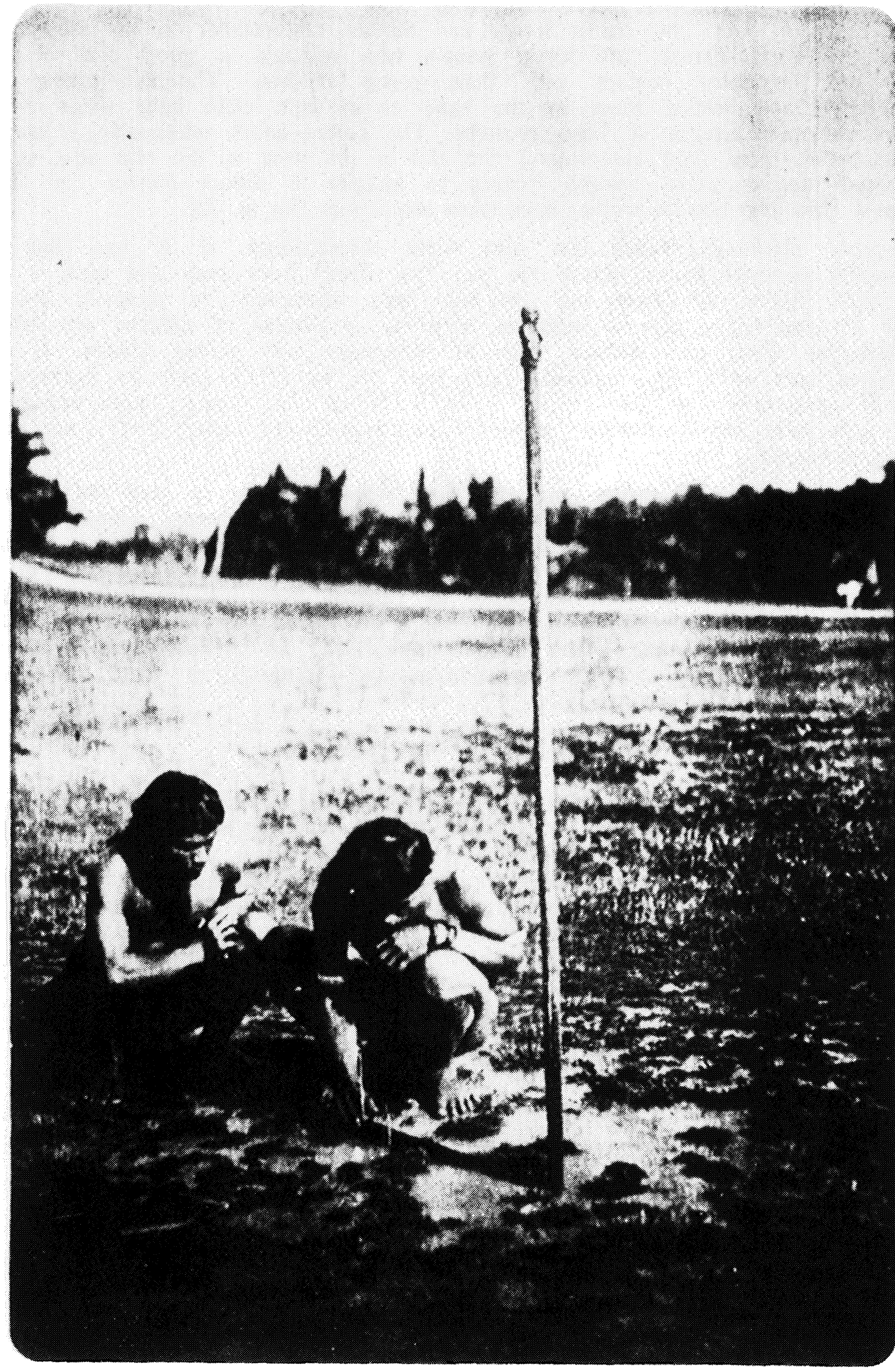

Figure 1. Kenyah *tukar do* or solar gnomon. (From Hose and McDougall, *Pagan Tribes of Borneo*, p. 108, facing.)

