Astronomical Inscriptions at Pagan : A Computer Analysis

J. C. Eade

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We have always assumed, correctly, that astrologers had an important place in the society of the Southeast Asian Mainland. Who would be rash enough to dedicate a Buddha image, on the one hand; or determine the date for a marriage, record a child's birth, on the other, without consulting an expert as to the auspiciousness of the moment?

The record says little about who the experts were, and then only in connection with events sufficiently important to be public: "Ya Sing was the scribe who drew up this inscription ... The king's Indian slave was the stone-cutter who carved it"[1]—one class of professionals (for which "scribe" may be too lowly a designation), another of tradesmen.[2] The reticence in the record, however, is of no great consequence. The very complexity of the calculations required of the horas and the demonstrable competence with which they performed them are sufficient for us to conclude that they were indeed both professional and expert.

The hora's most important tasks were to maintain his society's luni-solar calendar and to determine the positions of the planets. This he did this by operating a computational method that derived from the *Suryasiddhanta*. There are some purists who suppose that the unravelling of the Southeast Asian method can only be accomplished by going back to its Indian sources. This, however, is a mistaken supposition for two reasons. Firstly, the SEAsian method was simplified and segmented in such as way as to allow it to be operated mechanically and without any comprehension of the theoretical basis of its procedures; and secondly, the modifications produced by these changes were sufficient to make the method's results distinctive. In other words, although the system used precisely the same elements as the *Suryasiddhanta*, it did not generate from them precisely the same values for a particular moment in time.

Two vitally important considerations attach to considering how the horas went about their job: they are that their calculation procedures remained stable over time and right across the Southeast Asian Mainland; and that there is only one route to obtaining their results. The astronomical values exhibited by the historical record can be recovered only by implementing precisely the same process and values as the horas themselves used. A few explanations of the procedure survive to the present.[3] It is dismay-

1. Shorto (1971), p. 97, s.v. "ca re".

2. These professionals were sometimes type-cast by Europeans travelling in Southeast Asia: they use the designation "Brahmin" as though it was synonymous with "astrologer".

3. Notably F. G. Faraut, who was taught by the Cambodian Astrologer Royal. He has sometimes been dismissed out of hand—but by people who did not have the competence to judge the value of this work, flawed though it is. Judged as an account of Indic astronomical theory Faraut's work would be

ing, however, to think that after many pages of exposition an author will have determined the position of the planets for one particular moment only—for any other moment the entire procedure has to be reworked. The massive advantage supplied by the computer, on the other hand, is that when once the input for any one day-month-year has returned a correct set of values, it will do the same—rapidly and without computational error—for any other moment in time. By this means the entire historical record can be opened up; an insight can be gained into the accuracy and expertise of the ancient chronographers; and the data, notoriously subject to severe degradation, can be assessed meticulously.

* * *

In his *Research on Pagan Scripts* (Burma Historical Commission, 1964), Bohmu Ba Shin included fifteen inscriptions from four sites, ranging in date from the 1280s to the 1670s AD. His focus was on the epigraphic and linguistic aspects of the data; but fourteen of the inscriptions are accompanied by astronomical diagrams that deserve attention in their own right. Data of this kind is plentiful *in situ*, but there is little or nothing in published form, which makes Ba Shin's the most convenient data to use.[4]

If we think of this type of inscription as a genre, then in its fullest form it is made up of three elements: (1) a horoscope diagram; (2) an inscriptional text or caption; and (3) an astronomical table.[5] In the case of diagram and the table the viewer is assumed —entirely unwarrantably these days—to know what the numbers represent: there is no form of labelling, even by initials, and one is obliged to proceed upon the principle that the function of a particular number is determined by its position in relation to the others.[6]

As a preliminary means of gaining one's bearings it will be useful to consider, first, an allied but slightly simpler example from Northern Thailand. For this purpose the Inscription of Wat Chiang Man, Chiang Mai provides a good example.

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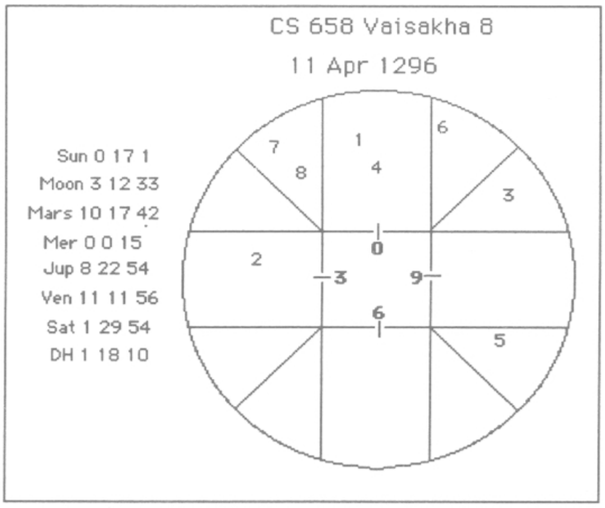
entirely useless: as a account of the actual procedures by which *f.*638 was implemented, it is extremely useful.

4. There are, for instance, very few examples in Luce's Plates, though Plate V. 608a is a particularly fine example of its kind. I am much indebted to M. Pierre Pichard for making available to me photographs of several dozen examples.

5. The tables are particularly useful for the data they contain. I have encountered only three examples of the kind in the Thai record: a Buddha pedestal at Wat Phra Chao Mangrai, Chiang Mai (of 1470 AD); Mission Pavie, no. 28 (of 1587 AD); and Wat Mahathat, Bangkok (?lost), Fine Arts Department, no. 115 (of 1685 AD).

6. The tables do usually carry the numerals 1 to 8 (sometimes 3 4 5 1-2 6 7 8) as planetary labels for their respective columns.



