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THE CALENDARS OF SOUTHEAST ASIA. 4: MALAYSIA AND INDONESIA

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Abstract: The archipelago region of Southeast Asia is characterised by a great number of calendars of which we treat only a few. The early calendars were essentially original Indian calendars although with modified intercalation schemes. From the fifteenth century in the Christian era the region was increasingly dominated by Islamic influences and successively adopted Muslim calendars although with some modifications.

Keywords: History of astronomy, calendars, Malaysia, Indonesia, *mangsa* calendar

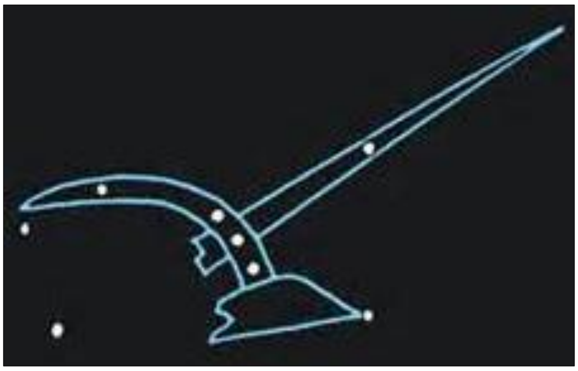
1 THE AGRICULTURAL CALENDARS

In Indonesia[1] there is an ancient harvest calendar[2] that is quite widespread and still extant that uses the constellation of Orion (Dhitasari, n.d.). For locations on the Earth close to the equator, the rising and setting of this constell-ation (plus three of the four outer stars and excluding Betelgeuse) appears to be lying on its side and is in Indonesia seen to resemble a traditional Javanese plough (*waluku*)—see Figure 1. The heliacal rise of Orion, its first appearance at dawn above the eastern horizon, occurs close to the summer solstice. It then looks like an upright plough and marks the start of the harvest year. It then rises more and more early in the night. About five months later the constellation has its acronycal rise, the last time it rises after sunset, when Orion and the Sun are almost opposite each other, which indicates that it is time for rice planting. Four months later Orion has passed its culmination at sunset and is then to be seen setting in the evening Western sky but now upside down. The planting season is then over, and it is time to put away the plough.

Many people in the Indonesian archipelago use stars or group of stars like the Pleiades to determine agricultural activities (Ammarell, 1988). The most common method is to use heliacal phenomena, i.e. the position of the marker stars at sunset or sunrise. Raising and settings may be difficult to see due to forest vegetation and often the heliacal culminations are used instead. Sometimes the altitude of a specific star at some specified time was used to mark important events like planting of rice.

One way of measuring the altitude of a selected star at a selected moment is the bamboo device (Figure 2) documented by Hose and McDouhall (1912) from Borneo. The bamboo cylinder is filled to the rim with water and then pointed at the star. When held vertical again, the water level indicates the altitude of the star which in turn tells if it is time to plant rice.

In Java there is also, still in use, an ancient solar calendar used for agriculture, the *mangsa* (seasons) calendar. It has 12 solar months with different lengths (Dhitasari, n.d.; Ginzel, 1911: 128, Van den Bosch, 1980; Van Sandick, 1885). The original way of setting up the calendar was to use a vertical stick, a gnomon (Figure 3) on which the positions of the noon shadow were marked at the summer and winter solstices. As Java lies south of and close to the equator, the



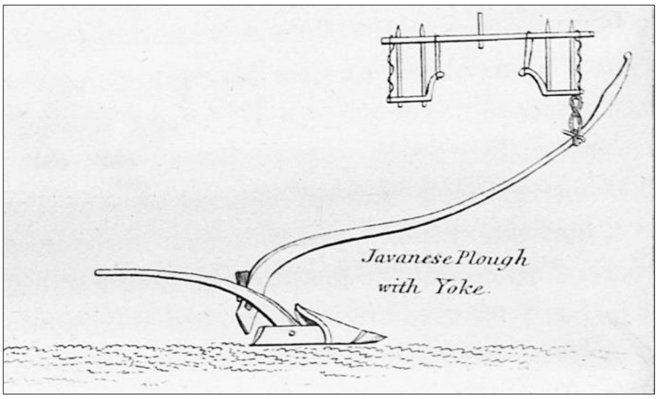


Figure 1a (left): Orion as a plough (after Dhitasari, n.d.). Figure 1b (right): Javanese plough (after Crawfurd, 1820: Plate 14).

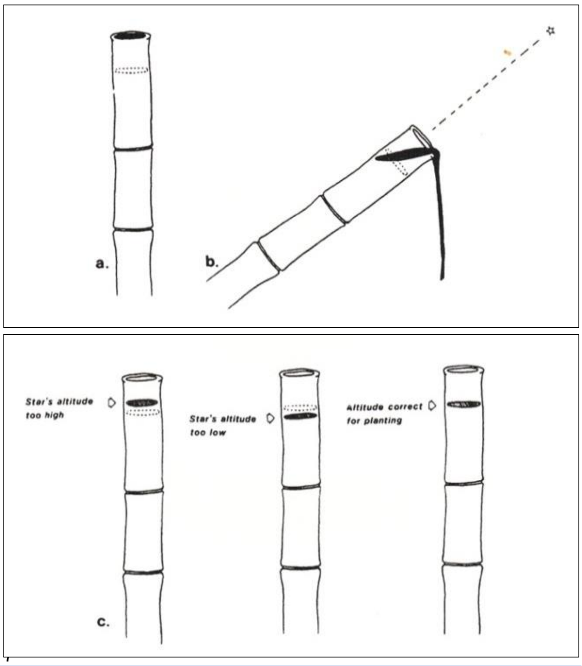


Figure 2: A bamboo device for measuring the altitude of stars (based on Hose and McDougall, 1912: 109).

noon Sun will be north of the zenith on the summer solstice and south of the zenith on the winter solstice and these two extremal positions will be situated on either side of the foot of the gnomon. The interval between these positions is divided into six equal parts, each part representing a solar month. As the Sun spends a longer time close to the solstices and shorter time near the equinoxes, the extremal months will be longer and the middle months shorter. As the Sun moves from equinox to equinox it will spell out a solar year with twelve unequal months.

