 12 *māsas*) of Brahmā = $12 \cdot 30$ day-and-nights of Brahmā.

1.2.6

Verse 1.2.6 states exactly the same division of the *yuga* as in *Āryabhaṭīya* 3.9.

45 VĀYUPURĀṆA

The *Vāyupurāṇa* has many parallel passages in the *Brahmāṇḍapurāṇa* (BAP) and a few in the *Manusmṛti* (MS). See pp. 38, 48 above.

50.169

Verse 50.169 (= 57.7) gives the following relationships.

	ni	*kā*	*ka*	*mu*	*rā*
nimeṣa[a]	1				
kāṣṭhā	**15**	1			
kalā	450	**30**	[b]1		
muhūrta	13500	900	**30**	1	
rātryahaṇī	405000	27000	900	**30**	1

[a] The unit *nimeṣa* is equated, in 57.6cd, to a *laghvakṣara* ('light letter') or a syllable of one mora.

[b] I emended the text, both कलान्तम् (50.169b) and कलास्ताः (57.7b) to कलां ताः.

50.170–77

Verses 50.170 and 176–77 refer to the annual increase and decrease of the length of day and night. The five verses between them (50.171–75) mention the division of the daytime on an equinoctial day (= 15 *muhūrtas*) into 5 intervals of 3 *muhūrtas* each: *prātar*, *saṃgava*, *madhyāhna*, *aparāhṇa*, and *sāyāhna*.

50.178

Verse 50.178 gives the common definition of the units from *ahan* (day, i.e., day-and-night) to *saura-varṣa* (solar year).

	ah	*pa*	*mā*	*ṛ*	*ay*	*va*
ahan	1					
pakṣa	**15**	1				
māsa	30	**2**	1			
arka-ṛtu	60	4	**2**	1		
ayana	180	12	6	**3**	1	
saura-varṣa	360	24	12	6	**2**	1

50.179–82

Verses 50.179–82 treat *carāṃśa* (?, *varāṃśa* in BAP 1.21.183a); the time units, *nimeṣa*, *kāṣṭhā*, *kalā*, and *mātrā* occur here, but the verses, both in VP and in BAP, are too much corrupted to be understood correctly.

31.26–28B, 49AB, 50.183–88

Verse 31.26 says that the duration of time (*kālāvasthā*) is divisible in five ways, i.e., by *divasa* (day), by *ardhamāsa* (half month), by *māsa* (month), by *ṛtu* (season), and by *ayana* (course).

Verses 31.27–28b and 49ab refer to the *yuga* of five years: *saṃvatsara*, *parivatsara*, *idvatsara*, *anuvatsara*, and *vatsara*. Verses 50.183–84 repeat the same and the next four verses (50.185–88) give the following relationships:

$$
\begin{aligned}
1\ \textit{yuga}\ (\text{of 5 years}) &= 120\ \textit{parvans}^{a} \\
&= 1830\ \textit{bhāskara-udayas}\ (\text{sunrises, i.e., civil days or } \textit{ahorātras}) \\
&= 30\ \textit{saura-ṛtus}\ (\text{solar seasons}) \\
&= 10\ \textit{ayanas} \\
&= 60\ \textit{saura-māsas}\ (\text{solar months}),
\end{aligned}
$$

where

$$
\begin{aligned}
1\ \textit{saura-māsa} &= 30\langle\tfrac{1}{2}\rangle\ \textit{ahorātras}, \\
1\ \textit{ṛtus}^{b} &= 61\ \textit{ahorātras}, \\
1\ \textit{saura-ayana}^{c} &= 183\ \textit{ahan}\ (\text{i.e., } \textit{ahorātras}).
\end{aligned}
$$

[a] *viṃśaṃ śataṃ* (185a) for 120 is irregular. See the parallel passage in *Brahmāṇḍa-purāṇa* 1.21.133a, which reads *triṃśacchataṃ*.

[b] I emended the text (187d), अहोरात्रा देनुरेको to अहोरात्रा ऋतुरेको.

[c] I emended the text (188d), विज्ञेयं भुवनस्य to विज्ञेयमयनस्य.

These relationships may be combined into one table as follows.

	ah	*pa*	*s-mā*	*s-ṛ*	*s-ay*	*va*	*yu*
ahorātra	1						
parvan	$15\frac{1}{4}$	1					
saura-māsa	**30**$\langle\frac{1}{2}\rangle$	2	1				
saura-ṛtu	**61**	4	2	1			
saura-ayana	**183**	12	6	3	1		
varṣa	366	24	12	6	2	1	
yuga	**1830**	**120**	**60**	**30**	**10**	5	1

50.189, 57.8

Verse 50.189 refers to the four kinds of measurement (*māna*) of time, i.e., *saura* (solar), *saumya* (lunar), *nākṣatra* (sidereal), and *sāvana* (civil).

Verse 57.8 (≈ MS 1.65) mentions that the sun causes the day for action and the night for sleep for both men and gods.

57.9–11

Verses 57.9–11, elaborating MS 1.66 (≈ VP 57.9), define the day-month-year system for ancestors:

1 *pitrya-rātryahanī* (ancestral night-and-day) = 1 *mānuṣa-māsa* (human month), where the day is *kṛṣṇa-pakṣa* and the night is *śukla-pakṣa*,

1 *pitrya-māsa* (ancestral month) = 30 *mānuṣa-māsas* (human months),

1 *pitrya-saṃvatsara* = 360 *mānuṣa-māsas*,

100 *mānuṣa-varṣas* (human years) ⟨= 1200 *mānuṣa-māsas* = 360 × 3 + 30 × 4⟩ = 3 *pitrya-saṃvatsaras* + 4 *pitrya-māsas*

57.12–16

Verses 57.12–16, elaborating MS 1.67 (= VP 57.13), define the divine day-month-year system:

1 *divya-ahorātra* (divine day-and-night) = 1 *mānuṣa-abda* (human year), where the day is *udagayana* and the night is *dakṣiṇāyana*,

1 *divya-māsa* = 30 *divya-ahorātras*,

100 *mānuṣa-varṣas* (human years) = 3 *divya-māsas*[a] (divine months) +
⟨= 30 × 3 + 10 human years⟩ 10 *divya-ahas* (divine days),
1 *divya-saṃvatsara* (divine year) = 360 *divya-ahas* (divine days).

[a]I emended the text (15b): मासास्त्रयस् to मासास्त्रयस्.

57.17, 18

Verses 57.17 and 18 respectively define the *saptarṣi-vatsara* and *krauñca-saṃvatsara*:

1 *saptarṣi-vatsara* (Seven-sage year) = 3030 (or 2700[a]) *mānuṣa-varṣas*,
1 *krauñca-saṃvatsara* (Heron year) = 9090 *mānuṣa-varṣas*.

[a] *Brahmāṇḍapurāṇa* 1.29.17 and *Matsyapurāṇa* 142.13 also give the same number, 3030 *mānuṣa-varṣas*, but if we slightly emend the text (17c), त्रिंशद्यानि तु to त्रिंशतोनानि, then we have 2700 human years, which coincides with the theory that the constellation *Saptarṣi* (the Seven Sages, i.e., Ursa Major) stays with each of the twenty-seven *nakṣatras* for one hundred years.

Vāyupurāṇa 99.421–22 read:

> सप्तर्षीणां तु ये पूर्वा दृश्यन्ते उत्तरादिशि। (read दृश्यन्त)
> ततो मध्येन च क्षेत्रं दृश्यते यत्समं दिवि॥४२१॥
> तेन सप्तर्षयो युक्ता ज्ञेया व्योम्नि शतं समाः।
> नक्षत्राणामृषीणां च योगस्यैतन्निदर्शनम्॥४२२॥
>
> The foremost (or Eastern) ⟨stars⟩ of the Seven Sages are seen ⟨rising⟩ in the northern direction; through their middle an area ⟨of the ring of the lunar mansions⟩ is seen on the same level in the sky; the Seven Sages should be known as connected with it (i.e., the lunar mansion) in the sky for one hundred years. This indicates the combination of the lunar mansions and the ⟨Seven⟩ Sages.

Similar statements occur also in other *Purāṇas*. *Viṣṇupurāṇa* 4.24.25 reads:

> सप्तर्षीणां तु यौ पूर्वौ दृश्येते ह्युदितौ दिवि।
> तयोस्तु मध्ये नक्षत्रं दृश्यते यत्समं निशि।
> तेन सप्तर्षयो युक्तास्तिष्ठन्त्यब्दशतं नृणाम्॥२५॥

Bhāgavatapurāṇa 12.2.27–28b read:

> सप्तर्षीणां तु पूर्वौ यौ दृश्येते उदितौ दिवि।
> तयोस्तु मध्ये नक्षत्रं दृश्यते यत्समं निशि॥२७॥
> तेनैत ऋषयो युक्तास्तिष्ठन्त्यब्दशतं नृणाम्।२८ab।

Matsyapurāṇa 273.42–44b read:

सप्तर्षयस्तु वर्तन्ते यत्र नक्षत्रमण्डले।
सप्तर्षयस्तु तिष्ठन्ति पर्यायेण शतं शतम्॥४०॥
सप्तर्षीणामुपर्येतत्स्मृतं वै दिव्यसंज्ञया।
समा दिव्याः स्मृताः षष्टिर्दिव्याब्दानि तु सप्तभिः॥४१॥
एभिः प्रवर्तते कालो दिव्यः सप्तर्षिभिस्तु वै।
सप्तर्षीणां च यौ पूर्वौ दृश्येते ह्युदितौ निशि॥४२॥
तयोर्मध्ये तु नक्षत्रं दृश्यते यत्समं दिवि।
तेन सप्तर्षयो ज्ञेया युक्ता व्योम्नि शतं समाः॥४३॥
नक्षत्राणामृषीणां च योगस्यैतन्निदर्शनम्।४४ab।

Varāhamihira, too, in his *Bṛhatsaṃhitā* 13.4 refers to the same theory:

एकैकस्मिन्नृक्षे शतं शतं ते चरन्ति वर्षाणाम्।
प्रागुदयतोऽप्यविवरादृजून्नयति तत्र संयुक्ताः॥४॥

They (the Seven Sages) move through each lunar mansion for one hundred years; they are connected to it (i.e., the lunar mansion) to which ⟨the two stars of the Seven Sages⟩ rising in the East without interval (i.e., simultaneously) straightly lead.