Inscription of Wat Chiang Man, Chiang Mai (Fine Arts Department, no. 76)
Constructed 1581 AD

The horoscope diagram has 12 segments representing the signs of the zodiac. These are read anticlockwise from the top, as follows:

clockface position	name of sign / rasi	number
12	Aries / mesa	0
11	Taurus / prissa	1
10	Gemini / methun	2
9	Cancer / kakkha	3
8	Leo / sinkha	4
7	Virgo / kan	5
6	Libra / tula	6
5	Scorpio / priccha	7
4	Sagittarius / dhanu	8
3	Capricorn / makara	9
2	Aquarius / kum	10
1	Pisces / minna	11

The planets are allocated numerals in weekday order, and these numbers are placed in the segments of the zodiac, the "signs" or "rasi", appropriate to their position at the time:[7]

1 = the sun
2 = the moon
3 = Mars
4 = Mercury
5 = Jupiter
6 = Venus
[7] / 0 = Saturn
8 = Rahu
L = the lagna.

7. Under "planets" (from the geocentric perspective that has to be used here) I include the sun, the moon, and Rahu. The values ranged to the left of the circle in the above diagram are those generated by a computer program and are presented for comparison..

The last three items in this list all require some comment.

• In the Pagan material a zero, rather than a 7, is used to represent Saturn in the diagram.[8]

• The entity in eighth position, "Rahu", is the moon's ascending node, i.e. that point on the sun's path where the moon crosses it when going from south to north of it. More colourfully, in Southeast Asia this point is considered to be the Head of the Dragon that constantly attempts to devour the sun or the moon at eclipse time.

• The entity represented by an "L" is the lagna, known in the West as the ascendant. It is that part of the sky that lies on the observer's eastern horizon at the auspicious moment. The lagna of Southeast Asia and the ascendant of the West have an equal, and major, importance when it comes to the astrological significance of a given diagram.

This then is the organisation of the diagram—from which immediately another constraint emerges. The paths of Mercury and Venus around the sun are such that, as seen from the earth, Mercury cannot appear to be distant more than 22° from the sun and Venus not more than 47° distant from the sun. It follows directly from this that because each slot in the diagram represents 30°, the number 4 (Mercury) cannot be removed more than one segment from the sun; and a 6 (Venus) cannot be more than two segments away from the sun. Were Mercury represented as being two slots away from the sun, its minimum distance from it would necessarily be more than 30°. This constraint, of course, was well known to the ancient chronographers and it is useful to bear it in mind when reading doubtful numbers in the inscriptions. One may add that if one were dealing with a set of inscriptions that had a chronological relation to each other one would bear in mind that

° the sun moves through one rasi each month and is in Aries at the start of the year

° the moon and the sun will be in the same rasi at New Moon and in opposite rasi at Full Moon

° Mars moves through six rasi in a year

° Jupiter moves through one rasi each year

° Saturn takes two and a half years to move through one rasi

° Rahu moves backwards through one rasi every 18 months.

° the Lagna moves through all twelve rasi in 24 hours, and if the sun and the Lagna are in the same rasi, it must be close to dawn.

Kubyauk-nge

Guided by these preliminaries, we may now investigate the Pagan material presented by Ba Shin. The first four examples are from Kubyauk-nge.[9]

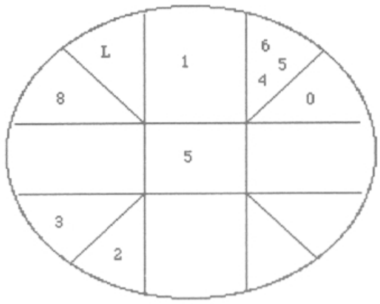
The earliest of the four is dated in its caption to BE 650 month Kason, a Wednesday. The accompanying table is as follows.

8. The most obvious explanation for this involves us in a minor technicality. The calculation system is based upon a value known as the "ahargana" (Burmese: savana; Thai: horakhun), which represents the number of days that have elapsed since the era began. Consequently, a value assigned to the ahargana by definition uniquely identifies a given day. One of the many by-products of this number is that it can by used, modulo 7, to find the weekday, where a remainder of 0 defines Saturday. We can say, then, that the principle whereby 0 answers to Saturday became entrenched to the point where "0", rather than 7, could represent Saturn.

9. Site 1391 / 710, at N: 45.870 E: 6.520 on the grid reference adopted by Pichard (1991) which has Shwe-zigon as its zero.

0 19 59	5 9 45	5 8 45	11 25 48	0 1 3 44	11 17 13	10 3 2 0	0 22 2 59
11 38	11 3 15 1 11	345	6177	530	1403	9763	8
		03	40	5	6	0	
0 18 2	5 14 5	3 8 3					
9	2						
4	4						

8040 | 57 |2374 37| 14677 |880 |



14 April 1288

Since there are eight boxes in the top row of the table, it is reasonable to conjecture that the values given represent planetary positions running from the sun to Rahu. And if this were the case, then the numerals "03 40 5 6 0 -" (3rd row of boxes) could prove in fact to be a distortion of the numeric labels for the planets.

These notions can easily be tested. For instance, if the numbers in the very first row of the table (0 5 5 ...) were the signs occupied by the planets, they ought to correspond with the positions of the planets in the diagram.[10]

boxes, row 3	boxes, row 1, first number	position in diagram
[1 Sun, not labelled]	0	0
[2 Moon, not labelled]	5	5
3 (Mars "03")	5	4
4 (Mercury "40")	11	11
5 (Jupiter)	[10]	11
6 (Venus)	11	11
0 (Saturn)	10	10
8 (Rahu, misplaced)	0	2

10. The values given ought to have three places if they are longitudes—signs, degrees, and minutes. First-place values must be less than 12, second-place values less than 29, and third-place values less than 59.