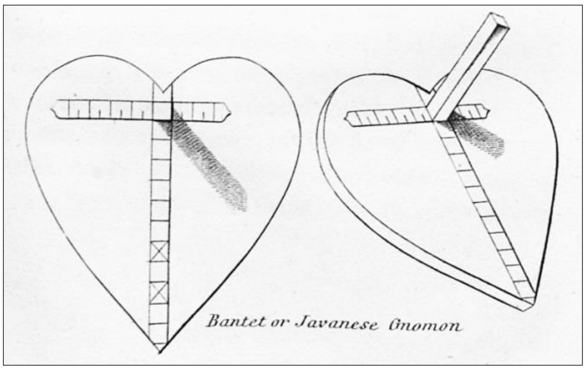


Figure 3: A Javanese gnomon (after Crawfurd, 1820: Plate 14).

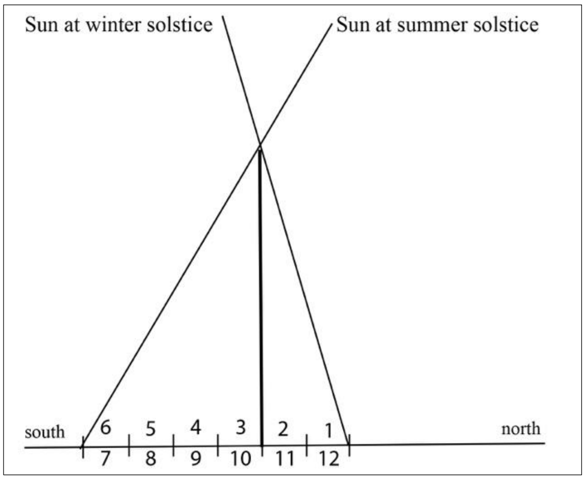


Figure 4: Measuring solar shadows (diagram: Lars Gislén).

Central Java is situated at a geographical latitude of about 7.5° S. At the summer solstice the noon Sun will have a zenith angle of about 31° north, at the winter solstice the noon zenith angle will be 16° south (see Figure 3). With a gnomon height of G, the summer equinox noon shadow will have a length of $G \times \tan 31° = G \times 0.60$, the winter solstice noon shadow will have a length of $G \times \tan 16° = G \times 0.29$. The summer shadow will very nearly be twice the length of the winter shadow and we can divide the distance between these extremes shadows into six parts, each having a length of $G \times 0.15$, two of the divisions being north of the foot of the gnomon and four of them being south of the gnomon (see Figure 4).

Table 1: Javanese months.

Kasa
Karo
Katiga
Kapat
Kalima
Kanem
Kapitu
Kaulu
Kasanga
Kadasa
Destha/Jiestha
Sadha

Sultan Pakubuwono VII (1796–1858) of Surakata standardised the length of these months to 41, 23, 24, 25, 27, 43, 43, 26, 25, 24, 23, and 41 days, starting from the summer solstice. Every fourth solar year is a leap year when the month with 26 days instead gets 27 days. The epoch of this standardised calendar is the summer solstice on 22 June 1855. These 12 months are sometimes grouped three by three in *mangsa utama* (main seasons) of 41 + 23 + 24 = 88, 25 + 27 + 43 = 95, 43 + 26/27 +24 = 94/95, and 24 + 3 + 41 = 88 days. The names of the Javanese months are given in Table 1. This table shows the names of the solar months. The first ten names are merely Javanese ordinal number, the last two names are of unknown origin. Figure 5 shows a bowl with the signs of the solar months (upper row) and the corresponding Indian months (bottom row, right to left).

There are several other calendrical methods based on the altitude of the Sun in the Indonesia-Malaysia region (Ammarell, 1988; Maass, 1924). The Kenyah people in northern Borneo use a straight cylindrical pole (*tukar*) with a length equal to the span of the maker's outstretched arms plus the span from the tip of the