For discussion on the meaning of these statements see Sule et al. 2007.

57.19–20

Verses 57.19–20: relationship of the *mānuṣa-* and *divya-varṣas*.

100 *divya-varṣas* = 36000 *mānuṣa-varṣas*,[a]
1000 *divya-varṣas* = 360000[b] *mānuṣa-varṣas*.

[a] I deleted the half verse (19cd), षष्टिश्चैव …, which coincides with 20cd and which does not occur in three manuscripts according to the footnote of the text I used.
[b] I emended the text (20c), सहखाणि to सहस्राणि.

32.58–66

Verses 32.58–66 define the *yuga* system in terms of divine year (*divya-varṣa*).

1 *kṛta-yuga* = 4000 *varṣas*,
its *saṃdhyā* = *saṃdhyāṃśa* = 400 *varṣas*;
1 *tretā-yuga* = 3000 *varṣas*,
its *saṃdhyā* = *saṃdhyāṃśa* = 300 *varṣas*;
1 *dvāpara-yuga* = 2000 *varṣas*,
its *saṃdhyā* = *saṃdhyāṃśa* = 200 *varṣas*;

1 *kali-yuga* = 1000 *varṣas*,
its *saṃdhyā* = *saṃdhyāṃśa* = 100 *varṣas*;
1 *catur-yuga* = the 4 *yugas* + their *saṃdhyā* and *saṃdhyāṃśa*
= 12000 *varṣas*;
total of the *saṃdhyās* and *saṃdhyāṃśas* = 2000 *varṣas*.

57.22–28

Verses 57.22–28 explains the *yuga* system by citing and elaborating MS 1.69–70 (= VP 57.23–24):

1 *caturyuga* = *kṛta* + *tretā* + *dvāpara* + *kali-yugas*,
kṛta-yuga = 4000 ⟨*divya-*⟩*varṣas*,
its *saṃdhyā* = *saṃdhyāṃśa* = 400 ⟨*divya-*⟩*varṣas*,

tretā-yuga etc. diminish 1000 *varṣas* each and their *saṃdhyā* and *saṃdhyāṃśa* 100 *varṣas* each,

tretā-yuga = 3000,
its *saṃdhyā* = *saṃdhyāṃśa* = 300 *varṣas*,
dvāpara-yuga = 2000,
its *saṃdhyā* = *saṃdhyāṃśa* = 200 *varṣas*,
kali-yuga = 1000,
its *saṃdhyā* = *saṃdhyāṃśa* = 100 *varṣas*,
1 *caturyuga* = 12000 ⟨*divya-*⟩*varṣas*.

57.29–32

Verses 57.29–32 define the *yuga* system in terms of human year (*mānuṣa-varṣa*):

1 *kṛta-yuga* = 1440000 *mānuṣa-varṣas*,

[the next passage (30d–31b) for the remaining three *yugas* is corrupt; the corresponding passage in the *Brahmāṇḍapurāṇa* (1.29–36) preserves the correct verses.]

1 *caturyuga* without *saṃdhyā* and *saṃdhyāṃśa*[a] = 3600000[b] *mānuṣa-varṣas*,
1 *caturyuga* with *saṃdhyā* and *saṃdhyāṃśa*[c] = 4320000 *mānuṣa-varṣas*.

[a] I emended the text (31d), विना संख्यांशकैः to विना संध्यांशकैः.

[b] I emended the text (32ab), नियुतान्येकषष्ट्रिशन्निरंशानि तु तानि वै to नियुतान्येव षष्ट्रिशन्निरंशानि तु तानि वै.

[c] I emended the text (32f), स संख्याशश्चतुर्युगे to ससंध्यांशचतुर्युगे.

57·33–35

Verses 57.33–35 define the *manvantara*:

$$\begin{aligned} 1\ \textit{manvantara} &= 71^{a}\ \textit{caturyugas}\ \langle = 71 \times 4320000 \rangle \\ &= 306720000\ \textit{mānuṣa-varṣas}. \end{aligned}$$

[a] I emended the text (33b), एकसप्तविः to एकसप्ततिः.

We do not find any definition of the *kalpa* in these passages but, in chapter 21, come across several time lengths related to the *kalpa*. According to verse 21.12, 'the seventh *kalpa* named Padma has already passed and we are presently in the ⟨eighth⟩ *kalpa* named Varāha.' This does not agree with other *purāṇas*, according to which the present *kalpa* named Varāha is not the eighth but the first of the latter half of Brahmā's life, i.e., the 36001st *kalpa* (González-Reimann 2009: 420).

21.14–16

Verses 21.14–16 give 'the time length of seven *manvantaras*' (14ab), which is 'half of the *kalpa*' (16a), as follows.

कोटीनां द्वे सहस्रे वै अष्टौ कोटिशतानि च।
द्विषष्टिश्च तथा कोट्यो नियुतानि च सप्ततिः ॥ १५ ॥

That is,

$$\begin{aligned} \text{(A) half } \textit{kalpa} &= 7\ \textit{manvantaras} \\ &= (2000 + 800 + 62)\ \textit{koṭi} + 70\ \textit{niyuta} \\ &\langle = 28627000000 \text{ human years} \rangle. \end{aligned}$$

Strictly speaking, however, a half *kalpa* and 7 *manvantaras* are not equivalent since a *kalpa* consists of 14 *manvantaras* and 15 *sandhis*. See D_2 and E below.

21.17–18

Verses 21.17–18 give the time length 'up to the Vaivasvata-⟨manu⟩antara' (18b), i.e., the present, seventh *manvantara*, as follows.

शतं चैव तु कोटीनां कोटीनामष्टसप्ततिः।
द्वे च शतसहस्रे तु नवतिर्निर्युतानि च॥ १७॥

That is,

(B) up to Vaivasvata-manu = (100 + 78) *koṭi* + 200 *sahasra* + 90 *niyuta* ⟨= 1789200000⟩ human years (cf. D_1 below).

21.19–20

And, finally, verses 21.19–20 give the 'length of the seven ⟨*manvantaras*⟩ to come' (अनागतानां सप्तानां प्रमाणं) as follows.

नियुतान्यष्टपञ्चाशत्तथाशीतिशतानि च।
चतुरशीतिश्चान्यानि प्रयुतानि प्रमाणतः॥ २०॥

That is,

(C) 7 *manvantaras* to come = 58 *niyuta* + 8000 *niyuta* or *prayuta* + 84 *prayuta*.

The numeral *prayuta* usually means 10^6, that is, ten times *niyuta*. See *Āryabhaṭīya* 2.2. Here we have two possibilities in interpreting the middle term. If it denotes 8000 *niyuta*, then the total time length is: (C_1) 84 *prayuta* + 8058 *niyuta* = 889800000 ⟨human years⟩; if 8000 *prayuta*, then (C_2) 8084 *prayuta* + 58 *niyuta* = 8089800000 ⟨human years⟩.

I do not see any significant relationships between these three time lengths, A, B, and C_1 or C_2. Since 1 *manvantara* = 306720000 human years and 1 *saṃdhi* = 1 *kṛta-yuga* = 1440000 human years, the time duration from the beginning of the present *kalpa* to the end of the seventh, Vaivasvata-manvantara is:

(D_1) 7 (*saṃdhi* + *manvantara*) = $7 \times (1440000 + 306720000)$
= 2157120000 human years.

If we exclude the seven *saṃdhis* from D_1,

(D_2) 7 *manvantaras* = 7×306720000
= 2147040000 human years.

If 1 *kalpa* = 4320000000 human years as in other *purāṇas*, then

(E) half *kalpa* = 2160000000 human years,

which is the time from the beginning of the present *kalpa* to the middle of the next *saṃdhi* that lies between the seventh and the eighth *manvantaras*.

We are now in the *kali-yuga* of the 28th *caturyuga* of the 7th *manvantara* of the 8th (or 36001st) *kalpa* named Varāha. Therefore, the time from the beginning of the present *kalpa* to the end of the latest *dvāpara-yuga* is,

$$\begin{aligned} \text{(F) } 6 \textit{ manvantaras} &= 6 \times 306720000 \\ + 7 \textit{ saṃdhis} &\quad +7 \times 1440000 \\ + 27 \textit{ catruyugas} &\quad +27 \times 4320000 \\ + \textit{kṛta-tretā-dvāpara-yugas} &\quad +1728000 + 1296000 + 864000 \\ &= 1970928000 \text{ human years.} \end{aligned}$$

These time lengths (A) to (F) can be arranged as follows according to their lengths:

$$B < F < D_2 < D_1 < E < C_2 < A < C_1,$$

where A, B, C_1, and C_2 seem to be corrupted.

46 VIṢṆUDHARMOTTARAPURĀṆA

The *Viṣṇudharmottarapurāṇa* treats the time units in chapter 73 of the first volume and in chapter 168 of the second volume.

1.73.1–4B

Verses 1.73.1–4b give the following relationships.

	ni	*tru*	*prā*	*vi*	*nā*	*mu*	*a*
nimeṣa	1						
truṭi	**2**	1					
prāṇa	20	**10**	1				
vināḍikā	120	60	**6**	1			
nāḍikā	7200	3600	360	**60**	1		
muhūrta	14400	7200	720	120	**2**	1	
ahorātra	432000	216000	21600	3600	**60**	**30**	1

The unit *nimeṣa* is defined as follows in verses 1–2b:

लघ्वक्षरसमा मात्रा निमेषः प्रकीर्तितः।
अतः सूक्ष्मतरः कालो नोपलभ्यो भृगूत्तम॥

नोपलभ्यं यथा द्रव्यं सुसूक्ष्मं परमाणुतः।

'One *mātrā*, which is equal to ⟨the period for uttering⟩ a light letter (i.e., a short syllable), is declared to be a *nimeṣa*. No time finer than this cannot be recognized, O best of the Bhṛgus, just as no substance finer than the ultimate atom (*paramāṇu*) cannot be recognized.'