The match is not complete, but it is sufficiently good to suggest that misreading and/or misplacement, rather than a mistaken hypothesis, will explain the differences.[11] On these grounds we should look at the relation between the planetary labels and the numbers immediately above them:

row 2:	345	6177	530	1403	9763	8
row 3:	[0]3	4[0]	5	6	0	-

The clue to the meaning of row 2 lies in the relative sizes of the numbers, as the following table will indicate. Each planet has a "revolution period", the number of days it takes on average to go round once from Aries 0° back to Aries 0°. Its position at any one time defines its "mean longitude", which could be expressed as so many degrees on the circle of the zodiac but can also be rendered in terms of its "age" in days. If a body revolved from 0° to 360° in 200 days, after 100 days it would be at 180°, and so on:

		inscription		computer	
planet	period[12]	age	position	age	position[13]
3	687	345	180°	369	193.36°
4	8797	6177	252°	6157	251.96°
5	12997	530	14°	505	13.98°
6	2247	1403	224°	1398	223.97°
7	10766	9763	326°	9749	325.99°
8	6795	"8"	--	2963	156.9°
		inscription		computer	

Here it can be seen that Mars's mean longitude is about 12° too low and that Rahu's "8" is its planetary label in the wrong row. Otherwise the match is satisfactory.

As a final check on this part of the data, we may set the table's mean and true longitudes for the sun and the moon against the computer's findings—testing the assumption that this is what is represented in rows 1 and 3 at the left of the table.

	inscription[14]	computer
mean sun	0 18 02	0 18 02
true sun	0 19 59	0 19 59
mean moon	5 14 05	5 14 05
true moon	5 09 45	5 09 37

11. Other evidence from Pagan (unpublished) indicates that where the two differ, values in the table are more likely to be correct than those in the diagram. For instance, site 258, Shwe-leik-pauk, has a horoscope for BE 987 on the north wall of the shrine, in which the planetary table is correct in all places but the diagram mislocates three of the eight numerals (those for sun, moon, and Mars).

12. As a device to avoid fractions the calendrists multiply Mercury's period by 100, Jupiter's by 3, and Venus' by 10. Mercury's actual period is 87.97 days, not 8797 days.

13. These are values generated by a computer program for midnight on 14 April 1288 AD. In the SEAsian system the values for the Mean Sun are found the by method of the *Surya Siddhanta* but then are routinely reduced by 3′ of arc, a modification that has the effect of locating them at about 94°E (i.e. 18° east of Ujjain), a value acceptable for Pagan.

14. The SEAsian system does not use zeros in the tens position, but in the interests of clarity it is useful to add them.

It remains now to examine more closely the other planetary values in row 1. For instance, which is correct—the zata's "3" (Mars) in rasi 4 (Leo), or the table's "5" (for Virgo)?

	duang	inscription	computer
Mars	4	5 08 45	5 05 18
Mercury	11	11 25 48	11 27 08
Jupiter	11	0 13 44	0 17 45
Venus	11	11 17 13	11 14 34
Saturn	10	10 23 00	10 22 13
Rahu	2	0 22 59	6 22 49

For Mars and Jupiter the table's reading are preferable; Rahu is twice in error.

The true longitudes do not agree with the computer as well as do the mean longitudes. The reason for this is that the process of deriving true position from mean position requires four separate adjustments for each planet, where the effect of any slight error or of any slight difference in the Correction Tables used will be cumulative. In the case of Rahu, on the other hand, where no such form of correction is needed, the astrologer got into the wrong quadrant and produced a 180° reversal in its position.

We may now turn our attention to the rest of the table. There we find "11 38" below the sun and "11 3 15 1 11" below the moon, where we already have a sense that position in the table means something, that the grouping of the values is intended to reflect relationships.

Even in the simpler forms of inscription, where there are no diagrams, the horas often present two values, those for the tithi and the rœk. Of these, the tithi expresses the time of the month in terms of the distance between the sun and the moon, this distance being divided by 12. And here, when 5 09 45 (moon at 159° 45′) minus 0 19 59 (sun at 19° 59′) is divided by 12 it indeed yields 11:38, as shown in the table.[15] The companion value, the rœk (naksatra, lunar mansion), represents the moon's true longitude when divided by 13° 20′. In this instance the correct value would be 11 rœk and 58 nadi-rœk, and a value with apparently five places must be a consequence of retouching or the work of an ill-informed epigrapher.[16]

The bottom right of the table presents the numbers 8040 157 237437 14677 880.[17] Again their status is not declared, but again a hypothesis readily presents itself. In the process of calendrical calculation the hora begins by finding the ahargana, which defines the number of days that have so far elapsed in the era.[18] From this he derives four other quantities in a chained set of calculations. These other elements are known as

15. The fractional part is hexagesimal, as is also the case with the naksatra (below).

16. A horoscope at site 280 for Tabaung BE 763 appears to read

1	0
2	4 7

It is obviously useful to know, in this instance, that the naksatra times 13.333 gives the longitude, since naksatra 1:05 converts to 0 14 27—not an obvious reading of the data. In the present instead the values for Jupiter, Saturn and Rahu are all ambiguously arranged.

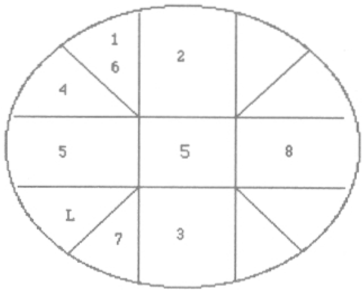
17. Ba Shin's reproduction crops the last two digits of the third number and omits the last two numbers, which lie outside the frame. His transcription reads "57" for the middle number, since he treats the adjacent vertical mark as a separator, not a numeral.