SKY CALENDARS OF THE INDO–MALAY ARCHIPELAGO: REGIONAL DIVERSITY/LOCAL KNOWLEDGE[1]

Gene Ammarell

> . . . in recent years anthropology has begun to face up to the implications of the truism that people do not respond directly to their environment but rather to the environment *as they conceive of it:* e.g. to animals and plants as conceptualized in *their* minds and labeled by *their* language. In other words, understanding human ecology requires understanding human conceptual systems. It is not enough to understand the role of a type of organism in economics and/or ritual. One must also understand how the people involved classify and think about it.[2]

Anthropologists, not unlike the traditional peoples they study, have long recognized the fundamental interrelationship of human populations and the natural environments in which they live.[3] The study of this interrelationship, carried out by an objective observer using the categories and tools of Western science, has come to be known as human ecology.[4]

But it is also true that all societies have their own body of knowledge through which they seek to understand the natural environment and their relationship to it. Thus we may be better able to understand a society by going beyond the objectivity and categories of science and begin to consider the interrelationship of a society with its environment from the viewpoint of the members of that society. It is this attempt to understand how members of a society, themselves, conceive of their environment that has come to be known as ethnoecology.[5] Ethnoastronomy, the subject of this paper, may be seen as a branch of ethnoecology wherein the

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1. Earlier versions of this article were delivered at the Southeast Asia Summer Studies Institute on August 3, 1986, and at the International Astronomical Union Colloquium #91, History of Oriental Astronomy, held in New Delhi, India, on November 16, 1985. I would like to thank all those who have commented on this article, especially Anna L. Tsing, Charles O. Frake, Harold C. Conklin, and John R. Bowen.

2. Robert K. Dentan, "An Appeal to Members of the Society from an Anthropologist," *Malayan Nature* 23 (1970): 121–22.

3. See, for example, C. Wissler, *The Relations of Man to Nature in Aboriginal America* (New York: Oxford University Press, 1926); A. L. Kroeber, *Cultural and Natural Areas of Native North America* (Berkeley: University of California Press, 1939); Clifford Geertz, *Agricultural Involution* (Berkeley: University of California Press, 1963).

4. Eric S. Casiño, "Jama Mapun Ethnoecology: Economic and Symbolic," *Asian Studies* 5 (1967): 1–3.

5. Ibid.

interrelationship of human populations with their celestial environment is the focus of interest.

Although researchers in Southeast Asian cultures have made significant contributions to the growing body of literature in ethnoecology,[6] few have attempted to put together regional knowledge of the celestial environment in comparative studies that would make this knowledge more accessible to students of ethnoecology and ethnoastronomy.[7] As recently as 1982 archaeoastronomer Anthony Aveni noted that the Indo–Malay region represented "a significant gap in the archaeoastronomical and ethnoastronomical record between the Indian mainland and Oceania."[8] The gap, however, is quickly closing. Literature searches,[9] personal communications, and interviews conducted over the past several years have revealed an astronomical tradition that is, at once, unique to this cultural area and richly diverse in its local variation.

It is the intent of this article to share some of this richness by: 1) describing several of the many techniques of astronomical observation employed by the Indo–Malay peoples to help regulate their agricultural cycles; and 2) suggesting, in three cases, how traditional knowledge of the celestial environment appears to be integrated with other environmental knowledge and with social practices within the respective cultures.

The Celestial Landscape

The passage of time is mirrored in all of nature; in the light and warmth of day and the dark and coolness of night; in the flowering of plants; in the mating and migratory behavior of animals; in the changes in weather; and in the recurring cycles within cycles of the sun, moon, planets, and stars as they transit the celestial sphere. Of these cycles, perhaps the most obvious is the diurnal rising and setting of the sun, moon, planets, and stars, as well as the synodic, or cyclic changes in the phase of the moon and in the time of day that it rises and sets. More subtle than these might be the annual changes in the sun and stars; the north–south shift in the path of the sun across the sky (including its rising and setting points and

6. See, for example, Harold C. Conklin, "The Relation of Hanunoo Culture to the Plant World" (PhD dissertation, Yale University, 1954); Charles O. Frake, "Cultural Ecology and Ethnography," *American Anthropologist* 64 (1962): 53–59; Dentan, "Appeal to Members of the Society"; Karl L. Hutterer, A. Terry Rambo, and George Lovelace, eds., *Cultural Values and Human Ecology in Southeast Asia* (Ann Arbor: University of Michigan, 1985); and Gerald G. Marten, ed., *Traditional Agriculture in Southeast Asia: A Human Ecology Perspective* (Boulder, Colorado: Westview Press, 1986).

