4.14 SKY CALENDARS OF THE INDO-MALAY ARCHIPELAGO

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Research conducted over the past several years has revealed a richly diverse astronomical tradition in the Indo-Malay cultural area. I wish, in this paper, to share some of this richness by describing several of the many and diverse observational techniques used by the Indo-Malay peoples to help regulate their agricultural cycles.

Inhabiting mountain sides, river valleys, and coastal plains, the Indo-Malay peoples are faced with a rather unpredictable tropical monsoon climate. In response to this geography and climate they have adopted two distinct types of rice farming: swidden and padi, or dry and wet.

Padi farming is sedentary and relies upon heavy monsoon rains and/or irrigation for the rather large and dependable supply of water required: rice plants must be submerged from the time that they are planted in the nursery through transplanting and until seed is set. From thereon, dry weather is essential for the seed to properly ripen. Padi farming is widely practiced on coastal plains and terraced hillsides by people such as the Javanese, the Sasak of Lombok, and the Malays of Kedah and Perak.

Swidden rice requires less water than padi, but the tropical lateritic soils can provide only limited nourishment under dry cultivation. Usually after 2 years, swidden farmers clear a new area, returning to an old field only after it has remained fallow for 10 to 20 years. Since adequate rainfall is generally available for much of the year in the areas where swidden farming is practiced, the most critical operations are the burn and the dibbling and sowing of the seed. The forest growth must be cut and ready to burn at the height of the dry season, usually no more than a month long, and the planting must occur just as the rain returns. Swidden farming is practiced by the Iban, Kenyah, Kayan, and Maloh, all of northwestern Borneo, among others.

To briefly digress, much of my information has come from sources whose authors have been more or less skilled in observational astronomy. Using a planetarium star projector, I have, in each case, recreated the phenomena described and refined the descriptions in the literature.

For both swidden and padi farmers, nature has long provided dependable markers against which agricultural operations can be timed; recurring celestial phenomena did not go unnoticed. I will now describe examples of the extraordinarily diverse calendrical techniques employed, past and

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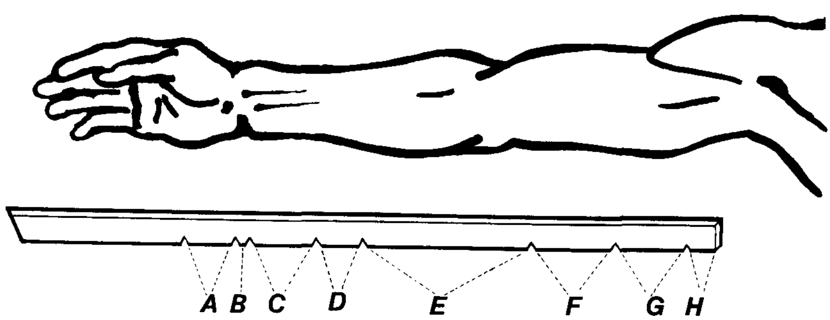
present, by a few of the many cultures of the region. For convenience, I group them using Western astronomical categories as follows: solar gnomons, heliacal apparitions of stars and groups of stars, and lunar-solar and sideral-lunar observations.

A solar gnomon consists of a vertical pole or other similar device that is used to cast a shadow. By measuring the relative length of this shadow each day at local solar noon, one can observe and more or less accurately measure the changing altitude of the sun above the horizon through the year and, thereby, determine the approximate date.

Heliacal (Greek helios: 'sun') apparitions of stars or groups of stars are those which occur at dusk (when the star or stars first become visible in the twilight) or at dawn (when the stars are last seen in the new light). Since the altitudes of stars vary as a function of both the time of night and the day of the year, a certain star or group of stars, when observed at the same time each night, will appear at a given altitude above the eastern or western horizon on one and only one night of the year. Hence the use of any technique or device to measure the altitude of a star or groups of stars as they appear heliacally can provide the observer with the approximate date. The heliacal rising of a star or group of stars occurs on the date that the star or stars are observed just above the eastern horizon at dusk or dawn. Likewise, the heliacal setting of a star or group of stars occurs on the date that the star or stars are observed just above the western horizon at dusk or dawn. The phenomenon that I shall refer to as an "heliacal culmination" occurs on the date that the star or stars under observation reach the height of their nightly climb in the sky (ie. transit the meridian) 1) just as they first appear at dusk or 2) just as they are fading at dawn.