18. More strictly, it is the numbers of days that will have elapsed by midnight Local Time at 94°E.

the kammacubala, the uccabala, the avoman, and the masaken.[19] These five values, when found by the computer are as follows:

element	computed value	inscription
ahargana	237437	237437
kammacubala	14677	14677
uccabala	880	880
avoman	157	157
masaken	8040	8040

Another number, "383", appears in the vertical to the left of these values. This is an associated value, the "mean ucca", which again is correct.[20]



<table>
<tr><td rowspan="2">11
17
55</td><td rowspan="2">0
17
8</td><td rowspan="3"></td><td>380</td><td>2766</td><td>4066</td><td>306</td><td>4505</td><td>1680</td></tr>
<tr><td>6
41
8</td><td>2
5
48</td><td>3
13
44</td><td>11
7
1 -</td><td>5
8
38</td><td>9
1
0</td></tr>
<tr><td>12
26</td><td>1
17</td><td rowspan="2">6
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48</td><td rowspan="2">2
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58</td><td rowspan="2">3
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50</td><td rowspan="2">5
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47</td><td rowspan="2">2
29
0</td></tr>
<tr><td>11
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55</td><td>0
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25</td><td rowspan="2">11
21
34</td></tr>
<tr><td>10</td><td>0</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
</table>

8226 541 24[2]945 37972 3156

14 May 1303

19. The procedures for finding these values are explained in the Introduction to Eade (1989).

20. The labyrinthine process of finding this value involves multiplying the uccabala by 3 and then dividing the result twice by 808: the first remainder is multiplied by 30 before being divided again and the second remainder is multiplied by 60 before being divided again. The end result is then increased by 2. In the present instance:

(1) 880 * 3 = 2640
(2) 2640 / 808 = **3**:216
(3) 216 * 30= 6480
(4) 6480 / 808 = **8**:16
(5) 16 *60 = 960
(6) 960 /808 = 1:152
(7) 1 + 2 = **3**.

All the evidence of the handbooks suggests that it precisely by such mechanical procedures the horas went to work. The simpler method is to treat the uccabala value in the same way as a mean longitude expressed in days. Thus: (880 / 3232) * 360 = 98° 1′, which plus 2′ gives 3 signs, 8 degrees, and 3 minutes, as required.

The companion diagram (not shown by Ba Shin) dates to BE 665 Kason waning 12. It confirms some suspicions raised by the first diagram. The person who set up or who restored the pair made some mistakes. If it is Kason, with the sun and Venus in the second slot of the zata, i.e. in Taurus, then the numbers in the table for these two planets cannot be "11" (sun: 11 17 55, Venus 11 7 1-). It is also highly improbable (and was not the case) that the true and the mean longitudes of Mercury would have the same value (2 5 48[21]).

The mean longitudes from Mars to Rahu are again represented by their age, but are also expressed directly as are the uccabala (3156, bottom row) and the mean ucca "11 21 34". If the uccabala's value is 3156 parts of 3232, then the mean ucca's value will be 351° 34′ of 360°.

In the following table the last three columns present firstly what the planet's age would be if its mean longitude had been given correct; secondly what its present age will be if the time interval from the first inscription is added on to its age in the first inscription (with a correction for Mars); and thirdly what mean longitude corresponds to that value:

	inscription: age & mean longitude		1: age from mean long.	2: age by addition	mean long. from age 2
Mars	380	6 1 48	347	381	6 19 39
Mercury	2766	2 5 48	2569	2766	3 23 11
Jupiter	4066	3 27 3	4226	4057	3 22 22
Venus	306	11 8 50	242	308	1 19 21
Saturn	4505	5 4 47	4629	4505	5 0 38
Rahu	1680	2 29 0	1680	n/a	n/a

The operation involved here, the conversion from age to longitude and vice versa, is so simple that one is forced to conclude either that some other factor has been introduced or that the data has been very badly scrambled. The fact that the mean longitudes of Mars and Mercury merely repeat their true longitudes inclines one to the latter view. Clearly the 11 8 50 for Venus ought to be read as 1 18 50, but the gap between 5 4 47 and 5 0 38 for Saturn may be unbridgeable. On the other hand, the notorious confusability of "0" and "8" makes it suspicious that 5 0 38 ought to be the mean longitude answering to 4505 days, whereas Saturn's true longitude is given as 5 8 38. Add to this that the computer yields 5 4 8 for Saturn's true longitude, and 5 4 (4)7 also becomes suspect.

After this confusion it comes as a relief that all five for the ahargana family are correct in all places—or would be, if the second "2" had not dropped out of the ahargana.

In the first horoscope the final values ascribed to the sun are "9" and "2", to the moon, "2" and "4". In the second horoscope the sun acquires "10" and the moon "0". And in the horoscope of BE 672 the values are again "9" and "2". A search in the handbooks fails to yield any indication of the function of these numbers or of the scale on which they are based.[22]

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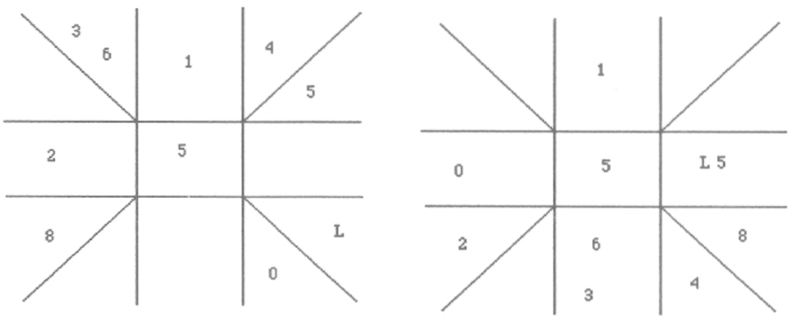
21. The value appears to be 2 45 8, but "45" is not a possible value for second place, since "2 45" would be expressed as 3 signs 15.

22. From experience with the astoundingly complicated Thai "duang pichai songkhram" and the equally arbitrary Burmese "athibodi", one knows that the answer, if ever discovered, will be crushingly simple—the years and months of the reigning prince, for instance.

1 28 6	1 29 12	10 27 49	1 27 24	7 26 36	4 17 31		0 12 30	3 14 51	3
152	7550	11626	792	7025	4200		7	7	
3	4	5	6	0	8		41	8	
8312	581	245465		8523	2444		0 10 26	3 13 52	9 2 15
							9	6	



7 April 1310

With the groundwork of this investigation now established, one may now move more rapidly.