7. A notable exception is A. Terry Rambo, "Of Stones and Stars: Malaysian Orang Asli Environmental Knowledge in Relation to Their Adaptation to the Tropical Rain Forest Ecosystem," *Federation Museums Journal* 25 (1980).

8. Anthony F. Aveni, personal communication.

9. Much of the information for this article has come from historical and ethnographic literature where the authors have been more or less knowledgeable in the field of observational astronomy. Utilizing a technologically sophisticated and precise planetarium star projector, it has been possible, in each case, to recreate visually the astronomical phenomena described and to refine the descriptions of the observations found in the literature. The star projector has proved itself to be an invaluable tool in this research.

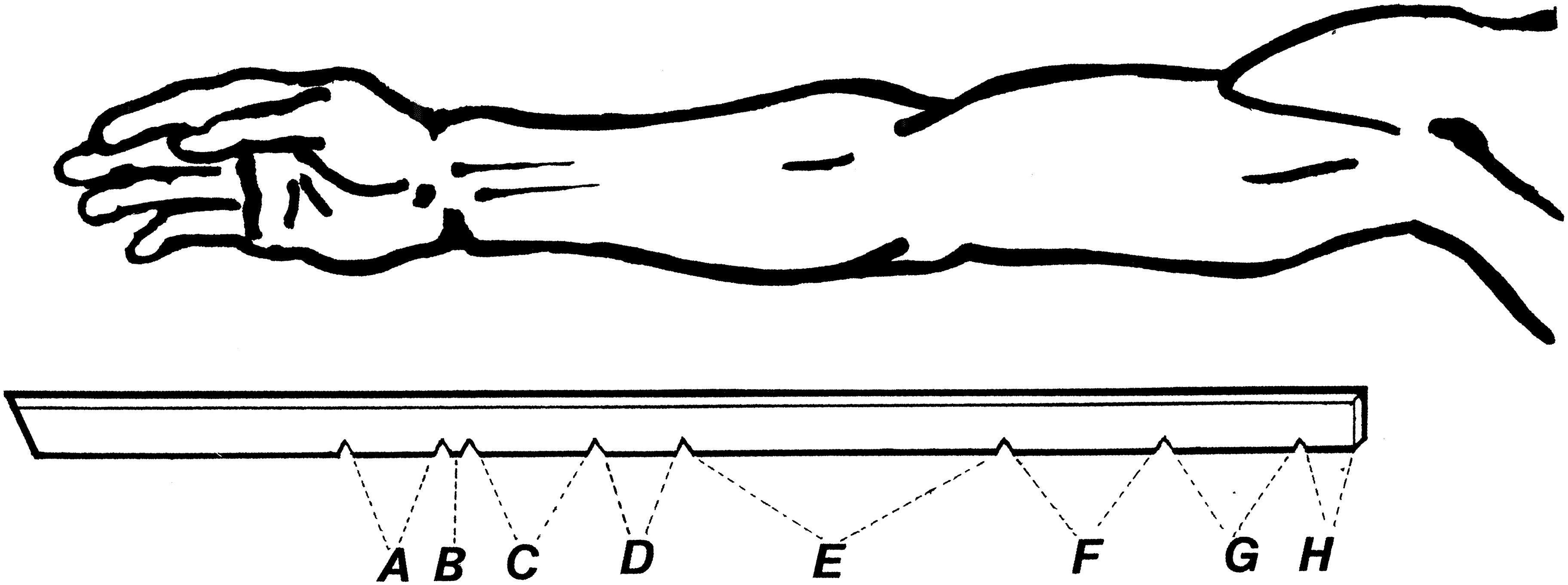

Figure 2. Kenyah *aso do* or base of solar gnomon. (Adapted from Hose, "Various Methods of Computing Time," appendix.)

its relative distance above the horizon at noon) and the appearance, disappearance, and reappearance of familiar patterns of stars at various times of night. To the trained eye, nature is replete with signs of seasonal change. As an integral part of the natural landscape, these recurring celestial phenomena have long provided traditional farmers worldwide with dependable markers against which agricultural operations can be timed.