Two distinct types of solar gnomons have been reported. Both measure the length of the sun's shadow at local solar noon to determine the date. The first has been employed by various tribes of the Kenyah. It consists of a precisely measured, permanently secured, plumbed, and decorated vertical hardwood pole (tukar do) and a neatly worked flat measuring stick (aso do), marked with two sets of notches (Figure 1). The first set corresponds to specific parts of the maker's arm and ornaments worn upon it, measured by laying the stick along the radial

Figure 1. Kenyan aso do.



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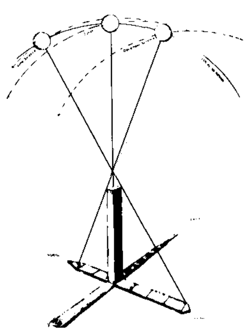
side of the arm, the butt end against the inside of the armpit. The measuring stick is placed at the base of the vertical pole, butt end against the pole and extending southward at the time that the shadow is shortest during the day, local solar noon. On the day that the sun's shadow is longest (the June solstice) a notch is carved to mark its extent on the other edge of the stick. This event indicates that the agricultural season is at hand. The extent of the noonday shadow is then recorded every three days, as a record keeping device. Dates, both favorable and unfavorable, for various operations in rice cultivation, such as clearing, burning, and planting, are determined by the length of the shadow relative to the marks on the stick that correspond to parts of the arm and to the marks made every three days (Hose 1905).

The Kayan, a culture closely associated with the Kenyah, use a similar technique except that the length of the sun's shadow is not measured with a vertical pole in the out-of-doors. Instead, a hole is made in the roof of the weather prophet's room in the longhouse and a measuring stick is securely positioned such that the sunbeam which passes through the hole falls upon the stick at local solar noon (Hose 1905).

On Java a highly accurate gnomon, called a bencet, was in use from about AD 1600 until 1855. A smaller, more portable device than that employed by the Kayan and Kenyah, the bencet divides the year into twelve unequal periods, called mangsa, two of which begin on the days of the zenith sun, when the sun casts no shadow at local solar noon, and another two of which begin on the two solstices, when the sun casts its longest mid-day shadows. At the latitude of Central Java, 7 degrees south, a unique condition exists which is reflected in the bencet. As the illustration shows, when, on the June solstice, the sun stands on the meridian and to the north of the zenith, the shadow length, measured to the south of the base of the vertical pole, is precisely double the length of the shadow, measured to the north, which is cast when the sun, on the December solstice, stands on the meridian south of the zenith. By simply halving the shorter segment and quartering the longer, the Javanese produced a calendar with 12 divisions, divisions which are spatially equal but ranging in duration from 23 to 43 days. Figure 2 shows the bencet and the twelve mangsa with their starting dates and numbers of days.

Figure 2. The Javanese bencet (after Aveni 1981) and mangsa calendar (after Van den Bosch 1980).



ORDINAL NUMBER	NAME(S)		DURATION	FIRST DAY(S) CIVIL CALENDAR
Ka-1	Kasa		41 Days	21 or 22 Jun
Ka-2	Karo	Kalih	23	1 or 2 Aug
Ka-3	Katelu	Katiga	24	24 or 25 Aug
Ka-4	Kapat	Kasakawan	25	17 or 18 Sep
Ka-5	Kalima	Gangsal	27	12 or 13 Oct
Ka-6	Kanem		43	8 or 9 Nov
Ka-7	Kapitu		43	21 or 22 Dec
Ka-8	Kawolu		26/27	2 or 3 Feb
Ka-9	Kasanga		25	ult Feb/1 Mar
Ka-10	Kasepuluh	Kasadasa	24	25 or 26 Mar
Ka-11	Desta		23	18 or 19 Apr
Ka-12	Sada		41	11 or 12 May