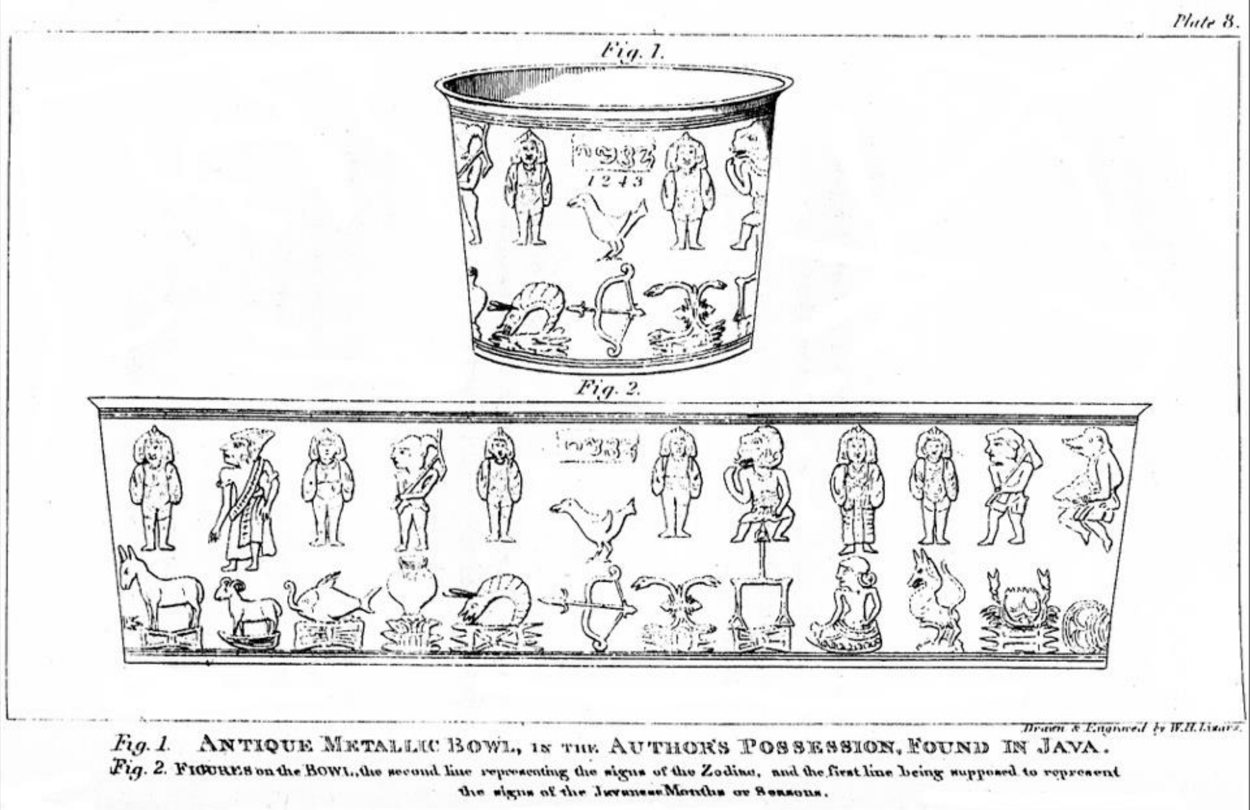


Figure 5: Signs of Javanese and Indian months (after Crawfurd, 1820: Plate 8).

thumb to the first finger (Figure 6). This system uses the noon shadow of the pole. It is carefully set vertical using plumb lines and fixed in its lower end to a horizontal board. The shadow length is measured with a stick, also fitted to the size of the maker (Figure 7) with a length equal to the distance from the maker's armpit to the tip of the fingers. The stick is marked with notches corresponding to important dates for agriculture.

2 THE BATAK CALENDAR

The Batak people in northern Sumatra have a traditional luni-solar calendar called Porhalaan that was still in use in the beginning of the twentieth century and where the start of the year is determined as follows (Maass, 1924: 23–25). The year begins when the constellation of Orion sets in the Western sky in the evening while at the same time the constellation Scorpio with the bright star Antares (α Scorpii) rises in the east. The first day of the first month then occurs with the appearance of the new Moon crescent rising in the east north of Orion under these conditions. This normally happens in May. Fourteen days later, the rising full Moon in the east having moved about 180° in the starry sky, will pass the constellation of Scorpio, an important calendrical event in the calendar. The following months start by the first appearance in the evening of the New Moon crescent. The Moon will pass Scorpio about two days earlier each month as the difference between the synodic and sidereal months is 29.53 – 27.32 = 2.21 days. Figure 8

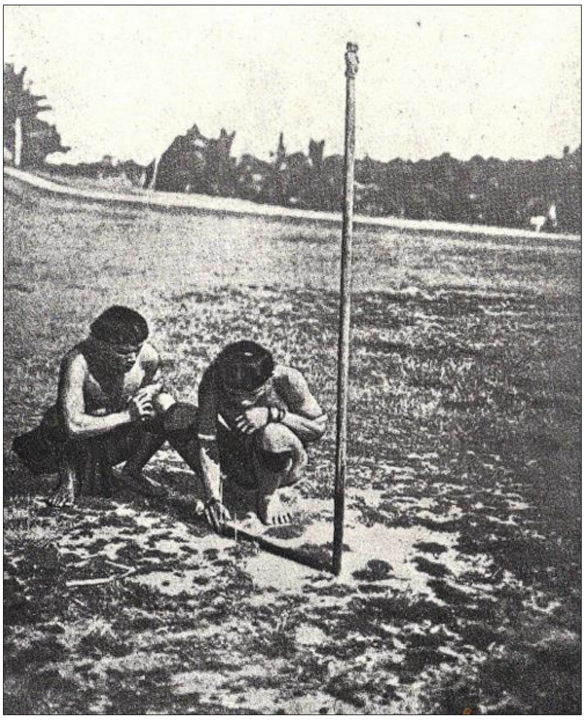


Figure 6: A solar gnomon (after Maass, 1924: Figure 24).

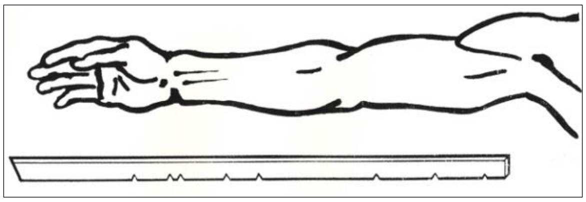


Figure 7: The base of the solar gnomon (after Ammarell, 1988: 87).