Many traditional, sedentary desert and plains cultures use the shift in the rising and/or setting points of the sun along the horizon both to mark important dates and seasons and to commemorate the passage of years. Such an environment is conducive to the development and use of these horizon–based solar calendars: a permanent location from which to make sightings, a series of permanent distant horizon markers, either natural or manufactured, and a clear view are all that is needed for such a calendar.[10] Such conditions are not common in Indonesia and Malaysia. Here the landscape may consist of anything from a nearby or distant mountain to, more often, some nearby trees; the horizon is, therefore, a rather undependable device against which to sight and measure the rising and setting positions of the sun.[11] But in cultivated areas of the region, even from swiddens located deep within the rainforest, one can usually find a field or homesite from which much of the sky is visible.

Diversity of Techniques

Where permanent, distant horizon markers are not commonly available, several types of observations of annually recurring celestial phenomena can still be made. These include cyclic changes in the phases of the moon, the annual changes in the apparitions of familiar groups of stars, and the annual changes in the altitude of the sun at noon. Variations of these types of observations as practiced by traditional Indonesian and Malaysian farmers will now be presented. For the sake of clarity, they are grouped using Western astronomical categories as follows: solar gnomons, heliacal apparitions of stars and groups of stars, and lunar–solar and sidereal–lunar observations.

Solar gnomons. Most often seen on sundials in Western cultures, a solar gnomon is simply a vertical pole or other similar device that is used to cast a shadow. The altitude of the sun above the horizon varies not only through the day, however, but through the year as well. 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 (or, reciprocally, from the zenith) through the year and, thereby, determine the approximate date.

Two distinct types of solar gnomons have been reported. Both measure the altitude of the sun at local solar noon to determine the date. One type has been attributed to various groups of the Kenyah (Fig. 1). It consists of a precisely measured

10. Anthony F. Aveni, *Native American Astronomy* (Austin: University of Texas Press, 1977), esp. pp. xiv, 18.

11. During my 1986 field work in South Kalimantan, a young Meratus Dayak man gave a detailed account of changes in the rising and setting points of the sun through the year from his rice field. He noted the relative north–south shift and was able, when questioned, to correlate this shift with the local agricultural calendar. However, this kind of correlation was not a feature of Meratus traditional skylore, nor was it conventionally used to predict or describe the timing of agricultural events.