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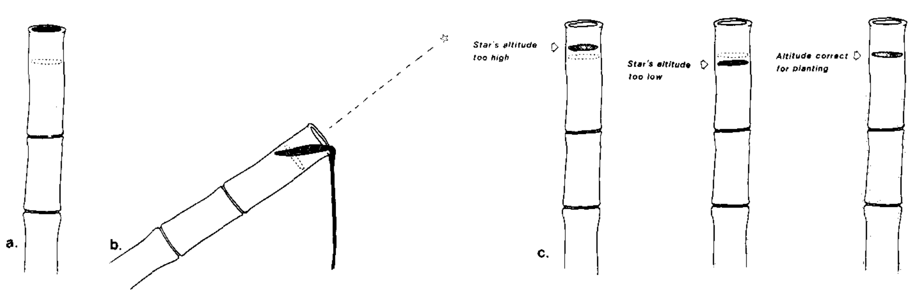
My second category of observational techniques regularly employed by traditional farmers of the region include all of those which involve heliacal (dusk or dawn) apparitions of stars or groups of stars. In a tropical rainforest the horizon may consist of anything from a distant mountain to, more often, some nearby trees; the horizon is, therefore, a rather undependable device against which to sight and measure the positions of astronomical objects. Regardless of location, however, one can usually find a clearing from which much of the sky is visible.

Heliacal risings and settings of stars have been systematically observed by traditional cultures world-wide. From the Indo-Malay region there are references in the literature, too numerous to include here, to the calendrical use of heliacal risings and settings at both dusk and dawn of the stars we know as the Pleiades, Orion and, to a lesser extent, Antares, Scorpius, and Crux. Heliacal culminations (defined above) at both sunrise and sunset of the Pleiades, Orion, and Sirius are noted in the literature. Interestingly, the observation for calendrical purposes of heliacal culminations seems to be unique to peoples of the Indo-Malay Archipelago. The systematic observation of heliacal apparitions of stars by the Iban is described further on; a discussion of such observations made by the Javanese can be found in Ammarell (in press). The heliacal sightings of certain stars at other critical altitudes for calendrical purposes has been recorded throughout the region; three examples follow.

The first technique in this category was practiced by a small Dyak tribe related to the Kenyah-Kayan complex mentioned earlier. Like their neighbors, they were swidden rice farmers but, unlike their neighbors who tracked the sun, this tribe depended upon the stars to fix the date of planting. Each night water was poured into the end of a vertical piece of bamboo in which a line had been inscribed at a certain distance from the open end (Figure 3a). The bamboo pole was then tilted until it pointed toward a certain star (unrecorded) at a certain time of night (also unrecorded), causing some of the water to pour out (Figure 3b). It was then made vertical again and the level of the remaining water noted (Figure 3c). When the level concided with the mark, it was time to plant (Hose and McDougall 1912).

Figure 3. A Dyak bamboo stellar diopter.



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The Maloh, living near but unrelated to the Kenyah-Kayan, used the time between the heliacal culminations at dawn of the Pleiades and Orion (3 - 30 September) to fix the period for planting rice. The time was right for planting, it was pointed out, when a man looked up to see the Pleiades and his hat fell off (King 1985)!

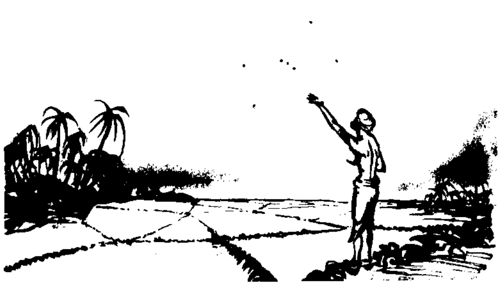
Near Jogyakarta, Central Java, the ritual practitioner (wali puhun) raised his hand toward the East in the direction of Orion at dusk, rice seed in his open palm (Figure 4). On the night that kernals of rice rolled down, it was time to sow seed in the nursery (Van den Bosch 1980). I have fixed the date of this at about 4 January (Ammarell in press).