The textual part of this inscription gives the date as sakarat 672, Pusya year, Kason waxing 8, Tuesday. This presents no difficulty.[23]

We can immediately assume that the numbers 3 - 8 (cols 1-6 of row 3 in the left block of the table) supply the planetary labels for rows 1 and 2; also that these two rows respectively supply true longitudes and mean longitudes. We also note that at the base of the table all five values of the ahargana family are present (the numbers 8312 ... 2444). Values for the sun and the moon are here presented to the right of the planets, which is not the normal arrangement.[24]

23. The Pagan system was not to use an animal name for the year, but to attach one of twelve lunar names drawn from the 27 belonging to the lunar mansions. (The Thai, when they do not use a month number, attach these twelve to the lunar months). The formula for matching year with year name is given by (year minus 2) modulo 12, where Caitra equals 1. Thus: (672 - 2) mod 12 = 10 = Pusya, as required. As for the weekday, the ahargana 245465 modulo 7 yields 3 = Mars = Tuesday, as required.

24. When the order 1-8 is not observed, the sun and moon are usually dignified with a central position:

3 4 5 1 - 2 6 7 8.

E.g. horoscopes for 3 February 1592 and 2 April 1645 at site 1917.

	Mean Longitude		True Longitude	
	Inscription	Computer	Inscription	Computer
sun	0 10 26	0 10 26	0 12 30	0 12 30
moon	3 13 52	3 13 50	3 14 51	3 14 49
Mars	152	152	1 28 06	1 29 35
Mercury	7550[25]	8446	1 29 12	0 04 54
Jupiter	11626	11618	10 27 49	10 28 09
Venus	792	788	1 27 54	1 26 32
Saturn	7025	7024	7 26 36	8 00 07
Rahu	4200	4191	4 17 41	4 17 30

value	Inscription	Computer
tithi	7:41	7:41
rœk	7:08	7:51
ahargana	245465	245465
kammacubala	8523	8523
uccabala	2444	2444
avoman	581	581
masaken	8312	8312
mean ucca	9 02 15	9 02 15

In this calendrical table the agreement is absolute, except for the naksatra.

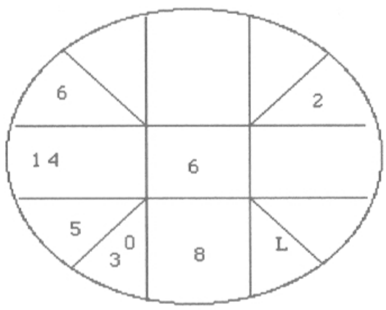
The chief peculiarity is the second diagram in which the planetary numbers have been rearranged. The fact that "1"(sun) and "6" (Venus) are in opposite slots and that "4" (Mercury) is five slots removed from the sun means that the diagram is not a horoscope at all.

*

3	4	5	6	0	8
5	3	4	2	5	6
10	15	17	13	15	5
40	38	44	14	56	30
3	4	5	6	0	8

235
264935
97562
2522

3 29 42	10 23 54	
1 44	24 13	
4 0 7	10 27 28	10 56



28 July 1363

25. 7550 is wrong. With an ahargana interval of 8029 days (inclusive) between this inscription and that of BE 650, Mercury's age will increase from 6177 to 8550, not to 7550. The working is as follows:

6177 + (8029 *100) modulo 8797 = 8550 exact.

It may be added here that seeding the inscription's mean longitudes into the computer program does not generate the inscription's true longitudes. Despite the exact agreement for the sun and the moon, something more complicated and probably irrecoverable is affecting the values for Mars to Saturn.

The third inscription is similar in layout to the second, but does not include mean longitudes for the planets from Mars onwards.

The text is dated to Friday, 2 waning of Namka (= Wagaung) in saka 725[26]. We may begin with the calendrical details:

	inscription	computer
avoman	235	231
ahargana	264935	264935
kammacubala	97562	97563
uccabala	2522	2522
mean ucca	[ ] 10 56	9 10 56

Once again the values tally closely where the calendrical part of the data is concerned[27]. We need no longer remain in hypothetical mode as to the significance of the first and third rows of the left-hand block—we merely note that, for decorative purposes (albeit uninspired), the planetary labels have been given both at top and bottom.

	inscription	computer
Mean sun	4 00 07	4 00 07
True sun	3 29 42	3 28 42
Mean moon	10 27 28	10 27 27
True moon	10 23 54	10 23 54
Mars	5 10 40	5 14 01
Mercury	3 15 31	3 28 19
Jupiter	4 17 44	4 18 00
Venus	2 13 14	2 14 04
Saturn	5 15 56	5 19 59
Rahu	6 05 30	6 05 58

The values for the sun and moon are, as usual, very close; and none of the others are widely discrepant—not to a point where minor differences in Correction Tables and minor errors in the tedious calculation process would not account for them. The tithi and the rœk values, on the other hand, present a new area of attention:

	inscription	computer
tithi	1: 44	2:01
rœk	24:13	24:17

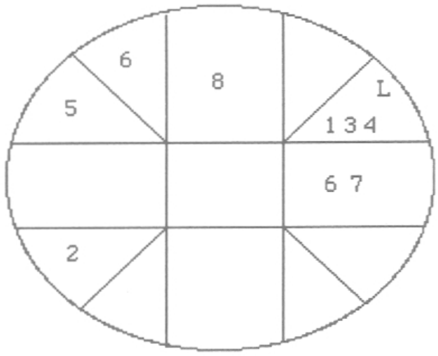
Although the planetary values given were those operative at midnight (doing duty for the whole twenty-four hours), the tithi was sometimes corrected for an earlier time of day. In fact, the tithi increased from 1:09 to 2:06 on this day and reached 1:44 at exactly the time (14:12 hrs) when the lagna entered Scorpio, the position it occupies in the zata diagram.

26. This is stated (line 1 of the caption) to be a "Chitta" (Caitra) year, but to be in accord with the previous inscription and with the rule, it should be a "Zeta" (Jyestha) year.

27. The ahargana 264935 modulo 7 equals 6 (Friday), as required.

The inscription again exhibits two zata, but they are duplicates. They agree at all points with the table.