1.73.5–9

Verses 1.73.5–9 refer to the increase and decrease of the lengths of the day and the night according to the sun's motion along the northward course (*uttara-kāṣṭhā*) and the southward course (*dakṣiṇa-kāṣṭhā*) and to their equality at Meṣa and Tulā.

1.73.11–12B

Verses 1.73.11–12b give the following definitions:

1 *saura-māsa* (solar month) = interval between two consecutive *saṃkramaṇas* (sun's entries into the zodiacal constellations),
1 *ṛtu* = 2 *saura-māsas*,
1 *ayana* = 3 *ṛtus*,
1 *samā* (solar year) = 2 *ayanas*.

1.73.12C–13

Verses 1.73.12c–13 give the definition, 1 *samā* (solar year) = 1 divine day-and-night, where the day and the night are respectively when the sun is in the six constellations beginning with Meṣa and Tulā.

1.73.14–16B

Verses 1.73.14–16b give the definition,

1 *cāndra-māsa* (lunar or synodic month) = 1 ancestral day-and-night,

where the sunrise[a] occurs at the middle of the 8th *tithi* of the *kṛṣṇa-pakṣa*, the midday at the end of the *kṛṣṇa-pakṣa*, the sunset at the middle of the 8th *tithi* of the *śukla-pakṣa*, and the midnight at the end of the *śukla-pakṣa*.

[a] I emended the text (14d), रात्र्युदय to रव्युदय.

1.73.17–18

Verses 1.73.17–18 define the *caturyuga*:

1 *tiṣya-yuga* (Ti) = 1200 *divya-samās* (divine years),
1 *dvāpara-yuga* (Dv) = 2 × Ti,
1 *tretā-yuga* (Tr) = 3 × Ti,
1 *kṛta-yuga* (Kṛ) = 4 × Ti,
1 *caturyuga* = Ti + Dv + Tr + Kṛ
= 12000 divine years.

1.73.34c–39

Verses 1.73.34c–39 define the *yuga-manvantara-kalpa* system:

1 *manvantara* = 71 *caturyugas*,
1 *kalpa* = 14 *manus* + 15 *saṃdhis*
= 1000 *caturyugas*, where
1 *saṃdhi* = 1 Kṛ,
1 *kalpa* = day of Brahmā = night of Brahmā,
1 life span of Brahmā = 100 years of Brahmā
⟨= 2 × 360 × 100 = 72000 *kalpas*⟩
= day of Puruṣa = night of Puruṣa.

CHAPTER 2.168

Chapter 168 of the second volume (fol. 295ab) deals with the day and night and larger units as follows.

1 *saura-ahorātra* (solar day) = ⟨the time for⟩ the sun's passing over one degree (*arka-bhāga-bhoga*),
1 *tithi* = ⟨the day⟩ of the moon (*cāndra*),
1 *sāvana-dina* (civil day) = sunrise to sunrise,
1 *nākṣatra-dina* (sidereal day) = ⟨the time for⟩ the moon's passing over one *nakṣatra* (*candra-nakṣatra-bhoga*),
1 human day-and-night = 1 *sāvana-dina*, where the day is with the sun and the night without the sun,
1 ancestral day-and-night = 1 *candramasa* (synodic month), where the sunrise, midday, sunset, and midnight occur respectively at *kṛṣṇa* 8, at *amāvasyā*, at *śukla* 8, and at *pūrṇimā*,

1 divine day-and-night = ⟨the time for⟩ the sun's passing over the ecliptic (*bha-gaṇa*), where the sunrise, midday, sunset, and midnight occur respectively at the sun's entry into Meṣa, Karkaṭa, Tulā, and Makara; the mean Jīva (Jupiter) at Meṣa etc. determines the ⟨12⟩ years[a] beginning with Āśvayuja,

1 *saura-abda* (solar year) = ⟨the time for⟩ the sun's passing over the ecliptic (*arka-bhagaṇa-bhoga*),

1 *kali-yuga* (Ka) = 432000[b] *saura-abdas*,

1 *dvāpara-yuga* (Dv) = 2 × Ka,

1 *tretā-yuga* (Tr) = 3 × Ka,

1 *kṛta-yuga* (Kṛ) = 4 × Ka,

1 *caturyuga* = 4320000[c] *saura-abdas*,
⟨= Ka + Dv + Tr + Kṛ⟩

1 *manvantara* = 71 *caturyugas*,

1 *kalpa* = 14 *manvantaras* + 15 *saṃdhis*,
where 1 *saṃdhi* = 1 Kṛ.

[a] For the 12-year cycle see *Mañjuśrīmūlakalpa* above.

[b] I emended the text (fol. 295a, line 17), वै त्रयेण गुणमेकं वेदः to खत्रययमगुणवेदाः.

[c] I emended the text (fol. 295a, line 18), शून्यचतुष्टयं यमाग्निवेगाश् to शून्यचतुष्टययमाग्निवेदाश्.

47 VIṢṆUPURĀṆA

1.3.8–10B

Verses 1.3.8–10b give the following relationships.

	ni	*kā*	*ka*	*mu*	*ah*	*pa*	*mā*	*ay*	*va*
nimeṣa	1								
kāṣṭhā	**15**	1							
kalā	450	**30**	1						
muhūrta	13500	900	**30**	1					
ahorātra	405000	2700	900	**30**	1				
pakṣa					15	1			
māsa					**30**	**2**	1		
ayana					180	12	**6**	1	
varṣa					360	24	12	**2**	1

The first half of this table (up to *ahorātra*) is repeated in 2.8.59 and the latter half, with 15 *ahorātras* = 1 *pakṣa* instead of 30 *ahorātras* = 1 *māsa* and with 2 *māsas* = 1 *ṛtu* and 3 *ṛtus* = 1 *ayana* instead of 6 *māsas* = 1 *ayana*, in 2.8.69–70.

The same table, without *pakṣa* and *ayana*, is repeated in 6.3.6–10a, in the middle of which the definition of *nāḍikā*, i.e., 15 *kalās* = 1 *nāḍikā* and 2 *nāḍikās* = 1 *muhūrta*, and a description of a water clock for measuring the *nāḍikā* are inserted.

> उन्मानेनाम्भसः सा तु पलान्यर्धत्रयोदश।
> हेममाषैः कृतच्छिद्रं चतुर्भिश्चतुरङ्गुलैः।
> मागधेन प्रमाणेन जलप्रस्थस्तु स स्मृतः ॥८॥
>
> By the quantity of water it (*nāḍikā*) ⟨measures⟩ twelve and a half *palas*. ⟨The bowl⟩ has a hole made ⟨at its bottom⟩ by means of four *māṣas* of gold four *aṅgulas* ⟨long⟩. It has been ordained to have one *prastha* of water by Magadha standard.

2.89.61–65

According to verses 2.89.61–65, the daytime consisting of 15 *muhūrtas* (on the equinoctial day) is divided into 5 parts (*bhāgas*) of 3 *muhūrtas* each; they are named, in order from sunrise, *prātar*, *saṃgava*, *madhyāhna*, *aparāhṇa*, and *sāyāhna*. Cf. *Matsyapurāṇa* 124.87c–91b and *Brahmāṇḍapurāṇa* 1.21.118c–22 = *Vāyupurāṇa* 50.171–75b.

2.8.71–72

Verses 2.8.71–72 refer to the *yuga* of five years. Cf. *Arthaśāstra*, *Pañcasiddhāntikā*, *Lokaprajñapti*, *Vāyupurāṇa*, *Vedāṅgajyotiṣa* (pp. 5, 27, 59, 61 and 75).

1.3.10cd

Verse 1.3.10cd defines the day and the night for gods respectively as *uttarāyaṇa* and *dakṣiṇāyana*, and the next eleven and a half verses (1.3.11–22b) define the *caturyuga-manu-kalpa* system as follows without the word *kalpa*.

1 *caturyuga*	=	12000 *divya-varṣas* (divine years),
kṛta-yuga, etc.	=	1000*i*, respective *saṃdhyā* = *saṃdhyāṃśa* = 100*i*, where *i* = 4, 3, 2, 1 for *kṛta-*, *tretā-*, *dvāpara-*, and *kali-yugas*;
1 day of Brahmā	=	1000 *caturyugas* = 14 *manvantaras*,
1 *manvantara*	=	71 *caturyugas*
	=	852000 *divya-varṣas* (divine years)
	=	306720000 *mānuṣa-varṣas* (human years).

6.3.10b–12b

Verses 6.3.10b–12b repeat the same definition of the *caturyuga-manu-kalpa* system without a definition of *manu*.

1 *varṣa* (year)	=	1 *divya-ahorātra* (divine day-and-night),
360 *divya-ahorātras*	=	1 *divya-varṣa*,
12000 *divya-varṣas*	=	1 *caturyuga*,
1000 *caturyugas*	=	1 *dina* (day) of Brahmā
	=	1 *kalpa*
	=	14 *manus*.

The above table of *Viṣṇupurāṇa* 1.3.8–10b is repeated almost verbatim in *Kūrmamahāpurāṇa*, pūrva, 5.6c–8.