The systematic observation of the heliacal apparitions of stars by the Iban is described further on, while the observation of both the heliacal apparitions and general altitudes of stars by the Javanese can be found in Ammarell (in press).

Lunar calendars of the region seem to fall into two general categories: lunar-solar and sideral-lunar. Examples of the lunar-solar calendar include the Balinese ceremonial calendar, still in use, and the old Javanese Saka calendar, used from the 8th - 16th Centuries. Both are apparently of a common Hindu origin and are primarily lunar; both employ complex mathematical techniques to provide the intercalary days which periodically synchronize the lunar with the solar year (Covarrubias 1937; Geertz 1973; Van den Bosch 1980). Another lunar calendar which provides intercalary days is indigenous to the island of Savu. But rather than employing direct observations of the sun or mathematical formulae, the Savunese insert an intercalary month, as needed, to synchronize their lunar calendar with the most economically important and reliable occurrence of the year: the second blossoming of the lontar palm, their main source of subsistence (Lebar 1972; Fox 1979).

A second type of lunar calendar is found spread throughout the region, one which uses the heliacal apparitions of stars and groups of stars to determine which month is current. In these cases, it is only important to know which month it is for a few months each year (that is, during

Figure 4. Using rice seed to determine the altitude of Orion (Javanese).



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the agricultural season), thereby obviating the need for codified schemes for realigning the lunar with the solar/stellar year. Such 'short' calendars are widely employed in the region (cf Ecklund 1977 & Dove 1981). The Iban sidereal-lunar calendar provides a good example.

The stars play a central role in Iban mythology and agricultural practices. Several Iban stories tell how their knowledge of the stars was handed down to them by their deities (Howell 1963; Freeman 1970; Jensen 1974) and, according to one village headman, "If there were no stars we Iban would be lost, not knowing when to plant; we live by the stars." (Freeman, 1970) The Iban lunar calendar is annually adjusted to the heliacal apparitions of two groups of stars: the Pleiades and the three stars of Orion's belt. That is, when the Pleiades reappear and are visible above the horizon just before sunrise (June 5), the month, taken from new moon to new moon, that is current is called the " 5th Month" (bulan lima). It is during this month that two members of the house go into the forest to seek favorable omens so that the land selected will yield a good crop. This may take from 2 days to a month, but once the omens appear, they return to the longhouse to begin clearing the forest.

If it takes so long for the omens to appear that Orion's belt rises before daybreak (25 June), the people " must make every effort to regain lost time or the crop will be poor." The heliacal rising of Orion at dawn occurs during the 6th month, time to begin clearing the land.

When the Pleiades culminates at dawn (3 September) and Orion is about to do so (26-30 September), it is the 8th month and time to burn and plant. For good yields the burn should occur between the time that the Pleiades and Orion reach the meridian at dawn, usually when the two are in balance or equidistant from the meridian (16 September). Padi sown after Sirius has completed its heliacal culmination at dawn, (October 15) will not mature properly. Planting may carry into the 10th month (October - November), but it must be completed before the moon is full or the crop will fail. At this point the lunar calendar ends: only months 5 - 10 are numbered and fixed while the remaining months vary according to how quickly the crop matures (eg. bulan mantun, the 'weeding month'). The lunar months from November - April are simply not numbered; it is difficult to see the stars during the rainy season and unimportant in any case (Hose 1905; Annonymous 1963; Howell 1963; Freeman 1970; Jensen 1974).

In this brief survey of sky calendars of the Indo-Malay Archipelago I have attempted to share some of the rich diversity of observational techniques employed throughout the region. Of particular interest to the study of indigenous astronomical systems world-wide are the apparently unique calendrical applications of 'heliacal culminations' of groups of stars and the 'short' sidereal-lunar years. The practice and ecological and social context of these calendrical systems calls for further research and will be the subject of a future paper.

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DISCUSSION

E.S.Kennedy : You gave a date in the 17th Century marking the beginning of a certain practice. How did you determine this date ?

Gene Ammarell: By ethnographic records.

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