10	25 6	
46	49	
2	11	
40		



9 February 1373

The fourth inscription is dated Wednesday, 2 waning of Tabaung in 734. It has a much briefer table, but some numbers appear in the short text:

saka 734, Tabaung waning 2, Wednesday
king's son born ...
9 [0 8] 9 masaken, 2 6 8 4 - 9 [ahargana]
2 [7] 4 8 8 9 0 kammacubala, 11 nakkhat

	inscription	computer
masaken	9[08]9	9089
ahargana	2684[]9	268419[28]
kammacubala	2[7]4889	254889[29]

The condition of this inscription is such that the computer values are here of more use as an assistance in reading the information than in verifying it:

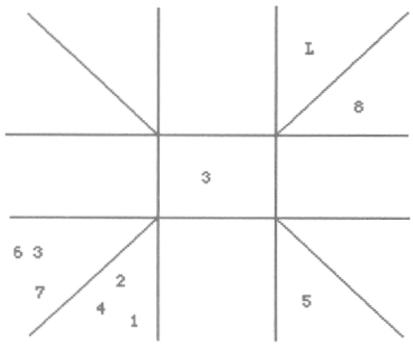
	inscription	computer
sun	10 [ ] 46	10 15 46
moon	25 06 49	5 05 56
tithi	2:40	1:40
rœk	11 [ ]	11:41

The numbers in the diagram are correctly placed, except that Mars was in rasi 8, not rasi 10 at the time (though the "3" seems to be clear); and Venus cannot be in two places at once.[30]

28. 268419 modulo 7 = 4 (Wednesday), as required.
29. The kammacubala increases by 800 a day. Here the date is 318 days into a year whose initial kammacubala value was 489—hence 254889.
30. The "two segment" rule also applies here: Venus cannot be three rasi away from the sun.

Hpaya-thon zu[31]

1	2	171
5	2	313
16	13	
57	21	
14	12	
43	17	



16 September 1449

The earliest inscription in this group dates to saka 811,[32] also called (Mohnyin) year 14. No lunar date is given, though it proves to be Tawthalin waning 14. It exhibits two numbers alongside the table: 171 and 313. The second of these belongs to the ahargana family, it being the avoman; but the first number is a new quantity—the number of days elapsed from the start of the year up until the chosen date.[33]

The planetary data is sparse, and the moon's rasi value in the table is clearly in error for a New Moon; the zata diagram, however, is correct in all respects.

	inscription	computer
sun	5 16 57	5 16 57
moon	2 13 21	5 13 51
tithi	14: 43	14: 44
rœk	12: 17	12:17

The rœk value is repeated in the text, which also says that the "nakkha" is 12 and the "gathi" are 17.

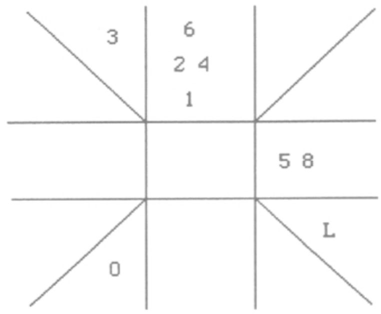
31. Sites 477-9 at N: 46.210 E: 11.000.

32. Correctly described as a "Tharawan" (Sravana) year. Were it not for his alarming methods and the contorted presentation of his findings, Pillai could have achieved a success rate of 97 out 156 Bodawpaya inscriptions when attempting to match the "Jovian" year name with the year number (Report, 1924).

33. This quantity is called "thokdadein" by Irwin (§29). The Thai name is "sutin".

1	2	3	4	5	6	0	8
0	0	1	0	9	0	5	9
6	16	16	22	17	8	13	19
11	33	55	50	19	12	27	
0	1						
51	13						

1	2	8	
1	8	6	
2	7	8	
5	4	9	4
3	3	3	6
2	2	2	7



3 April 1451

This inscription is dated year 15 (i.e. sakarat 813[34]), 3 waxing of Kason. The first element to draw attention is the very low value of the numbers underneath the planetary table. They indicate that the new era began on 11 Tagu in saka 798 (=28 March 1435). The ahargana of date is given as 5494, but should be 5484.[35]

	computer	inscription
uncorrected avoman	128	128
new masaken	186	186
avoman proper	278	278
new ahargana	5484	5494
kammacubala	3336	3336
uccabala	2257	2227

As regards the longitudes of the planets, the correspondences between the diagram, the table, and the computer are good:

34. Correctly described as an "Athawin" (Asvina) year.
35. A glance at the calculation is in order:

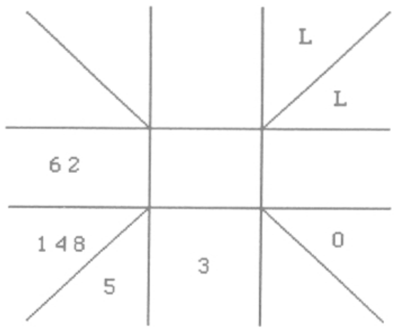
$$15 * 292207 + 759 / 800 + 1 = 5480: 664$$

15 is the number of years in the new era, and 759 is the new era constant. 5480 is the ahargana the start of the year, but the date commemorated is four days into the year, so the end result is 5484.

	diagram	inscription	computer
sun	0	0 06 11	0 06 12
moon	0	0 16 33	0 16 34
Mars	1	1 16 55	1 17 33
Mercury	0	0 22 32	0 25 42
Jupiter	9	9 17 50	9 17 47
Venus	0	0 8 19	0 8 34
Saturn	5	5 13 12	5 13 59
Rahu	9	9 19 27	9 19 17
tithi		0: 51	0: 51
rœk		1 13	1: 14

* * *

1	2
4	3
24	11
53	26
12	7
40	46



25 August 1459

The text of this inscription presents the date as 13 waning of Tawthalin in saka 821, but the sun's position in the accompanying diagrams points to the previous day.