48 VIṢṆUSMṚTI

20.1–18

Cords 20.1–18 define the divine time units from the *ahorātra* up to the *mahā-kalpa*:

1 *saṃvatsara* (year) ⟨of men⟩	=	1 *ahorātra* (day-and-night) of gods, where the day is *uttarāyaṇa* and the night is *dakṣiṇāyana*,

30 ⟨divine⟩ *ahorātras* = 1 ⟨divine⟩ *māsa*,
12 ⟨divine⟩ *māsas* = 1 ⟨divine⟩ *varṣa*,
1200 divine *varṣas* = 1 *kali-yuga* (Ka),
2 Ka = 1 *dvāpara-yuga*,
3 Ka = 1 *tretā-yuga*,
4 Ka = 1 *kṛta-yuga*,
12000 divine *varṣas* = 1 *caturyuga*,
71 *caturyugas* = 1 *manvantara*,
1000 *caturyugas* = 1 *kalpa*
= Day of Pitāmaha (i.e., Brahmā)
= Night of Pitāmaha,
100 *varṣas* = life span of Brahmā
⟨= 2 *kalpas* × 360 × 100
= 72000 *kalpas*⟩
= Day of Puruṣa
= Night of Puruṣa
= 1 *mahā-kalpa* (great *kalpa*).

20.19–22

And then cords 20.19–22 say that 'the number (*saṃkhyā*) of the past day-and-nights for Puruṣa does not exist (*nāsti*, i.e., countless or *asaṃkhya*), nor does that of the future day-and-nights for Puruṣa, because time has neither beginning nor end.'

49 VEDĀṄGAJYOTIṢA

The *Vedāṅgajyotiṣa*, in Sastry and K. V. Sarma's edition, pp. 37–39, gives the following relationships.

	ak	*kā*	*pā*	*ka*	*nā*	*mu*	*ah*
akṣara	1						
kāṣṭhā	**5**	1					
pāda	155	**31**	1				
kalā	620	124	[a]⟨**4**⟩	1			
nāḍikā	6231	$1246\frac{1}{5}$	$40\frac{1}{5}$	$10\frac{1}{20}$	1		
muhūrta	12462	$2492\frac{2}{5}$	$80\frac{2}{5}$	$20\frac{1}{10}$	**2**	1	
ahan	373860	74772	2412	**603**	60	**30**	1

[a] The conversion ratio, 4, between *pāda* and *kalā* is not given but inferred from the meaning of the word *pāda* ('quarter') itself.

	ah	*mā*	*ṛ*	*ay*	*ab*	*yu*
ahan	1					
māsa (*sūrya-*)	$30\frac{1}{2}$	1				
ṛtu	61	**2**	1			
ayana	183	6	3	1		
abda	[a]**366**	**12**	**6**	**2**	1	
yuga	1830	60	30	10	**5**	1

[a] In Sastry and K. V. Sarma's edition, verse 28 of the Yājuṣa recension reads:

त्रिंशत्यह्नां स⟨षट्⟩षष्टिरब्दः षड्ऋतवोऽयने।
मासा द्वादश सूर्याः स्युरेतत्पञ्चगुणं युगम्॥

where I supplied '**षट्**' in the first line as '**सषष्टिर्**' is obviously a typographic error (see Sastry and K. V. Sarma's translation and note 1 on p. 39).

In the same context (Sastry and K. V. Sarma's ed., p. 37), the text vaguely alludes to a water clock for measuring one *nāḍikā*. It is most probably the one later called *nāḍikā* ('tube'), a clepsydra of the outflowing type. See Falk 2000: 116–17.

The *Vedāṅgajyotiṣa* (Sastry and K. V. Sarma's ed., pp. 46–47 etc.) also uses the concepts of the (mean) *tithi* and the *parvan*, that is, one thirtieth and a half, respectively, of a lunar (synodic) month: 1 synodic month = 2 *parvans* = 30 *tithis*. Since the five year *yuga* contains 62 synodic months (pp. 41–42), the number of *parvans* in a *yuga* is 124. Compare this with 120 in the *Vāyupurāṇa* (3rd table) and 130 in the *Bramāṇḍapurāṇa* (2nd table), pp. 61, 38 above.

50 ŚATAPATHABRĀHMAṆA

12.3.2.2–6

Paragraphs 12.3.2.2–6 give the following relationships.

	prā	*i*	*e*	*kṣi*	*mu*	*ah*	*ar*	*mā*	*saṃ*
prāṇa	1								
idāni	**15**	1							
etarhi	225	**15**	1						
kṣipra	3375	225	**15**	1					
muhūrta	50625	3375	225	**15**	1				
ahorātra	1518750	101250	6750	450	30	1			
ardhamāsa					450	15	1		
māsa					900	30	2	1	
saṃvatsara					**10800**	**360**	**24**	**12**	1

The words *ana* (breath) and *nimeṣa* (twinkling) are also mentioned as synonyms of *prāṇa* (breath).

The *Taittirīyabrāhmaṇa* in 3.12.9.6 refers to *muhūrtas* as submultiples of the day and the night: अहोरात्रे पशुपाल्यौ। मुहूर्ताः प्रेष्या अभवन्। ('The day and the night were tenders of cattle. The *muhūrtas* were servants.'); and in 3.9.10.1–3 and 7 lists their names. Each *muhūrta* is given a proper name also in the *Śārdūlakarṇāvadāna*. See p. 79 below.

51 ŚĀṄKHĀYANĀRAṆYAKA

7.21

Śāṅkhāyanāraṇyaka 7.21 enumerates the eleven time units from *dhvaṃsi* to *saṃvatsara* without conversion ratios as listed in the first column of the following table while *Śāṅkhāyanaśrautasūtra* 14.75–82 allows us to reconstruct the conversion ratios as given in the table. See Keith 1908: 49, n. 3. We cannot restore the conversion ratios of the three units, *kāṣṭhā*, *kalā* and *kṣaṇa*.

	dhva	*ni*	*kā*	*ka*	*kṣa*	*mu*	*ah*	*ar*	*mā*	*ṛ*	*saṃ*
dhvaṃsi	1										
nimeṣa	**10**	1									
kāṣṭhā			1								
kalā				1							
kṣaṇa					1						
muhūrta	100	**10**				1					
ahorātra	3000	300				30	1				
ardhamāsa[a]	45000	4500				450	15	1			
māsa	90000	9000				900	30	**2**	1		
ṛtu	180000	18000				1800	60	4	**2**	1	
saṃvatsara	**1080000**	**108000**				**10800**	360	**24**	**12**	**6**	1

[a] The word *pakṣa* also occurs in *Śāṅkhāyanāraṇyaka* 2.5 in relation to the two halves of a month: तौ वा एतौ पक्षौ बार्हतराथन्तरौ चतुर्विंशौ। चतुर्विंशतिर्वै संवत्सरस्यार्धमासाः संवत्सरस्यैवाप्त्यै।

Chattopadyay (1992: 217) reconstructs the table of *Śāṅkhāyanāraṇyaka* 7.21 as follows without documentation. He lists the conversion ratios printed in bold face in this table after saying: 'If *dhvaṃsi* is taken as the smallest unit, being $\frac{1}{100}$th part of a *muhūrta*, the divisions of time with measurement are as follows.'

Chattopadhyay's reconstruction

	dhva	*ni*	*kā*	*ka*	*kṣa*	*mu*	*ah*	*ar*	*mā*	*ṛ*	*saṃ*
dhvaṃsi	1										
nimeṣa	**2**	1									
kāṣṭhā	4	**2**	1								
kalā	10	5	$2\frac{1}{2}$	1							
kṣaṇa	50	25	$12\frac{1}{2}$	**5**	1						
muhūrta	*100*	50	25	10	**2**	1					
ahorātra	3000	1500	750	300	60	**30**	1				
ardhamāsa						450	**15**	1			
māsa						900	30	**2**	1		
ṛtu						1800	60	4	**2**	1	
saṃvatsara						10800	360	24	12	**6**	1

52 ŚĀRDŪLAKARṆĀVADĀNA

The *Śārdūlakarṇāvadāna* refers to three systems of time units. In the following tables, 'C-N,' 'M,' and 'V' indicate respectively Cowell and Neil's, Mukhopadhyaya's, and Vaidya's editions.

System 1 (C-N, pp. 643–44; M, p. 56; V, p. 337)

	ta	*kṣa*	*la*	*mu*	*a*	*mā*	*saṃ*
tatkṣaṇa[a]	1						
kṣaṇa	**120**	1					
lava	7200	**60**	1				
muhūrta	216000	1800	**30**	1			
ahorātra	6480000	54000	900	**30**	1		
māsa	194400000	1620000	2700	900	**30**	1	
saṃvatsara	2332800000	19440000	324000	10800	360	**12**	1

[a] The *tatkṣaṇa* is defined as follows (exactly the same passage occurs twice).

> भोः पुष्करसारिन्स्त्रिया नातिदीर्घह्रस्वकर्तिन्याः सूत्रोद्यामः। एवंदीर्घस्तत्क्षणः। (C-N, pp. 643 and 644; M, pp. 54 and 56; V, pp. 336 and 337: M and V read -ह्रस्वः कर्तिन्याः)
>
> 'Oh Puṣkarasārin, the *tatkṣaṇa* is ⟨the time⟩ of such length, so to speak, that a spinning lady raises a thread neither too long nor too short.'

System 2a (C-N, p. 644)

	ak	*la*	*kā*	*ka*	*nā*	*mu*	*ah*
akṣinimeṣa	1						
lava	**2**	1					
kāṣṭhā	8	**4**	1				
kalā	320	160	**40**	1			
nālikā	9920	4960	1240	**31**	1		
muhūrta	19840	9920	2480	62	**2**	1	
ahorātra	595200	297600	74400	1860	60	⟨30⟩	1

System 2b (M, pp. 57–58; V, p. 337)

	ni	*la*	*kā*	*ka*	*nā*	*mu*	*rā*
nimeṣa	1						
lava	**2**	1					
kāṣṭhā	16	**8**	1				
kalā	256	128	**16**	1			
nālikā	7680	3840	480	**30**	1		
muhūrta	15360	7680	960	60	**2**	1	
rātridivasa	460800	230400	28800	1800	60	**30**	1

System 3a (C-N, p. 645)

	ni	*kā*	*ka*	*mu*	*a*	*mā*	*saṃ*
nimeṣa	1						
kāṣṭhā	**16**	1					
kalā	256	**16**	1				
muhūrta	16384	1024	**64**	1			
ahorātra	491520	30720	1920	**30**	1		
māsa	14745600	921600	57600	900	**30**	1	
saṃvatsara	176947200	11059200	691200	10800	360	**12**	1

The conversion ratio 64 in this table is corrupted. It should be 60 as in the next table. Other numbers obtained by calculation based on it are naturally wrong. The number of *nimeṣas* in a *saṃvatsara* is given as follows but the text is corrupted here also.