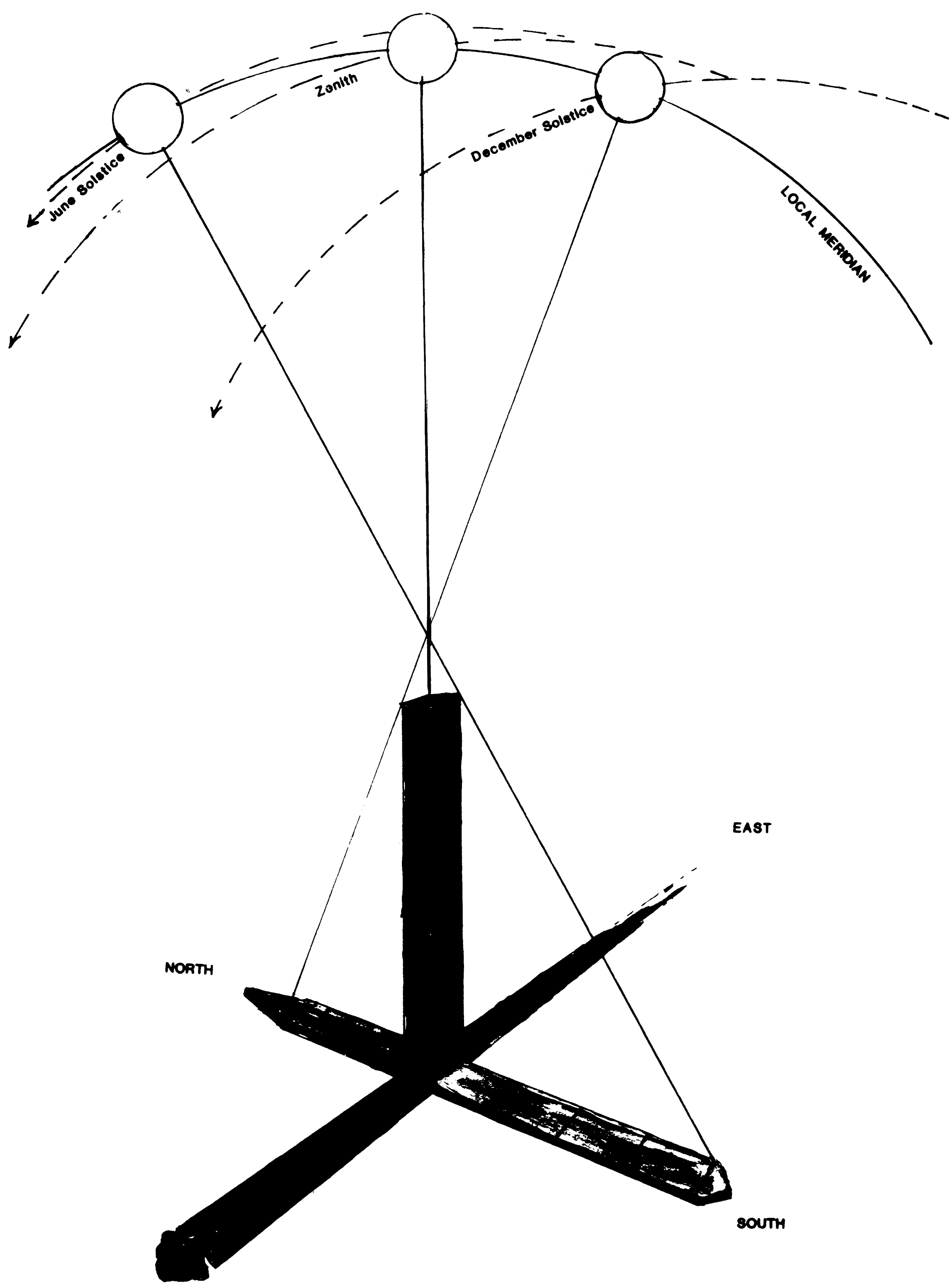

Figure 3. Javanese *bencet* or solar gnomon. (Adapted from Aveni, *Native American Astronomy*, p. 169.)

(= span of maker's outstretched arms + span from tip of thumb to tip of first finger), 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 (Fig. 2). The first set of notches corresponds to specific parts of the maker's arm and ornaments worn upon it, measured by laying the stick along the radial side of the arm, the butt end against the inside of the armpit. To mark the date, the measuring stick is placed at the base of the vertical pole, butt end against the pole and extending southward. This is done at the time of day that the shadows are shortest, local solar noon. On the day that the pole's noontime shadow is longest (the June solstice), a notch is carved on the other edge of the stick to mark the extent of the shadow made by the pole. This observation indicates that the agricultural season is at hand. From then on, the extent of the noonday shadow is 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.[12]

The Kayan, a culture closely associated with the Kenyah, were, in Hose's 1905 study, reported to use a similar technique except that the length of the sun's shadow was not measured with a vertical pole in the out–of–doors. Instead, a hole was made in the roof of the longhouse and a measuring stick was securely positioned and leveled such that the sunbeam (called *kleput toh*, the blow pipe of the spirit) which passes through the hole falls upon the stick at local solar noon.[13]

On Java a highly accurate gnomon, called a *bencet*, was in use from about AD 1600 until 1855 (Fig. 3). 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 (that is, at local solar noon) 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 (at noon) 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 which range in duration from 23 to 43 days. The twelve *mangsa* with their starting dates and numbers of days are shown on Table 1.[14]

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12. Charles Hose, "Various Methods of Computing Time among the Races of Borneo," *Journal of the Straits Branch of the Royal Asiatic Society*, no. 42 (1905): 4–5, 209–10; Charles Hose and W. McDougall, *The Pagan Tribes of Borneo* (London: Macmillan, 1912), pp. 106–8; W. Conley, *The Kalimantan Kenyah: A Study of Tribal Conversion in Terms of Dynamic Cultural Themes* (Kota Kinabalu: Yayasan Sabah Library, 1973), pp. 229–30.

13. Hose, "Various Methods of Computing Time," p. 4.

14. F. van den Bosch, "Der Javanische Mangsakalender," *Bijdragen tot de taal–, land– en volkenkunde* 136 (1980): 251–52; Anthony F. Aveni, "Tropical Archaeoastronomy," *Science* 213 (July 10, 1981): 169.