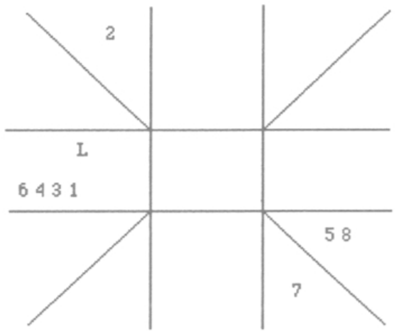
The moon's supposed longitude in the table is at odds with the sun's position and the tithi value. These two values define the moon's position as 3:26,53, not 3:11, 26. For good measure, the moon's longitude value as given yields 7:36, not 7:46 when divided by 13° 20′.

Taungbi First Group

The first selection is from Mon-gu.[36] The earliest of them dates to 12 waning of Wazo in saka 907:

36. Site 2013, at N: 48.070 E: 6.840.

1	2	3	4	5	6	0	8
3	1	3	3	8	3	7	8
4	17	3	27	11	19	15	15
48	20	33	9	56	12	23	10
11	3						
2	33						



4 July 1545

In this instance the planetary values are rather more at variance with the computer than usual, though none of the differences is sufficiently large to place a planet in the wrong rasi.[37]

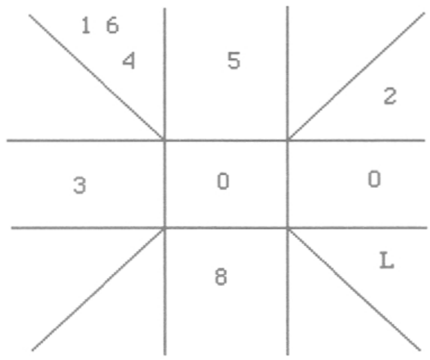
	diagram	table	computer
sun	3	3 04 48	3 04 48
moon	1	1 17 20	1 17 21
Mars	3	3 03 33	3 11 38
Mercury	3	3 27 09	3 25 01
Jupiter	8	8 11 56	8 12 05
Venus	3	3 19 22	3 22 49
Saturn	7	7 15 23	7 15 18
Rahu	8	8 15 10	8 25 20

There is nothing here to prompt particular comment.

* * *

37. One wonders whether the local hora had slightly difference methods or different tables of correction. The solar and lunar values, however, are sufficient to show that the procedures were the same in general.

1	2	3	4	5	6	0	8
1	10	3	1	0	1	9	-
20	11	10	9	27	11	4	10
15	11	3	4	54	38	7	6
6	23						
45	20						



18 May 1549

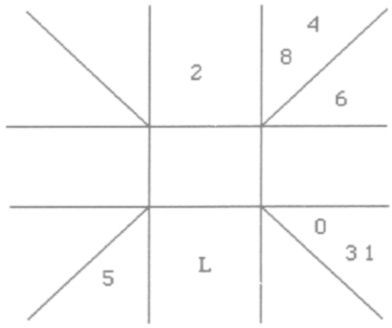
The second member of the group purports to date to saka 911, 9 waning of Kason, but the diagram and the table indicate that by normal reckoning the date would be 8 waning in Nayon of that year, one month later. This discrepancy presents no particular difficulty. The fact that the month is one short of what it ought to be indicates that an extra month has been inserted, probably in saka 910, a difference that could not cancel itself until the Wazo of saka 911, where "normal" reckoning would double the month and non-standard reckoning would not.

	diagram	table	computer
sun	1	1 20 15	1 20 11
moon	10	10 11 13	10 11 13
Mars	3	3 10 03	3 6 35
Mercury	1	1 05 04	1 02 08
Jupiter	0	0 27 54	0 26 51
Venus	1	1 11 38	1 4 25
Saturn	9	9 04 07	9 04 20
Rahu	6	[--] 10 06	6 10 25
tithi		6: 45	(15 +) 6: 45
rœk		23: 20	23: 20

This example again provokes no particular comment.

* * *

1	2	3	4	5	6	0	8
10	0	8	11	5	10	8	11
13	0	22	--	8	6	27	28
42	34	6	27	19	27	40	30
3	0						
9	2						



9 February 1578

The third inscription of the group dates to saka 939, 4 waxing of Tabaung. It is particularly degraded, and as transcribed the duang exhibits an astronomical impossibility, with the sun four rasi away from Mercury. The table, however, rectifies this anomaly by showing the sun in rasi 10:

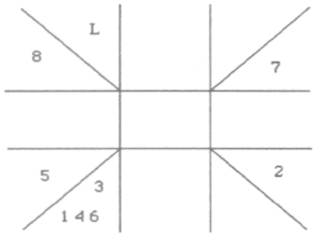
	diagram	table	computer
sun	8	10 13 42	10 14 42
moon	0	0 00 34	0 00 33
Mars	8	8 22 06	8 09 32
Mercury	11	11 [--] 27	10 27 13
Jupiter	5	5 08 19	5 27 56
Venus	10	10 06 27	9 25 00
Saturn	8	8 27 40	8 26 37
Rahu	11	11 28 30	11 24 24
tithi		3:09	3: 49
rœk		0: 02	0:02

As the table indicates, Mercury and Venus are both mislocated, and the amounts are small enough to suggest calculation error rather than epigraphic error. Even so, the difference in positioning would be of consequence in the astrological interpretation of the diagram, since its entire apparatus was based on the notion that the nature and influence of the planets changes with their variations in position.[38]

38. In the simplest case (i.e. one in which doctrine is relatively clear), Mercury would be "ari" (enemies; Monier-Williams, 87c) as placed, but would have been "putra" (offspring; M-W, 632c) if correctly located. Similarly, Venus would move from "putra" to "bandhu" (kin; M-W 721a).