> एते पुनरक्षिनिमेषेण षोडश काष्ठा अष्टपञ्चाशच्च शतसहस्राणि तदेवं मापिताः।
>
> On the other hand, these are measured by *akṣinimeṣa*: sixteen *kāṣṭhās*(?) and fifty-eight hundred thousand. Thus it is.

These are corrected in the editions of Mukhopadhyaya and Vaidya.

System 3b (M, p. 58; V, p. 338)

	ni	*kā*	*ka*	*mu*	*a*	*mā*	*saṃ*
nimeṣa	1						
kāṣṭhā	**16**	1					
kalā	256	**16**	1				
muhūrta	15360	960	**60**	1			
ahorātra	460800	28800	1800	**30**	1		
māsa	13824000	864000	54000	900	**30**	1	
saṃvatsara	**165888000**	10368000	648000	10800	360	**12**	1

Immediately before the time units the names of the thirty *muhūrtas* of one day are listed, fifteen each for the day and the night, where the fifteen for the day are accompanied by shadow lengths in *pauruṣa* (man). For *pauruṣa* see *pauruṣī* in the *Arthaśāstra* (p. 5 above).

Muhūrta no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Shadow length	96	60	12	6	5	4	3	–	3	4	5	6	12	60	96

As the list has 15 *muhūrtas* for the daylight, the shadow lengths given here must be those for the equinoctial days. The same list with exactly the same numerals occurs also in the two Chinese translations with the linear measures 尋 (fathom) in T1300.21.0408c28–0409a08 and 尺 (feet) in T1301.21.0416b12–21.

The shadow length for the eighth *muhūrta*, i.e., midday, is not given in the extant Sanskrit text and in T1301 but T1300 says that at that time 'the shadow is the same as the man' (影共人等). This may sugget that the Sanskrit text originally listed 'one *pauruṣa*' (man) for the equinoctial midday shadow. But the four shadow lengths before midday in this list decrease linearly and those after midday increase linearly again. This would rather suggest 'two *pauruṣas*' for the midday shadow. See the following diagram, where the plot is based on the assumption that the fifteen (in fact fourteen) shadow lengths are meant for the midpoint of each *muhūrta*.

Cf. the list of shadow lengths in the *Arthaśāstra* (p. 5 above).

53 ŚĀRDŪLAKARṆĀVADĀNA–CHINESE 1

T1300.21.0408C25–28

The *Śārdūlakarṇāvadāna*, in Chinese translation 摩登伽経, T1300.21.0408c25–28, gives the following relationships.

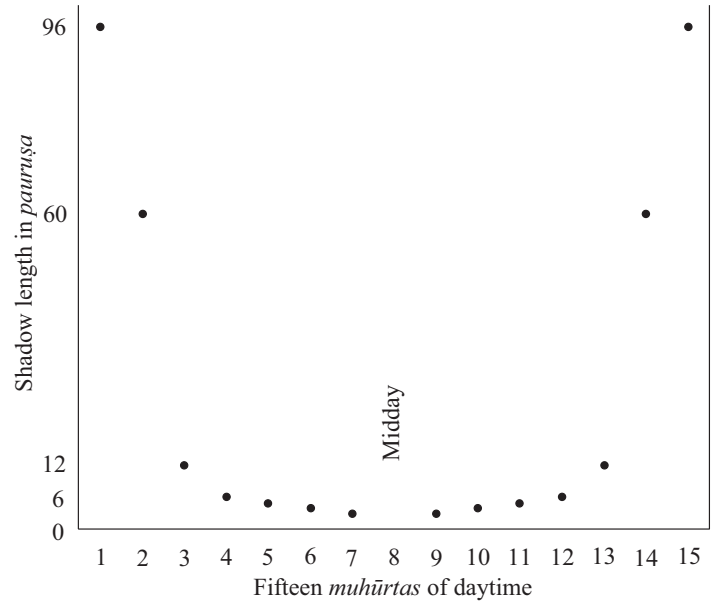

Figure 7: The shadow data in the *Śārdūlakarṇāvadāna*.

	Skt.	*kṣa*	*la*	*mu*	*a*
刹那	*kṣaṇa*	1			
羅婆	*lava*	**60**	1		
時	*muhūrta*	1800	**30**	1	
日夜	*ahorātra*	54000	900	**30**	1

The *kṣaṇa* (刹那) is defined as the time in which a lady spins one fathom (尋) of thread: 婦人紡糸得長一尋是則名爲刹那時也 (T1300.21.0408c25–26)

54 ŚĀRDŪLAKARṆĀVADĀNA–CHINESE 2

T1301.21.0416B07–11 & B28-C02

The *Śārdūlakarṇāvadāna*, in Chinese translation 舍頭諫太子二十八宿経, T1301.21.0416b07–11 & b28-c02, gives the following relationships.

System 1 (T1301.21.0416b07–11)

	Skt.	*kṣa*	*la*	*mu*	*a*
節	*kṣaṇa*	1			
限	*lava*	**60**	1		
須臾	*muhūrta*	720	**12**	1	
晝夜	*ahorātra*	21600	360	**30**	1

The *kṣaṇa* (節) is defined as the time in which a man cuts exactly three feet (尺) of thread, neither longer nor shorter: 譬如有人切三尺縷不長不短是號爲節 (T1301.21.0416b08–09)

The same passage cited by Entsū (Bukkokurekishōhen: 3.40b) reads 二十 (20) instead of 十二 (12). The resulting table is as follows.

System 1a (the same passage cited by Entsu)

	Skt.	*kṣa*	*la*	*mu*	*a*
節	*kṣaṇa*	1			
限	*lava*	**60**	1		
須臾	*muhūrta*	1200	**20**	1	
晝夜	*ahorātra*	36000	600	**30**	1

Seventeen lines after the above table in T1301, another system is stated:

System 2 (T1301.21.0416b28-c02)

	Skt.	*ni*	*kā*	*ka*	*mu*	*a*	*mā*	*va*
瞬	*nimeṣa*	1						
卒	*kāṣṭhā*	**15**	1					
時	*kalā*	300	**20**	1				
須臾	*muhūrta*	9000	600	**30**	1			
晝夜	*ahorātra*	270000	18000	900	**30**	1		
月	*māsa*	8100000	540000	27000	900	**30**	1	
年	*varṣa*	97200000	6480000	324000	10800	360	**12**	1

55 SAMARĀṄGAṆASŪTRADHĀRA

9.50c–53

Verses 9.50c–53 give the following relationships.

	ni	*kā*	*ka*	*mu*	*ah*	*pa*	*mā*	*ṛ*	*ay*	*va*
nimeṣa	1									
kāṣṭhā	**15**	1								
kalā	450	**30**	1							
muhūrta	13500	900	**30**	1						
ahorātra	405000	27000	900	**30**	1					
pakṣa					**15**	1				
māsa					30	**2**	1			
ṛtu					60	4	**2**	1		
ayana					180	12	6	**3**	1	
vatsara					360	24	12	6	**2**	1

56 SIDDHĀNTAŚIROMAṆI

BHĀSKARA II defines two systems of time units in the first section called Kālamāna (measurement of time) of the first chapter Madhyamādhikāra (on the mean planets) of the third book *Grahagaṇitādhyāya* (on the calculation of the planets) of his *Siddhāntaśiromaṇi* (1150 CE).

System 1 (Verses 17c–18b)

	gu	*a*	*pa*	*gha*	*di*	*mā*	*va*
gurvakṣara	1						
asu	**10**	1					
pala	60	**6**	1				
ghaṭikā[a]	3600	360	**60**	1			
dina	216000	21600	3600	**60**	1		
māsa	6480000	648000	108000	1800	**30**	1	
varṣa	77760000	7776000	1296000	21600	360	**12**	1

[a] The *ghaṭikā* is *ārkṣī* (sidereal).

System 2 (Verses 16–17b)

	tru	*ta*	*ni*	*kā*	*ka*	*gha*	*kṣa*	*di*
truṭi	1							
tatpara	**100**	1						
nimeṣa	3000	**30**	1					
kāṣṭhā	54000	540	**18**	1				
kalā	1620000	16200	540	**30**	1			
ghaṭikā	48600000	486000	16200	900	**30**	1		
kṣaṇa[a]	97200000	972000	32400	1800	60	**2**	1	
dina	2916000000	29160000	972000	54000	1800	60	**30**	1

[a] The *muhūrta* is substituted for *kṣaṇa* in the auto-commentary.

18CD

Verse 18cd refers to the divisions of arc, i.e., *cakra* (circle), *rāśi*, *aṃśa*, *kalā*, and *viliptā*, which are parallel to the above divisions of time from the year (*samā* = *varṣa*) to *pala* in System 1. Cf. *Ārybhaṭīya* and *Brāhmasphuṭasiddhānta* above.

19

Verse 19 defines the solar year and the lunar (synodic) month:

1 *ravi-varṣa* (solar year) = one revolution of the sun along the ecliptic,
1 *vidhu-māsa* (lunar month) = interval between two consecutive conjunctions of the sun and the moon.