Figure 8: Batak calendar (Museum of Anthropology, University of Michigan, Bartlett Collection).

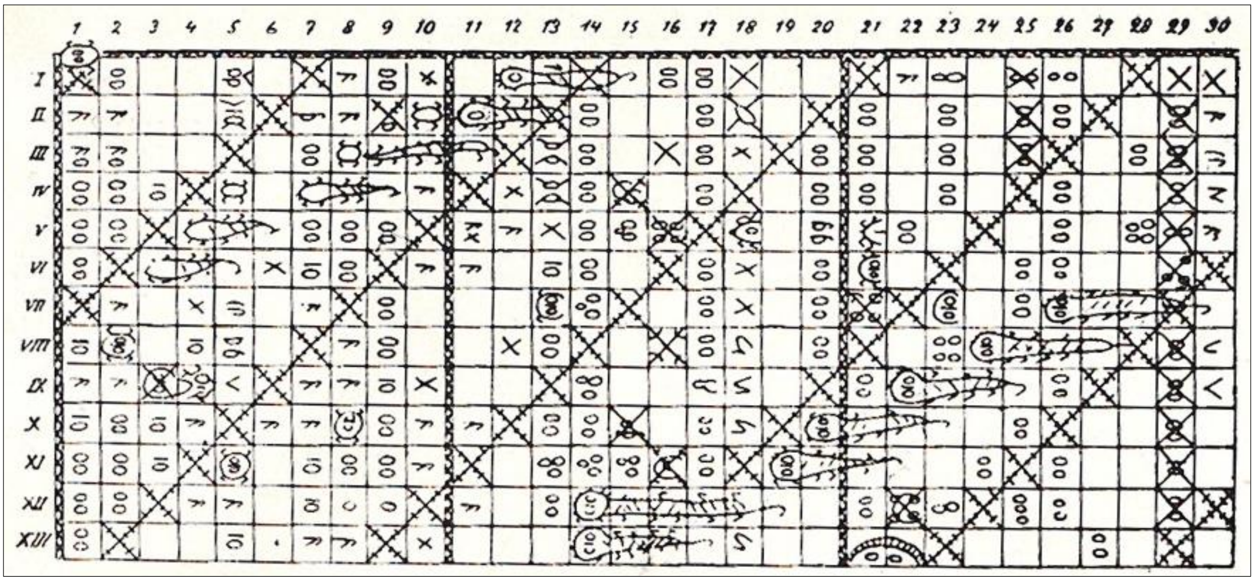


Figure 9: Batak calendar layout (after Maass, 1924: Figure 1).

shows a Batak calendar engraved on a bamboo cylinder. The calendar is made as a matrix with 12 rows of months, sometimes 13, each month having 30 lunar days. The layout of calendar matrix is shown in Figure 9 where day number 15 is the full Moon day. Some days are marked with the picture of a scorpion (looking like a worm), see for example the days in to the left in rows V and VI in Figure 9. The calendar is used for divination, the days in the matrix being marked with different symbols forming a kind of daily horoscope and where the days covered by scorpions have a special propitious significance.

Table 2: Names of the Pawukon weeks.

Day of the week	Name
1	Ekawara
2	Dwiwara
3	Triwara
4	Caturwara
5	Pancawara
6	Sadwara
7	Saptawara
8	Astawara
9	Sangawara
10	Dasawara

3 THE PAWUKON CALENDAR

The Pawukon calendar is specific to Bali (Reingold and Dershowitz, 2018) and was brought to Bali with fleeing Hindu Majapahitis in the fourteenth century (Eiseman, 1990: 223). It is a 210-day cyclical calendar, which in some respects is similar to the 5-, 6-, and 7-day *wuku* calendar in Java but is considerably more elaborate. It consists of 10 kinds of parallel weeks containing respectively 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 days (Table 2). The most important are the 3-, 5-, and 7-day weeks. The weeks with three, five, six, and seven days are merely a cyclical sequence of the days of the week, as for the Javanese *wuku* calendar. Table 3 shows the names of the individual days in the different weeks.

As 210 is not divisible by 4, 8, and 9, certain weekdays have to be repeated in order to fit into the scheme. For the 4- and 8-day weeks the penultimate weekday is repeated twice in a week

Table 3: Names of the days in the weeks.

Week / Day	1	2	3	4	5	6	7	8	9	10
Ekawara	Luang									
Dwiwara	Menga	Pepet								
Triwara	Pasah	Beteng	Kajeng							
Caturwara	Sri	Laba	Jaya	Menala						
Pancawara	Paing	Pon	Wage	Keliwon	Umanis					
Sadwara	Tungleh	Aryang	Urukung	Paniron	Was	Maulu				
Saptawara	Redite	Coma	Anggara	Buda	Wraspati	Sukra	Saniscara			
Astawara	Sri	Indra	Guru	Yama	Ludra	Brahma	Kala	Uma		
Sangawara	Dangu	Jangur	Gigis	Nohan	Ogan	Erangan	Urungan	Tulus	Dadi	
Dasawara	Pandita	Pati	Suka	Duka	Sri	Manuh	Manusa	Raja	Dewa	Raksasa

that would otherwise have ended on the 72nd day; and the first 9-day week in the 210-day cycle begins with four occurrences of the first day. The weeks with one, two, and 10 days have a more complicated intercalation, and the procedure for determining the sequence of week-days for these weeks is as follows: each week day of the 5- and the 7-day weeks is associated with a unique number, the *urip*. Table 4 shows these.