Table 1

The Pranatamangsa Calendar*

Ordinal Number	Name(s) of Mangsa		Duration in Days	First Day(s) Civil Calendar	
Ka–1	Kasa		41	June 22	June 21
Ka–2	Karo	Kalih	23	August 2	August 1
Ka–3	Katelu	Katiga	24	August 25	August 24
Ka–4	Kapat	Kasakawan	25	September 18	September 17
Ka–5	Kalima	Gangsal	27	October 13	October 12
Ka–6	Kanem		43	November 9	November 8
Ka–7	Kapitu		43	December 22	December 21
Ka–8	Kawolu		26/27	February 3	February 2
Ka–9	Kasanga		25	March 1	February ult.
Ka–10	Kasepuluh	Kasadasa	24	March 26	March 25
Ka–11	Desta		23	April 19	April 18
Ka–12	Sada		41	May 12	May 11

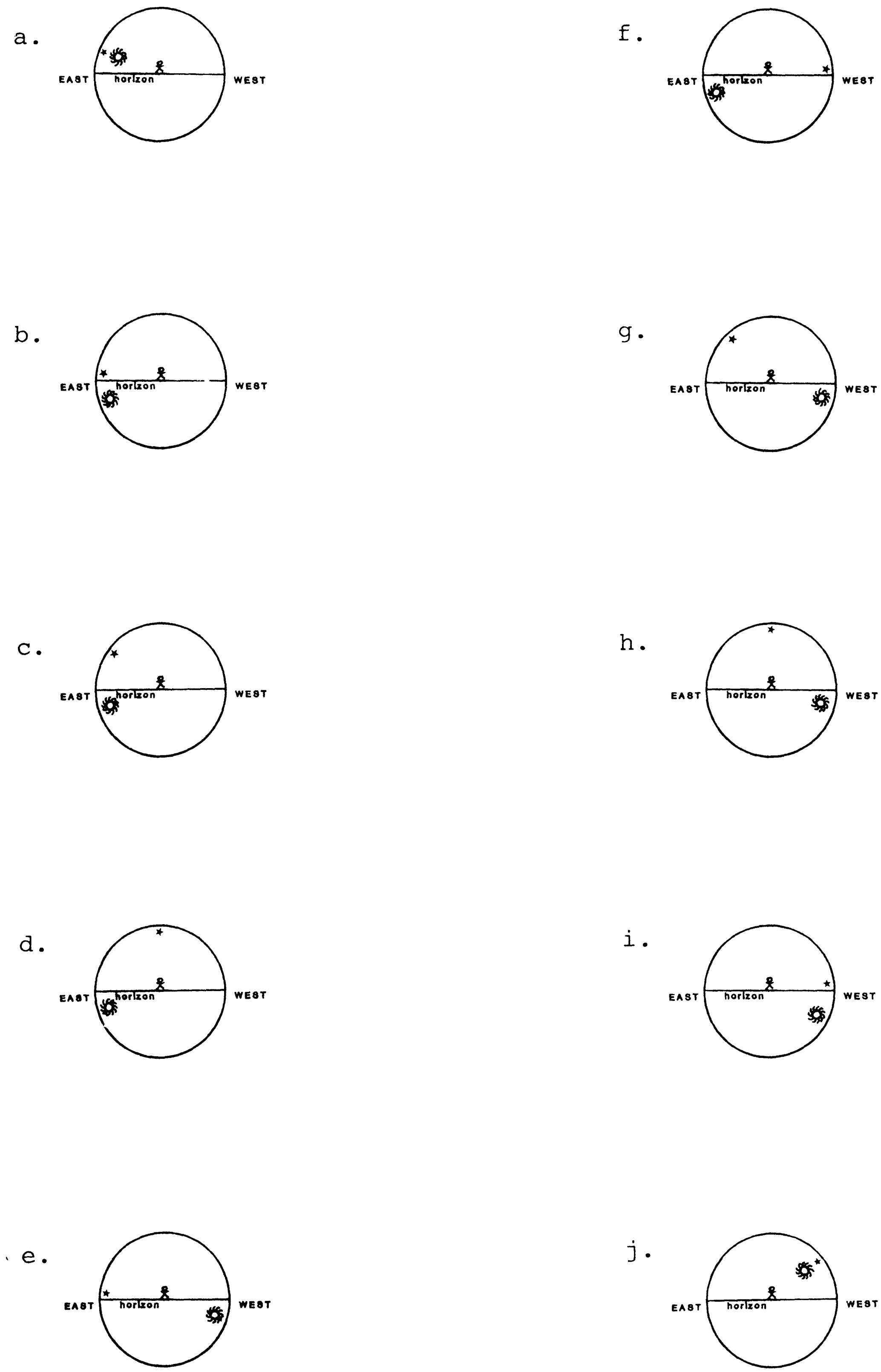
* Adapted from van den Bosch, "Javanische Mangsakalender," p. 250.