These are regarded as *daiva-dyurātra* (divine day-and-night) and *paitra-dyurātra* (ancestral day-and-night), respectively. In his own *Vāsanā* on this verse, Bhāskara states that the *ravi-varṣa* is divided into subunits according to the previous definitions (*pūrva-paribhāṣayā*), that is to say,

1 *ravi-varṣa* (solar year) = 12 *ravi-māsas* (solar months),
1 *ravi-māsa* = 30 *arka-dinas* (solar days),
1 *arka-dina* = 60 *arka-ghaṭikās* (solar *ghaṭikās*),
1 *arka-ghaṭikā* = 60 *arka-vighaṭikās* (solar *vighaṭikās*).

In the same *Vāsanā*, he also says: 1 *daiva-varṣa* (divine year) = 12 *daiva-māsas* (divine months) = 360 *daiva-dyurātras* (divine day-and-nights).

20

Verse 20 defines the civil day and the sidereal day.

1 *sāvana-dina* (civil day) = interval between two consecutive sunrises,
1 *nākṣatra-dina* (sidereal day) = one revolution of stars (*bhas*).

Bhāskara adds that the *sāvana-dina* is also called *ku-dina* (earth day) and that the interval between two consecutive rises of each planet (*graha*) defines the 'civil day' (*sāvana-dina*) of that planet.

21–25B

Verses 21–25b define the *yuga-manu-kalpa* system, which is exactly the same as that of the *Siddhāntaśekhara* and eventually the same as that of the *Sūryasiddhānta*. See below.

1 *kṛta-yuga* (Kṛ) = 432000 × 4 *ravi-varṣas*,
1 *tretā-yuga* (Tr) = 432000 × 3 *ravi-varṣas*,
1 *dvāpara-yuga* (Dv) = 432000 × 2 *ravi-varṣas*,
1 *kali-yuga* (Ka) = 432000 × 1 *ravi-varṣas*,
1 *saṃdhyakā* of *kṛta-yuga* etc. = 1 *saṃdhyakāṃśa* of the same *yuga*
= $\frac{1}{12}$ of that *yuga*, [which occupy the beginning and the end of the respective *yuga*,]
1 *yuga* = Kṛ + Tr + Dv + Ka
= 4320000 *ravi-varṣas*,
1 *manu* = 71 *yugas*,
1 *kalpa* = 14 *manus* + 15 *saṃdhis* = 1000 *yugas*, where 1 *saṃdhi* = 1 Kṛ
1 day-and-night of Brahmā = 2 *kalpas*,
1 *mahā-kalpa* = life of Brahmā
= 100 *varṣas* of His own ⟨= 72000 *kalpas*⟩.

25CD

In 25cd he adds that he does not know how many Brahmās or *mahā-kalpas* have gone because the time has no beginning.

57 SIDDHĀNTAŚEKHARA

1.11

Verse 1.11 says that time (*kāla*) is the cause of the Duration, Destruction and Creation of the world, that it is of two kinds, 'gross' (*sthūla* or *anaṇu*) and 'subtle' (*sūkṣma* or *aṇu*), and that the former, which begins with *asu* ('breath'), is also called 'real' (*mūrta*, lit. 'embodied') and the latter, which begins with *truṭi*, 'unreal' (*amūrta*, lit. 'not embodied').

1.12–13

Verses 1.12–13 define two systems of the 'real' time units, where *asu* is replaced with one of its synonyms, *prāṇa*.

System 1 (verse 12)

	dvi	*prā*	*vi*	*gha*	*a*
dvimātrākṣara[a]	1				
prāṇa	**10**	1			
vināḍikā (*ārkṣī*)	60	**6**	1		
ghaṭī	3600	360	**60**	1	
ahorātra (*ārkṣa*)	216000	21600	3600	**60**	1

[a] The *dvimātrākṣara* means 'letter (i.e. syllable) of two *mātrās* (morae).'

System 2-real (verse 13)

	ni	*kā*	*ka*	*gha*	*kṣa*	*a*
nimeṣa	1					
kāṣṭhā	**18**	1				
kalā	540	**30**	1			
ghaṭikā	16200	900	**30**	1		
kṣaṇa	32400	1800	60	**2**	1	
aharniśa	972000	54000	1800	60	**30**	1

System 1 is for the *ārkṣa* (sidereal) measurement while System 2 for other purposes related to the civil day.

1.14

Verse 1.14 gives the relations of the 'unreal' time units, which must be connected with System 2. Cf. System 2 of the *Siddhāntaśiromaṇi*, p. 84.

System 2-unreal (verse 14)

	tru	*ta*	*ni*
truṭi	1		
tatparā	**100**	1	
nimeṣa	3000	**30**	1

1.15

Verse 1.15 gives the following relations and refers to the similar structure in the arc divisions, *cakra*, *kṣa* (or *rāśi*), *aṃśa*, *liptā*, and *viliptā*. Cf. *Brāhmasphuṭasiddhānta* and *Siddhāntaśiromaṇi* above, pp. 39 and 84.

	a	*mā*	*va*
aharniśa	1		
māsa	**30**	1	
varṣa	360	**12**	1

1.16–20

Verses 1.16–20c define the *yuga-manu-kalpa* system, which is eventually the same as that of the *Sūryasiddhānta*.

1 *kali-yuga* (Ka) = 432000 × 1 *arka-varṣas*,
1 *dvāpara-yuga* (Dv) = 432000 × 2 *arka-varṣas*,
1 *tretā-yuga* (Tr) = 432000 × 3 *arka-varṣas*,
1 *kṛta-yuga* (Kṛ) = 432000 × 4 *arka-varṣas*,
1 *saṃdhyā* of *kṛta-yuga* etc. = 1 *saṃdhyāṃśa* of the same *yuga*
= $\frac{1}{12}$ of that *yuga*, [which occupy the beginning and the end of the respective *yuga*,]
1 *caturyuga* = Kṛ + Tr + Dv + Ka = 4320000 *arka-varṣas*,
1 *manu* = 71 *caturyugas*,
1 *kalpa* = 14 *manus* + 15 *saṃdhis* = 1000 *caturyugas*, where 1 *saṃdhi* = 1 Kṛ and 15 *saṃdhis* = 6 *caturyugas*,

1 day-and-night of Brahmā = 2 *kalpas*,
1 *mahā-kalpa* = life of Brahmā = 100 *varṣas* of His own ⟨= 72000 *kalpas*⟩.

Verse 20d adds that we do not know how many Brahmās (or *mahā-kalpas*) have gone because of the time's endlessness (*ānantya*).

58 SUVARṆAPRABHĀSASŪTRA

The Suvarṇaprabhāsasūtra (v. 5 on p. 94) refers to the four seasons of three months each of a year (I owe this information to Yukio Ôhashi). They are called *varṣā* (rainy), *śārada* (autumnal), *hemānta* (cold), and *grīṣmika* (hot). The two Chinese translations of the same work, 金光明經 (T0663.16.0351c29–0352a03) and 合部金光明經 (T0664.16.0395a10–13) render these four seasons (四時) as 夏 (summer), 秋 (autumn), 冬 (winter), and 春 (spring) respectively. Cf. 大唐西域記 above, p. 20

It is noteworthy that the *Suvarṇaprabhāsasūtra* does not use the word *ṛtu* (season) with regard to these four divisions of a year whereas it mentions the concept of *ṣaḍṛtūni* (six seasons) immediately after them (v. 6 on p. 95), although the Chinese translations use one and the same word (時) for both (四時 and 六時).

59 SUŚRUTASAṂHITĀ

The *Suśrutasaṃhitā*, at the beginning of Chapter 6 on *ṛtu-caryā* (seasonal routine) of the first part (Sūtrasthāna), gives definitions of 11 time units from *akṣinimeṣa* (or *nimeṣa* in some editions) to *yuga*.

1.6.3

The first half of sūtra 3 states characteristic features of time (*kāla*):

> Kāla (time) is (all poweful), self-emerged and without beginning, middle and end. Thereon are dependent derangement and excellence of rasa (nourishing sap) and also life and death of men. ...//3// (Tr. Sharma 1981–1994: 1.73)

1.6.4

Sūtra 4 enumerates the names of time divisions which the sun makes by its motion:

> Of that ⟨Kāla⟩ having the identity as saṃvatsara (year), Lord Sun

makes further divisions into akṣinimeṣa (blinking of eye), kāṣṭhā, kalā, muhūrta, day and night, fortnight, month, season, courses, year and yuga by His specific movements.//4// (Tr. Sharma 1981–1994: 1.74; the insertion of 'Kāla' by me.)

1.6.5–9

Sūtras 5–9 first defines the smallest unit *akṣinimeṣa* as the time for pronouncing a light letter (i.e. a short syllable) (*laghv-akṣara-uccāraṇa-mātra*) and then gives the following relationships with descriptions of the six seasons also in sūtras 6–7.

	ak	*kā*	*ka*	*mu*	*ah*
akṣinimeṣa	1				
kāṣṭhā	**15**	1			
kalā	450	**30**	1		
muhūrta	9045	603	[a]$20\frac{1}{10}$	1	
ahorātra	271350	18090	603	**30**	1

[a] For this ratio see *Vedāṅgajyotiṣa*.

	ah	*pa*	*mā*	*ṛ*	*ay*	*saṃ*	*yu*
ahorātra	1						
pakṣa	**15**	1					
māsa	30	[a]**2**	1				
ṛtu	60	4	**2**	1			
ayana	180	12	6	3	1		
saṃvatsara	360	24	[b]**12**	**6**	**2**	1	
yuga	1800	120	60	30	10	**5**	1

[a] Refers to the 'white and black' *pakṣas*: …पक्षः। स च द्विविधः। शुक्लः कृष्णश्च। तौ मासः। (1.6.5)

[b] तत्र माघादयो द्वादश मासाः संवत्सरः। (1.6.6).

Note that the table recorded in *Mahābhārata* 12.224.12–13 is part of this table although the ratio of *muhūrta* to *kalā* in it is $30\frac{1}{10}$ instead of $20\frac{1}{10}$.