For a given day in the 210-day cycle, you find the *urip* of its weekday in the 5-day and 7-day weeks. You add the *urip* numbers and increase the sum by 1. If the total is greater than 10 you subtract 10. If the resulting number is even, the 1-day weekday is Luang and the 2-day weekday is Pepet; if it is odd the 1-day weekday is without name and the 2-day week-day is Menga. The day in the 10-day week is the one with the calculated number.

Example: On the 57th day of the 210-day cycle, the 5-day week is Pon, number 2 and the 7-day week is Redite, number 1. The respective *urip* numbers are 7 and 5. 7 + 5 + 1 = 13. 13 – 10 = 3, an odd number. Thus the 1-day weekday is without a name, the 2-day weekday is Menga, and the 10-day weekday is Suka.

There are 30 wuku weeks of the 7-day week in a 210-day year. Each of these has a name (see Table 5). The names are almost all the same as or similar to the corresponding week names in the Javanese wuku calendar that uses a subset of the Pawukon weeks: the 5-day, the 6-day, and the 7-day weeks.

The Pawukon calendar cycles are unnumbered and can be extended arbitrarily in time. Thus, for example 3 February 2019 was Luang-Pepet-Beteng-Jaya-Wage-Was-Redite-Kala-Jangur-Raksasa, cyclical day 113 in the seven-day week Krulut.

Certain combinations of the cycles generate days of celebration like the 3- and 5-day combination Kajeng-Keliwon. The combination of the last day of the 7-day week, Saniscara and the day Keliwon in the 5-day cycle is called a *tumpek*. Day 74 in the Pawukon cycle, the Galungan Day, day 84, the Kuningan Day, is both a *tumpek* and Kajeng-Keliwon. In the period between these two days the most important celebrations are held.

Table 4: *Urip* numbers.

Day / Week	1	2	3	4	5	6	7
Pancawara	9	7	4	8	5		
Saptawara	5	4	3	7	8	6	9

A *tika* calendar is used in order to keep track of the most important of the weeks and days in the Pawukon calendar. The *tika* is a pattern of squares laid out in seven rows, representing the seven weekdays, and 30 columns representing the 30 7-day weeks in the Pawukon cycle. *Tikas* are either carved on wood or painted on cloth. Geometrical figures—dots, crosses, and circles—symbolize the various auspicious days and week cycles. Figure 10 shows an example of a *tika* carved in wood.

4 THE INDIAN CALENDAR

This section draws heavily on the excellent paper of Ian Proudfoot (2007).

The generic Indian calendar has a long history in Java and Bali. Dates in an Indian calendar appear in Java's oldest historical documents from the dated inscriptions of the eighth century. They continue right through the record of inscriptions in Java and Bali up to the fall of Majapahit Empire in the fifteenth century of the Common Era. Subsequent dates in Indian calendars appear in Old Javanese and Balinese liter-

Table 5: The 7-day week names

Week number	Name	Week number	Name
1	Sinta	16	Pahang
2	Landep	17	Krulut
3	Ukir	18	Merakih
4	Kulantir	19	Tambir
5	Taulu	20	Medangkungan
6	Gumbreg	21	Matal
7	Wariga	22	Uye
8	Warigadian	23	Menail
9	Julungwangi	24	Parangbakat
10	Sungsang	25	Bala
11	Dunggulan	26	Ugu
12	Kuningan	27	Wayang
13	Langkir	28	Kelawu
14	Medangsia	29	Dukut
15	Pujut	30	Watugunung

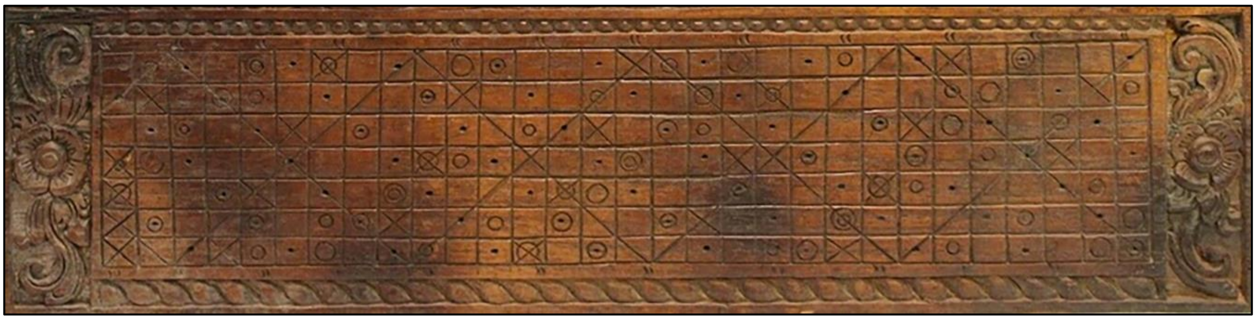


Figure 10: Part of a wooden *tika* calendar (Lars Gislén Collection).

ary sources and in administrative instruments issued by the courts of Bali and Lombok into the twentieth century. Indian calendars are still used in Bali for religious purposes.