Taungbi Second Group

The second selection is from temple 2011.[39] The inscriptions are not accompanied by tables and are in poor condition. They can be dealt with briefly:

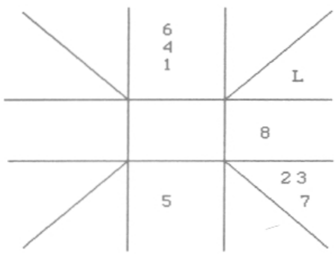


11 October 1611

The caption of the first inscription dates to saka 973 (also given as year 175), in the waxing phase [7th] of Tazaungmon:

	diagram	computer
sun	5	5 03 17
moon	8	8 12 11
Mars	5	5 07 17
Mercury	5	5 04 40
Jupiter	4	4 00 02
Venus	5	4 12 16
Saturn	10	10 03 59
Rahu	2	2 04 55

* * *



2 May 1638

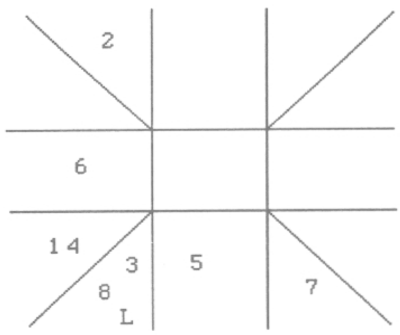
This inscription dates to saka 1000 (also represented as year 202), 6 waning of Kason.[40]

39. Old number 1307, at N:48.070 E: 6.840.
40. This item is transcribed (p. 108) but not illustrated (facing p. 107). Also in the group, but not included by Ba Shin, are two other inscriptions, dating to 995 Tabodwe 9 waning (21 February 1634) and 998 Tagu 1 waxing (25 March 1637).

	diagram	computer
sun	0	0 24 16
moon	8	8 18 25
Mars	8	7 26 06
Mercury	0	0 16 41
Jupiter	6	6 13 24
Venus	0	0 19 32
Saturn	8	9 11 21
Rahu	9	8 29 34

The three differences here are slight, and one suspects a reversal here between Saturn and Rahu, where Rahu's 8 and Saturn's 0 are frequently hard to tell apart.

*



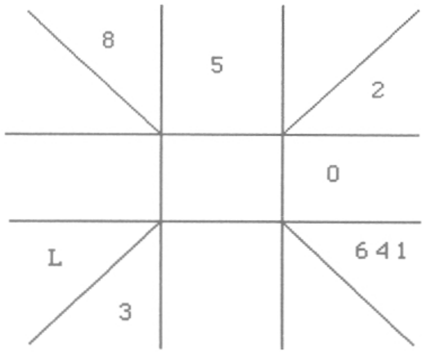
3 September 1662

This third inscription records the birth of a daughter in saka 1024 (year 226), on Sunday, 7 waning of Tawthalin:

	diagram	computer
sun	4	4 22 26
moon	1	1 03 14
Mars	5	5 24 21
Mercury	4	4 07 16
Jupiter	6	6 23 14
Venus	3	3 15 35
Saturn	7	7 06 13
Rahu	5	5 08 35

Here the match is complete, down to the weekday named.

* * *



20 December 1667

The last inscription of this group supposedly dates to saka 1029, 8 Waxing of Nadaw, Tuesday. But in fact the duang matches with a date one month later:

	diagram	Pyatho 6	Nadaw 8
sun	8	8 10	7 12
moon	10	10 20	10 24
Mars	5	5 18	5 03
Mercury	8	8 28	7 21
Jupiter	0	0 10	0 12
Venus	8	8 18	7 13
Saturn	9	9 04	9 02

It will be seen that the values relevant to the hora's supposed month Nadaw fail to match on three occasions (for the sun, Mercury, and Venus), whereas for Pyatho they match in all instances. The explanation here (legibility is not a problem) may be that the local hora inserted an extra month into his lunar calendar one year in advance of what would be required by normal reckoning (saka 1029 was not an *adhikamasa* year by normal reckoning).

APPENDIX: UPPER BOUNDS

As determined by their function, all the numbers in a planetary table have an upper bound. This consideration is obviously useful as a control upon one's attempts to read and interpret them.

1. True and Mean Longitudes and the Mean Ucca cannot exceed 11 29 59.
2. The Tithi cannot exceed 14: 59 (it is not normally counted past 15).
3 The Rœk cannot exceed 26: 59.
4. The Kammacubala cannot exceed 308000, since the longest Burmese lunar year cannot exceed 385 days.

5. The Uccabala cannot exceed 3232 and increases by 1 a day.
6. The Avoman cannot exceed 692 and increases by 11 a day.
7. The values of the Ahargana and the Masaken are controlled by the year value:

reasonable guides as to appropriate size are provided by the year number times 365.25 and by the month number times 12.5.

8. Numbers in a zata diagram cannot exceed 8 (7 being represented by "0"): numbers that look like "9" will in fact be an "L" for "lagna" (the ascendant).

a curious feature of the Pagan horoscopes is that even detailed planetary tables do not give precise values for the lagna.

Numbers in the centre square of the diagram will not usually exceed 7 ("0"), since they normally represent weekdays.

9. Numbers representing the "age" of the planets (equivalents of their Mean Longitudes) should be in groups of six (Mars to Rahu), with upper bounds as follows and in the following order:

Mars 687
Mercury 8797
Jupiter 12997
Venus 2247
Saturn 10766
Rahu 6795

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Résumé en français

Plusieurs sites à Pagan recèlent des horoscopes commémoratifs, qui comportent un schéma planétaire (*zata*), un texte succinct, et parfois une tabulation d'un ensemble de chiffres. Le meilleur exemple publié de ce genre se trouve dans *Pagan min sasu thuteithana lik ngan*, de U Ba Shin. Les principes selon lesquels les astronomes anciens organisaient ces matières n'ont jamais été élucidés jusqu'à présent. Mais, grâce à une appréciation de leurs méthodes et une analyse assistée par ordinateur des données historiques, on peut démontrer que ces documents contiennent de nombreuses informations exactes et utiles.

Ce genre de document est fréquent et couvre une période considérable. Son interprétation est intéressante, non seulement à cause des précisions chronologiques qu'il fournit, mais aussi à cause de la possibilité qu'il nous donne de mieux comprendre les méthodes de ces astronomes/astrologues, qui avaient une situation assez élevée dans la société de leurs temps.