Hemādri has recorded a similar but slightly different table in his commentary on Vāgbhaṭa's *Aṣṭāṅgahṛdaya* 1.1.24. Explaining the compound *kṣaṇādi* ('*kṣaṇa* etc.') that occurs in verse 24, he equates the *kṣaṇa* to *akṣinimeṣa*, enumerates the time units that follow the *akṣinimeṣa*, and states the conversion ratios between them as follows.

	ak	*kā*	*ka*	*nā*	*mu*	*yā*	*ah*
akṣinimeṣa	1						
kāṣṭhā	**15**	1					
kalā	450	**30**	1				
nāḍikā	9045	603	[a] $20\frac{1}{10}$	1			
muhūrta	18090	1206	$40\frac{1}{5}$	**2**	1		
yāma	$67837\frac{1}{2}$	$4522\frac{1}{2}$	$150\frac{3}{4}$	$7\frac{1}{2}$	[b] $4-\frac{1}{4}$	1	
ahorātra	542700	36180	1206	60	30	[c] **4–4**	1

[a] According to Vogel (1965: 66), Hemādri inserts another unit called *bhāga* between *kalā* and *nāḍikā* with the conversion ratios, 17 *kalās* = 1 *bhāga* and 20 *bhāgas* = 1 *nāḍikā*; consequently we have 340 *kalās* = 1 *nāḍikā*. This unit *bhāga* has not so far been found elsewhere. The text used by Vogel may be corrupt here.

[b] Here Hemādri adds a conditional clause, *tulyarātriṃdive rāśibhāge*. This no doubt refers to the condition for the equation, $3\frac{3}{4}$ *muhūrtas* = 1 *yāma*, which is correct only when the night and the day have equal lengths because the *yāma* is a seasonal (variable) time unit (see under the first table of the *Brahmavaivartapurāṇa*), although I do not understand the latter term, *rāśibhāge*.

[c] 'By four of them ⟨is made⟩ a day and so also a night' (तैश्चतुर्भिरहो रात्रिश्च).

Hemādri's table after the *ahorātra* is the same as Suśruta's table up to *saṃvatsara*, though it uses the term *varṣa* for *saṃvatsara* and gives the relationship 3 *ṛtus* = 1 *ayana* instead of 6 *ṛtus* = 1 *varṣa*. Note that this table contains *nāḍikā* and *yāma* which Suśruta's does not.

60 SŪRYASIDDHĀNTA

1.10–11B

Sūryasiddhānta 1.10 speaks of two kinds of time (*kāla*): that which causes the 'end' of the worlds (*lokānām antakṛt*) and that which is characterized by counting (*kalanātmaka*); and says that the latter is of two kinds: real (*mūrta*, lit. 'embodied') and unreal (*amūrta*, lit. 'not embodied') according to whether it is gross (*sthūla*) or subtle (*sūkṣma*). Verse 11ab says that the 'gross' units begin with *prāṇa* and the 'subtle' units with *truṭi*.

1.11C–13B

Then, verses 1.11c–12c give the following table for the former category. The *Sūryasiddhānta* does not mention the units of the latter category other than *truṭi*. Cf. the *Vaṭeśvarasiddhānta*, *Siddhāntaśiromaṇi*, and*Siddhāntaśekhara*, pp. 59, 84 and 87, above.

	prā	*vi*	*nā*	*a*	*mā*	*va*
prāṇa	1					
vināḍī	**6**	1				
nāḍikā/*nāḍī*	360	**60**	1			
ahorātra	21600	3600	**60**	1		
māsa	648000	108000	1800	**30**	1	
varṣa	7776000	1296000	21600	360	**12**	1

The *ahorātra* (a day and night) in this table is said to be *nākṣatra* (sidereal). Naturally, the *māsa* (month) is also sidereal. Other kinds of 'month' too are mentioned in verses 1.12d–13b: 1 *sāvana-māsa* (civil month) = 30 *sūrya-udayas* (sunrises); 1 *aindava-māsa* (lunar month) = 30 *tithis* (= the synodic month, i.e., the cycle of waxing and waning of the moon); 1 *saura-māsa* (solar month) = the interval between two consecutive *saṃkrāntis* (entries into zodiacal constellations), which is conventionally equated with one twelfth of a solar year.

1.14–17

Verses 1.14–17 define time units greater than *varṣa* as follows.

$$
\begin{aligned}
1\ \textit{divya-varṣa}\ (\text{divine year}) &= 360\ \textit{varṣas}\ (\text{human years}),\\
1\ \textit{caturyuga} &= 12000\ \textit{divya-varṣas}\\
&= 4320000\ \textit{sūrya-abdas}\ (\text{solar years})\\
1\ \textit{kaliyuga} &= \tfrac{1}{10}\ \text{of}\ \textit{caturyuga},\\
1\ \textit{dvāparayuga} &= \tfrac{2}{10}\ \text{of}\ \textit{caturyuga},\\
1\ \textit{tretāyuga} &= \tfrac{3}{10}\ \text{of}\ \textit{caturyuga},\\
1\ \textit{kṛtayuga} &= \tfrac{4}{10}\ \text{of}\ \textit{caturyuga},\\
\textit{caturyuga}\ (\text{four}\ \textit{yugas}) &= \textit{kaliyuga} + \textit{dvāparayuga} + \textit{tretāyuga} + \textit{kṛtayuga}.
\end{aligned}
$$

1.37ab

According to verse 1.37ab, on the other hand,

$$
1\ \textit{caturyuga} = 1577917828\ \textit{bhūmi-sāvana-vāsaras}\ (\text{civil days of the earth}).
$$

Therefore we can reconstruct the following table.

	vā	*a*	*ka*	*dvā*	*tre*	*kṛ*	*ca*
vāsara (*sāvana-*)	1						
abda (*sūrya-*)	$365\frac{279457}{1080000}$	1					
kaliyuga	$157791782\frac{4}{5}$	432000	**1**				
dvāparayuga	$315583565\frac{3}{5}$	864000	**2**	1			
tretāyuga	$473375348\frac{2}{5}$	1296000	**3**	3/2	1		
kṛtayuga	$631167131\frac{1}{5}$	1728000	**4**	2	4/3	1	
caturyuga	**1577917828**	**4320000**	**10**	5	10/3	5/2	1

Here we have the relation,

$$1\ \textit{sūrya-abda} = 365\frac{279457}{1080000} \approx 365.2588 \text{ civil days}$$

This shows that, strictly speaking, the 'year' (*abda*) meant here is 'sidereal' rather than 'solar.' This is because the precession of the equinoxes was ignored in Indian astronomy.

1.18–20

Verses 1.18–20 define *manvantara* (Manu's Period) as 71 *caturyugas* and *kalpa* as 14 *manvantaras* with *saṃdhi* ('joint') between them and at the beginning and the end. The length of *saṃdhi* is equal to *kṛtayuga*.

$$\begin{aligned} 1\ \textit{manvantara} &= 71\ \textit{caturyugas}, \\ 1\ \textit{saṃdhi} &= 1\ \textit{kṛtayuga} \\ &= \tfrac{4}{10}\ \textit{caturyuga}, \\ 1\ \textit{kalpa} &= 14\ \textit{manvantaras} + 15\ \textit{saṃdhis} \\ &= 1000\ \textit{caturyugas}. \end{aligned}$$

This is said to be the length of the day for Brahmā, after which the night of the same length comes.

61 CONCLUDING REMARKS

As I wrote at the beginning, this paper is meant to be a preliminary survey, which I hope will be useful for future projects to describe at length the history of time units in India. With this hope in mind I give here a brief sketch of the history in so far as I understand it at present. Since this survey is not

exhaustive, the sketch is only provisional.

Already in the Ṛgvedic period (ca. 1200–1000 BCE), the daytime was roughly divided into five parts from *prātar* (dawn) to *sāyāhna* (evening) (Dikshit 1969–1981: 41–42; Ôhashi 1993: 188). This division is preserved also in the *Purāṇas* (ca. 4th century CE or later, §29, §45, §47).

The division of a civil day into 30 *muhūrtas* (of 48 minutes each) were introduced in or before the Brāhmaṇa period (ca. 800–600 BCE). It has long been conjectured that the number 30 was chosen on the analogy of one of the most apparent natural cyclic phenomena, namely a synodic month. The *muhūrta* was accepted by almost all later tables of time units excepting those for purely astronomical purpose. The *muhūrta* in those days seems to have been measured either by a gnomon or by a water clock (cf. §5).

The *Śatapathabrāhmaṇa*'s table (§50) consists of the year, month, half-month, day-and-night (civil day), *muhūrta*, and four sub-units defined successively by quindecimal fractions of the *muhūrta*. This number 15 must have originated in the analogy of the days in a half month. The smallest unit in this table, *prāṇa* or 'breath,' is approximately equal to 0.057 second, which anticipates the unreal or imaginary portion that most of later tables, except again those for astronomical purpose, contain.

The *muhūrta* was divided into two *nāḍikās* by the time of the *Vedāṅgajyotiṣa* (ca. 500 BCE, §49). The new unit was so called because it was measured by the water clock called *nāḍikā* ('tube' or cylinder). It was of the outflowing type. By the 4th century CE another type of water clock called *ghaṭikā* ('bowl'), i.e., the sinking bowl type, was introduced to measure one *nāḍikā* (S. R. Sarma 2008: 147). Āryabhaṭa (b. 476 CE, §6) uses the unit name *nāḍī* (i.e., *nāḍikā*) in his table of time units in one of his two works and in the other refers to the new device *ghaṭikā*. The outflowing type was gradually replaced by the sinking bowl type and the unit was renamed after the new device (*ghaṭikā*) but even then the old names, *nāḍī* (or *nālī*) and *nāḍikā* (or *nālikā*), continued to be used side by side with the new names, *ghaṭī* and *ghaṭikā*.