The original Indian calendar was reformulated using locally adapted rules but retaining fundamental parts of the original calendar like the beginning the month with the new Moon, beginning the year near the Spring equinox, and enumerating the years in the Śaka Era (CE 78) as elapsed years. However, the finer point of Indian astronomy seems to have been lost in the transition from India. Therefore, it cannot be expected that the Javanese records would precisely conform to the astronomy of the *Sūryasiddhānta.* In fact, there is clear evidence to the contrary. The intercalation system of *Sūryasiddhānta* with its insertion of lunar months into its calendar confines itself for most of the time to the months from Vaisakha to Karttika whereas the Javanese intercalation system extends itself across the entire year. The Balinese astronomers in particular wanted to relate the Śaka calendar with their day-cycles used for Javanese and Balinese divination. Very early in the inscriptions the Śaka dates are accompanied by information about the three key day-cycles: the 6-day, the 5-day, and the 7-day cycle that combine in an endlessly repeating 210-day cycle, the wuku.

In the Śaka scheme there is a suppression of the tithi number when there is a *tithi* that is not current at any day, that is to say the *tithi* begins after sunrise on one day and is complete before sunrise on the next day. This can happen because the *tithi* is slightly shorter than a civil, solar day. Twelve lunar months, each containing 30 *tithi* make up a lunar year of 360 *tithi*. However, the lunar year corresponds to 12 lunations, each with on average 29.53059 days giving a total of 354.367 civil days. Thus, there will on average be 360 – 354.367 = 5.633 *tithi* that are suppressed. There will on average be one *tithi* suppressed every 354.367/5.633 = 62.9 solar days. Now it happens that this number is almost exactly 63 days, and 63 days exactly equals nine seven-day weeks. This consideration allows the pattern of suppressions to engage with the wuku cycle. This kind of calendar is implemented in the Balinese Śaka calendar, see Section 5 below. It is possible to list the successive named weeks in which suppression occurs, to form a cycle that repeats after 10 suppressions, or ninety weeks or 630 days. This is called *pangalantaka*. This cycle contains three 210-day cycles, another bonus.

In this scheme the Śaka calendar meshes nicely with the wuku cycles. What about the suppressed *tithi*? After each *pangalantaka* there will be 10 suppressed *tithi*, so that after three *pangalantaka* there will be 30 of them, just enough to make an intercalary lunar month in the Śaka calendar. A seemingly perfect assimilation has been made with the two calendars. An intercalary month occurs after each 3 × 630 = 1890 day. As 1890 days amounts to five years plus three months, the month that will be repeated is predictable according to a cycle of its own. The first intercalated month will be the 11th, the next, five years and three months later will be the second, then the fifth and then the eighth. After that the cycle repeats. The whole pattern or metacycle lasts 4 × 1890 = 7560 days and contains all the day cycles, of 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 days, the cycle of 35 days, 210 days and so on—a spectacular result.

However, this is just a theoretical speculation built on a confusion between *tithi* and calendar days. A suppressed *tithi* merely means that a civil day contains two *tithi* and at the end of the month the *tithi* on that day will be 29 civil days giving the impression that at *tithi* has been lost. It is quite common not only in Javanese inscriptions that there is a confusion between lunar days, *tithi* and civil day reckoning, something which shows that the connection of the calendar with the original Indian astronomy had become lost. Intercalation of a lunar month about every five years would rapidly make the lunar calendar lose connection with the seasons, what is needed is an intercalation about every 33 months. Instead, it seems that in practice in many regions like in Bali, the intercalation was make when needed by observation of the seasons. For this purpose, the constellations of Orion and the Pleiades were used, the first month of the star-based year began with the heliacal rising of Orion.

The problem of how the intercalation was made in practice has been investigated (Eade and Gislén, 2000; Proudfoot, 2007) with some different conclusions. The necessary intercalation would approximately need an extra month every 33 months or three years minus three months. If the first intercalated month would be the eleventh, the next one would be the eighth, then the fifth then the second, then the series would repeat. This would be the mirror image of the cycle above. Proudfoot (2007) found by testing that for Śaka years after 1040 this intercalation scheme actually works very well.

5 THE BALINESE ŚAKA CALENDAR

Bali has an ancient calendar that is slightly different from the traditional Indian Śaka calendar in Java. The Bali scheme (Eiseman, 1990: 220) has a lunar year with 12 months, each with 30 *tithis*. There are 15 *tithis* of waxing Moon, the *penanggal*, and 15 days of waning, the *pangelong*. Each lunar month starts on the day after new Moon, *tilem*. When converting the *tithis* to solar days, on every 63rd solar day or on every ninth week two *tithis* fall on the same solar day and a *tithi* is supressed. Such a day is called *ngunaratri* from Sanskrit meaning 'minus one night'. Taking it that 11 January 1950 has a suppressed *tithi* all other days with a suppressed *tithi* can be calculated. The fact that the distance between suppressed *tithis* is exactly nine weeks means that the calendar weekday is the same for all days with suppressed *tithis*. Before CE 2000 it was Wednesday.

A *tithi* corresponds to 63/64 solar days, thus generating a synodic lunar month of 30 × 63/64 = 29.53125 days. This is slightly longer than the true synodic month, 29.53059 days, which means that the suppression scheme has to be corrected by one day approximately every 122 years. This was for example done in CE 2000 when there was a step by only 62 days from the last suppressed *tithi* in the previous year, Wednesday 17 November to the first suppressed *tithi* on CE Tuesday 18 January 2000.

In order to align the lunar calendar with the solar year it is necessary to intercalate an extra lunar month about every 33 months. Before the middle of the twentieth century this intercalation was done 'when needed' and there was no definite intercalation rule. From about CE 1950 to 1992 the intercalation was determined by cyclical years in a 19-year cycle (Śaka year modulus 19) where 0, 3, 6, 8, 11, 14, and 16 are the cyclical years with an intercalated month and with month 11 being doubled for cyclical years 0, 6, and 11, and month 12 being doubled for the other cyclical years. In the interval CE 1992–2000 the cyclical years with an intercalary month were 2, 4, 7, 10, 13, 15, and 18 with corresponding doubled months according to Table 6, although only cyclical years 2 and 18 were implemented. From CE 1 January 2000 the intercalation reverted to the earlier system. To restore the calendar at the year shift CE 2000/2001, 6 Kaulu (the eighth month) was followed by 7 Kapitu (the seventh month), effectively intercalating a month.

The Bali New Year Day, the *nyepi*, is supposed to be a day of silence, prayer, and meditation and falls on the first day of the tenth month, Kadasa. This day normally falls in March around the time of the vernal equinox.

Figure 11a shows a month in a typical Balinese calendar taken from the website http://www.kalenderbali.info/?month=3&year=2019&submit=Tampilkan. At the top is the Śaka year 1940 which begins in the Gregorian calendar on 7 March 2019. The large numbers show the dates in this calendar. New and Full Moons are shown as a black or a red circle respectively. The *tithis* are represented by a small number in the upper left corner, red for waxing Moon and black for waning Moon. The date 12 March has a suppressed *tithi* as shown by two *tithi* numbers 6/7. Figure 11b shows a detail of 7 March, the *nyepi* or New Year Day, the first day of month 10, Kadasa. It also displays the Pawukon weekdays, in this case, the 1-day weekday is Luang, the 2-day weekday is Pepet, the 3-day weekday is Pasah, the 4-day weekday Jaya, the 5-day weekday Umanis, the 6-day weekday Tungleh, the 8-day weekday Kala, the 9-day weekday Urukung, and the 10-day weekday Duka. The 7-day weekday Wraspati appears above 7-day week name, Matal. The bottom line, *ingkel*, shows a sequence of six names of the 7-day weeks in a repeating cycle of 42 days and has astrological significance.

Table 6: Intercalary months.

Cyclical Year	Doubled month
2, 10	11
4	3
7	1
13	10
15	2
18	12

6 THE ISLAMIC CALENDAR

Muslim traders visited the Southeast Asian archipelago already in the sixth and seventh centuries profiting from the flourishing trade between India and China. During the following centuries Islam gradually spread and was, around CE 1500 when the Majapahit Empire had collapsed, the dominant religion, but with Bali as an exception. Most of the local rulers were then Muslims. The original Muslim calendar is purely lunar, with each year

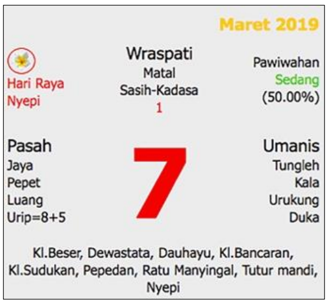


Figure 11a (right): The Balinese Calendar.
Figure 11b (above): Calendar details.

having 12 lunar months, each lunar month starting with the first observation in the evening of the new Moon crescent.

However, the rapid geographic expansion of the Muslim Empire made it pressing to have a standard civil calendar, which was introduced by the Caliph Umar in the eighth year after the death of the Prophet. The calendar had 12 months with alternating 30 and 29 days, and a total of 354 days in a year. To keep in step with the Moon a leap day was added to the last month of 11 intercalary days in a 30-year cycle. This will give 354 × 30 + 11 = 10631 days in a cycle and a synodical month of 10631/ (30 × 12) = 29.53056 days. The difference with the correct synodic month is only one day in about 2400 years.

In the Southeast Asian maritime area and on the Malay Peninsula the Muslim calendar appeared in a simplified variant based on an 8-year cycle (*windu*) (Proudfoot, 2006). As in the original Muslim calendar, the year (*tahun*) has 12 lunar months (*wulan*) with alternating 29 and 30 days. In this 'octaval' calendar, three leap years were distributed through each eight years with years 2, 5, and 7, or sometimes the years 3, 5, and 8 being leap years. This calendar will not be quite as accurate as the original Muslim calendar, having a slightly longer synodic month: (354 × 8 + 3)/(8 × 12) = 29.53125 days. However, an 8-year cycle contains 5 × 354 + 3 × 355 = 2835 days that happens to comprise exactly 407 7-day weeks and also exactly 567 5-day weeks. The result is that if one cycle begins on a particular weekday, so will the next and the beginning weekday of each year within the 8-year cycle will be determined and constitute the signature of that year. In order to align the calendar with the Moon the calendar in the can-

Figure 12: Sultan Agung on an Indonesian stamp.

onical version was adjusted by skipping the last leap day in the last 8-year cycle every 120 years (*kurup*) or 15 windu blocks. Thus, in a 120-year block there are 15 × 2835 – 1 = 42524 days with a total of 3 × 15 – 1 = 44 = 4 × 11 intercalary days. There will be exactly the same number of intercalary days in the Muslim arithmetic calendar, which has a leap year cycle with its 11 leap years in 30 years but the intercalation scheme will be slightly different. In practice it seems that the suppression of the leap day was more flexible and was made as the need was seen to arise and not at precisely regular intervals.

These 'octaval' variants of the Muslim calendar were gaining a foothold in Southeast Asia beginning with the Malacca Peninsula in about CE 1400 according to Malay sources (Proudfoot, 2006). There were many local variants in the adjustment of the calendar by skipping a leap day in order to align the calendar with the Moon.