The *tithi*, which played, and still plays, a very important role throughout in the history of calendars in India, was also introduced in the calendrical reckoning by the time of the *Vedāṅgajyotiṣa* (§49).

Āryabhaṭa, or someone else shortly before him, introduced a purely sexagesimal divisions of a sidereal day in such a way that the time units from the *varṣa* ('rain' or year) down to the *gurvakṣara* ('heavy syllable') exactly correspond to the divisions of the ecliptic on the celestial sphere from the circle (360°) down to the 3rd of a degree (0;0,0,1°). This table, that does not include *muhūrta*, was obviously meant for astronomy and adopted in almost all later astronomical works.

Bhāskara I (fl. 629 CE), commenting on Āryabhaṭa's table, refers to an example of 'other kinds of time divisions,' which includes the *muhūrta* and the seasonal

time unit called *yāma*; the day and the night were each divided into 4 *yāmas* (or *praharas* in some texts) for daily life (§7). The *Bhāgavatapurāṇa* (§32) provides us with interesting information about the relationship between the seasonal (variable) unit, *prahara*, and the fixed (constant) units, *muhūrta* and *nāḍikā*.

The unreal or imaginary nature of part of Brāhmaṇa tables of time units was inherited, with different names and conversion ratios, in all fields, that is, in the *purāṇas* (§27, §32), in the epic (§37), in Bauddha texts (§2, §3, §17, §18, §38, §39), in Jaina texts (§12, §13, §14), and even in arithmetical and astronomical texts. The oldest extant arithmetical text, *Bakhshālī Manuscript* (§26), which seems contemporaneous with Bhāskara I, used four sexagesimally defined subdivisions of a day; the smallest unit *viliptā* is 0;0,0,0,1 day, which is approximately equal to 0.0067 second. The smallest unit *truṭi* of the *Vaṭeśvarasiddhānta* (904 CE, §44) is approximately equal to 0.0000089 second.

Some astronomers seem to have felt it necessary to distinguish real, practical time units from unreal, imaginary ones. Thus, the *Sūryasiddhānta* (ca. 800 CE, §60) first distinguishes two kinds (or aspects) of time (*kāla*), that is, the time that causes the end of the worlds (*lokāntakṛt*), a notion whose germ may be traced back to the *kāla* as destroyer of human life in the Upaniṣads (González-Reimann 2009: 413–14), and the time that is characterized by counting (*kalanātmaka*), and then divides the latter into two groups, real (*mūrta*) or gross (*sthūla*), which begins with *prāṇa* (also called *asu*; this is not the *prāṇa* of the *Śatapathabrāhmaṇa* mentioned above but the unit of the same name used in the astronomical works), and unreal (*amūrta*) or subtle (*sūkṣma*), which begins with *truṭi* (cf. the two tables in §44). A similar classification of time occurs in the *Siddhāntaśekhara* (ca. 1040 CE, §57).

In the Jaina literature also mentions have been made of the nature of time (*kāla*). The *Jyotiṣkaraṇḍaka* (5th century CE, §14), for example, divides the time, on the one hand, into future (*aṇāgaya*), past (*atīta*), and present (*vaṭṭamāṇa*), and on the other hand, into countable (*saṃkhejja*), uncountable (*asaṃkhejja*), and infinite (*aṇaṃta*). The people of the Jaina faith also speculated about the ultimate unit of time, which they called *samaya* or 'instant' (§12, §14). Mahāvīra (ca. 850 CE), a Jaina mathematician, defined it as the duration of time in which an *aṇu* (a small particle or atom) passes over another *aṇu* (§12). In some of the *purāṇas* (§27, §32), the *aṇu* and *paramāṇu* (ultimately small particle) occur as the names of the two smallest time units.

Thus, the tables of time units up to the year recorded in the texts surveyed here can be boldly classified into two groups, that is, those with *muhūrta* and those without *muhūrta*. The former is obviously meant for various purposes of ordinary life, especially for religious rites, and the latter for technical, especially astronomical, computations. Some of the major works in astronomy such as *Siddhāntaśiromaṇi* (1150 CE, §56) and *Siddhāntaśekhara* (§57) contain tables of both types.

Time units for various periods longer than the year also abundantly occur in the texts surveyed here. Already in the Vedic literature, grouping of two, three, four, five, and six years was mentioned, among which the group of five years seems to have been most popular since each of the five years was given its own name (Pingree 1981: 534–35; Sastry and K. V. Sarma 1985: 11); these names are preserved also in the *purāṇas* (§27, §45). It seems this five year period called *yuga* that was employed, by the time of the *Vedāṅgajyotiṣa* (§49), for the first time as a basic unit for systematic, though crude, intercalation of month in their lunar calendar, although sporadic allusions to the intercalation itself are found already in the early Vedic literature.

The five year *yuga*, with or without two intercalary months, is mentioned also in various texts composed in the period covering a few centuries before and after the Christian era such as the *Arthaśāstra* (§5), *Suśrutasaṃhitā* (§59), *Mahābhārata* (§37), *Jambhūdvīpaprajñapti* (§13), *Jyotiṣkaraṇḍaka* (5th century, §14), *Lokaprajñapti* (6th century or earlier, §43), *Pañcasiddhāntikā* (6th century, §22), and *purāṇas* (ca. 4th century or later, §29, §45, §47).

In the former half of the same period, i.e., in the few centuries before the Christian era, the concept of an enormous time called *kalpa* was growing presumably in some Bauddha circles. The fourth and the fifth rock edicts of king Aśoka record its Prakrit form *kapa* in the sense of the whole duration of the worldly existence (Sircar 1991: 20–23). The Bauddha texts of this and later periods mention a cosmic cycle called *mahā-kalpa* ('great *kalpa*') consisting of *kalpas* and sub-*kalpas*, each characterized by creation and destruction of the worlds (§2, §3, §18, §39). The Jaina texts of the same period also mention a huge cyclic time scale consisting of an ascending (*ussappiṇi*) and a descending (*osappiṇi*) periods (§13).

Presumably in the latter half of the same period, i.e., in the early few centuries of the Christian era, another *yuga* appeared in Hindu texts with a totally new look. It is often called *caturyuga* ('four-fold *yuga*') as it consists of four *yugas* whose durations decrease in the ratios, $4 : 3 : 2 : 1$, in harmony with the decrease of morality and social order. The numbers $\{4, 3, 2, 1\}$ for the ratios and the names of the four constituent *yugas* (*kṛta*, *tretā*, *dvāpara*, and *kali*) originate from the four kinds of throws in a gamble with the vibhītaka seeds (Terminalia bellirica) played since the Ṛgvedic time.

On the analogy of the day and the night of a civil day of human beings, the day and the night for gods were defined as the two periods for the sun's northern and southern courses on the eastern or western horizon and naturally one year for them was defined as 360 divine days or 360 human years (§27). The smallest *yuga* in the *caturyuga* was then defined as 1000 divine years and each constituent *yuga* was made accompanied by its own dawn and dusk, their lengths being one tenth each of that *yuga*. Consequently, the *caturyuga* (also called the divine *yuga*) was equal to 12000 divine years or 4320000 human years. Brahmā's day and

night were severally regarded as lasting for a period of 1000 *caturyugas* (§36). This period of 1000 *caturyugas* was often called *kalpa*, and Brahmā's year and life span (called *mahā-kalpa*) were regarded as consisting respectively of 360 of his own days and 100 of his own years (§44, §48, §56, §57; 108 in §27). Therefore, 1 *kalpa* = day of Brahmā = night of Brahmā = 1000 divine *yugas* = 12×10^6 divine years = 432×10^7 human years, and 1 *mahā-kalpa* = life span of Brahmā = 72000 *kalpas* = 864×10^9 divine years = 31104×10^{10} human years.

Into this *yuga-kalpa* scheme the concept of *manvantara* ('Manu's Period'), which originated from the Ṛgvedic Manu (the father of mankind), was fitted presumably some time after the *Mahābhārata* (§37) and before the *Manusmṛti* (§36). Since 14 Manus of the same life length were assumed to appear in one *kalpa*, if the *kalpa* consists of 1000 *caturyugas*, one *manvantara* must be 71 *caturyugas* and a little more in length. The *Manusmṛti* and some of the early *purāṇas* (e.g., §35, §45) do mention the relation, 1 *manvantara* = 71 *caturyugas*, but do not refer to the small surplus; these *purāṇas* do not even refer to the 1000 *caturyugas*. Presumably, this caused Brahmagupta's criticism (628 CE) that some people 'do not want *saṃdhi* for interstices; their *kalpa* consists of 994 *caturyugas*' (§30). Some other *purāṇas* (§32, §40) added the relation, 1 *kalpa* = 1000 *caturyugas*, without explaining how to treat the surplus.

The problem of the surplus had been solved, either by Brahmagupta himself (§30) or by someone else before him, by distributing it as 15 *saṃdhis* ('joints'), each equal in length to one *kṛtayuga*, for the 13 interstices between consecutive *manvantaras* and at the beginning and end of the *kalpa* ($1000 - 14 \cdot 71 = 6$ *caturyugas* = 15 *kṛtayugas*). Āryabhaṭa (§6) got an integer solution to the problem without resort to the *saṃdhis*. He slightly modified the framework of the *kalpa* itself: 1 *kalpa* = 14 *manvantaras* = 1008 *yugas* (i.e., *caturyugas*), and therefore 1 *manvantara* = 72 *yugas*. But this scheme obtained only a few followers including Vaṭeśvara (904 CE, §44) and the anonymous author of the *Natvāśivam* (§19); the *caturyuga* of the latter, however, was not that of Āryabhaṭa, which consists of four parts of equal length, but the commonly accepted one, which consists of four parts in the ratios, 4 : 3 : 2 : 1.

These *yuga-kalpa* systems were necessary in India not only for the Purāṇic speculations and descriptions of the creation and destruction of the worlds but also for astronomical computations of the mean motions of movable bodies on the celestial sphere.

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