In CE 1633 Sultan Agung (1613–1645; Figure 12), inaugurated this kind of calendar as the current calendrical system in Indonesia with the regular suppression of a leap day in 120 years. The calendar still retains the Śaka calendar era, CE 78. The calendar is completely different from the earlier luni-solar calendar that tried to synchronise with the Sun. This lunar calendar today runs alongside but separated from the Gregorian calendar.

On top of the 7-day week (Table 7) in the Gregorian and Muslim calendars there is a cyclic 5-day week (*pasaran*). Together they form a 7 × 5 = 35-day cycle (*wenton*) that is used for important celebrations and for divination.

Table 7: Indonesian weekdays.

Indonesian weekdays	Indonesian weekdays
Sunday	Sunday
Monday	Monday
Tuesday	Tuesday
Wednesday	Wednesday
Thursday	Thursday
Friday	Friday
Saturday	Saturday

7 CONCLUDING REMARKS

Originally, Indonesia has had a multitude of different calendars, which is not surprising considering the many relatively isolated islands in the region. A typical feature was the use of cycles of different kinds, the Pawukon calendar being an extreme case. The later part of the calendrical history the Malaysian-Indonesian region is dominated by octaval variants of the Muslim calendar.

8 NOTES

1. This is the fourth paper in the series on the traditional calendars of Southeast Asia. The first paper (Gislén and Eade, 2019a) provided an introduction to the series. Paper 2 was about Burma (present-day Myanmar), Thailand, Laos and Cambodia (Gislén and Eade, 2019b); and Paper 3 about Vietnam (Lân, 2019).
2. For specialist terms used in this paper see the Glossary in Section 10.1.

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10 APPENDICES

10.1 Glossary

acronycal rising The last day when the star (after a period when it was visible at night) rises in the evening after sunset and the Sun is already far enough below the eastern horizon to make it visible in the evening twilight. See *heliacal rising* and *setting.*

Balinese Śaka calendar A calendar related to the traditional Śaka calendar in Java but with some special features.

gnomon A vertical pole casting a shadow of the Sun. It can be used for determining the time of the day or the time of the year.

heliacal rising The first day when the star (after a period when it was invisible) rises in the morning before the Sun and the Sun is still far enough below the eastern horizon to make it briefly visible in the morning twilight. See *acronycal rising*.

heliacal setting The last day when the star or planet (after a period when it was visible) sets after sunset and the Sun is already far enough below the western horizon to make the star briefly visible in the evening twilight. See *acronycal rising*.

kurup An Indonesian cycle of 120 lunar years.

Majapahiti Empire A thalassocracy based on the island of Java that existed from CE 1293 to about CE 1500. During its height it stretched from Sumatra to New Guinea.

mangsa An Indonesian agricultural solar calendar. *Mangsa utama* are the three main seasons in the Javanese *mangsa* calender.

nyepi The Balinese New Year day, the first day of month 10, Kadasa.

Orion A constellation used by many regions in Southeast Asia for calendrical purposes.

pangalantaka An Indonesian cycle of 630 days consisting of three 210-day cycles or ninety 7-day weeks.

pangelong Balinese for the waning phase of the Moon.

pasaran A 5-day week used in Indonesia in combination with the 5-day week.

Pawukon A Balinese cyclic calendar based on a combination of periods with 1-, 2-, 3, …, and 10-day 'weeks' generating a repeating 210-day period.

penanggal Balinese for the waxing phase of the Moon.

Pleiades A group of several quite dim stars that play an important rôle in Indian and Southeast Asian astronomy.

Porhalaan The traditional calendar used by the Batak people of northern Sumatra.

Śaka era An Indian era with epoch of CE 17 March 78. See *Mahasakarat era*.

sasih The Balinese lunar month.

solstice The moment of the year when the Sun is most north or south of the equator. The summer solstice occurs around 21 June, the winter solstice around 21 December.

suppressed tithi The days of the month in the lunar calendar are numbered by the *tithi* that is current on sunrise that day. In some months there is a *tithi* which is not current on any sunrise of the month. This can happen because the lunar day is somewhat shorter than the civil, solar day. That *tithi* is then suppressed.

tahun The Indonesian year of twelve lunar months, *wulan*.

tika A device to keep track of the cycles and celebration days of the Balinese *Pawukon* cycle. Carved in wood or painted on cloth.

tilem The last day in a Balinese lunar month, also being the day of new Moon.

tithi Originally a time unit being a lunar day of $1/30^{th}$ of a synodic month, in Southeast Asian astronomy being 692/703 of a solar day. It can also refer to the lunar day number in a month and also the relative position of the Moon relative to the Sun, the possible 360° divided into 30 *tithis*, each one covering 12°. This unit of time was used already by the Babylonians.

tukar A cylindrical vertical pole used by the Kenyah people of northern Borneo for calendrical purposes.

tumpek A combination in the *Pawukon* calendar of the last day of the 7-day week, Saniscara and the day Keliwon in the 7-day cycle.

urip A number used in the *Pawukon* calendar to determine the weekday name of the 1-day, 2-day, and 10-day weeks.

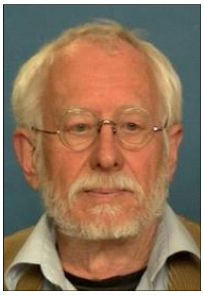
waluku The traditional Javanese plough connected with the constellation of Orion and used as a calendar indicator.

wenton An Indonesian 35-day cycle generated by the combination of a 5- and a 7-day cycle.

windu A block of eight Indonesian lunar years.

wuku calendar An Indonesian cyclic calendar based on a combination of 5-, 6- and 7-day weeks.

wulan The Indonesian lunar month.



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