Heliacal Apparitions of Stars. The second category of observational techniques regularly employed by traditional farmers of the region includes all of those which involve "heliacal" apparitions of stars or groups of stars. Heliacal (Greek *helios*: "sun") apparitions of stars are those which occur at dusk (when the star or stars first become visible in the twilight) or at dawn (when the star or stars are last seen in the new light).

The series of diagrams in Figure 4 shows the relative positions of the sun and of a star cluster, known in the West as the Pleiades, throughout the course of a year as observed from near the earth's equator. The circle represents the "dome" of the sky, bisected vertically by the horizon and with the observer located at the center. Because of the earth's rotation, the sun and stars appear to move in a clock–wise direction (east to west) each day while the motion of the earth around the sun appears to an observer on earth as the sun moving in a counterclockwise direction (west to east) relative to the background of stars over the course of the year.

It can be observed that each star rises and sets approximately four minutes earlier each night or, similarly, each star appears to have moved about one degree west, when viewed at the same time, each night. This means the altitudes of stars above the horizon vary as a function of both the time of night and the day of the year, such that a certain star or group of stars, when observed at the same time each night (in this case near dusk or dawn) 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 group of stars as it appears 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 dawn (Fig. 4b) or dusk (Fig. 4e).

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 dawn (Fig. 4f) or dusk (Fig. 4i). The phenomenon that is herein referred to as an "heliacal culmina–tion" occurs on the date that the star or stars under observation reach the height


a.
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b.
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Figure 4

Figure 4. Heliacal apparitions as calendrical markers.

a. *Conjunction:* On May 20 the star cluster is not visible but would appear just north of the sun if it were not lost in the sun's glare.

b. *Heliacal Rise at Sunrise:* On June 5 the star cluster returns to visibility after thirty-five days of apparent absence. It is visible only briefly before becoming lost in the rising sun's glare.

c. *Altitude = 36° above Eastern Horizon at Sunrise:* Rising earlier each morning, the star cluster and the sun seem to be moving apart. On July 21 the star cluster is already 36° above the eastern horizon as it fades from view in the dawn's light. (In Kedah and Perak this altitude was measured by watching for falling rice grains from the farmer's palm as he extended it skyward each night. See pp. 96–97.)

d. *Heliacal Culmination at Sunrise:* On September 3 the star cluster culminates (transits the meridian) just before it is obscured from view by the sun's glare. Prior to this date, culmination occurred during daylight hours; for the next five months it occurs at night and will, therefore, be visible.

e. *Heliacal Rise at Sunset:* The star cluster has been rising earlier each evening for five months. On November 8 it rises just as the sky has grown dark enough for the cluster to be visible. For the next six months the cluster will already have risen when the sun sets.

f. *Heliacal Set at Sunrise:* Prior to this apparition, the setting of the star cluster occurred during daylight hours and so could not be observed. On November 25 it sets minutes before it would be obscured from view by the dawn and for the next six months its setting will be observable as it occurs earlier each night.

g. *Altitude = 50° above Eastern Horizon at Sunset:* Rising earlier each afternoon, the star cluster, on December 30, is already 50° above the eastern horizon when it first appears after sunset. (On Java this apparition is named for the time during the day when the sun is at the same altitude, that is *pecat sawad*. See page 9.)

h. *Heliacal Culmination at Sunset:* For five months culmination of the cluster has been visible and occurring earlier each night. On January 27 it culminuates (transits the meridian) just as it is becoming visible in the evening twilight. Henceforth occurring before sunset, culmination will not be visible again for seven months.

i. *Heliacal Set at Sunset:* Setting earlier each night, the star cluster, by late April, appears only briefly in the evening twilight before it sets. On May 1 the cluster sets soon enough after sunset that, totally obscured by the sun's glare, it is not visible at all.

j. *Conjunction:* On May 20 the star cluster is aligned again with the sun and will not be visible again until June 5.

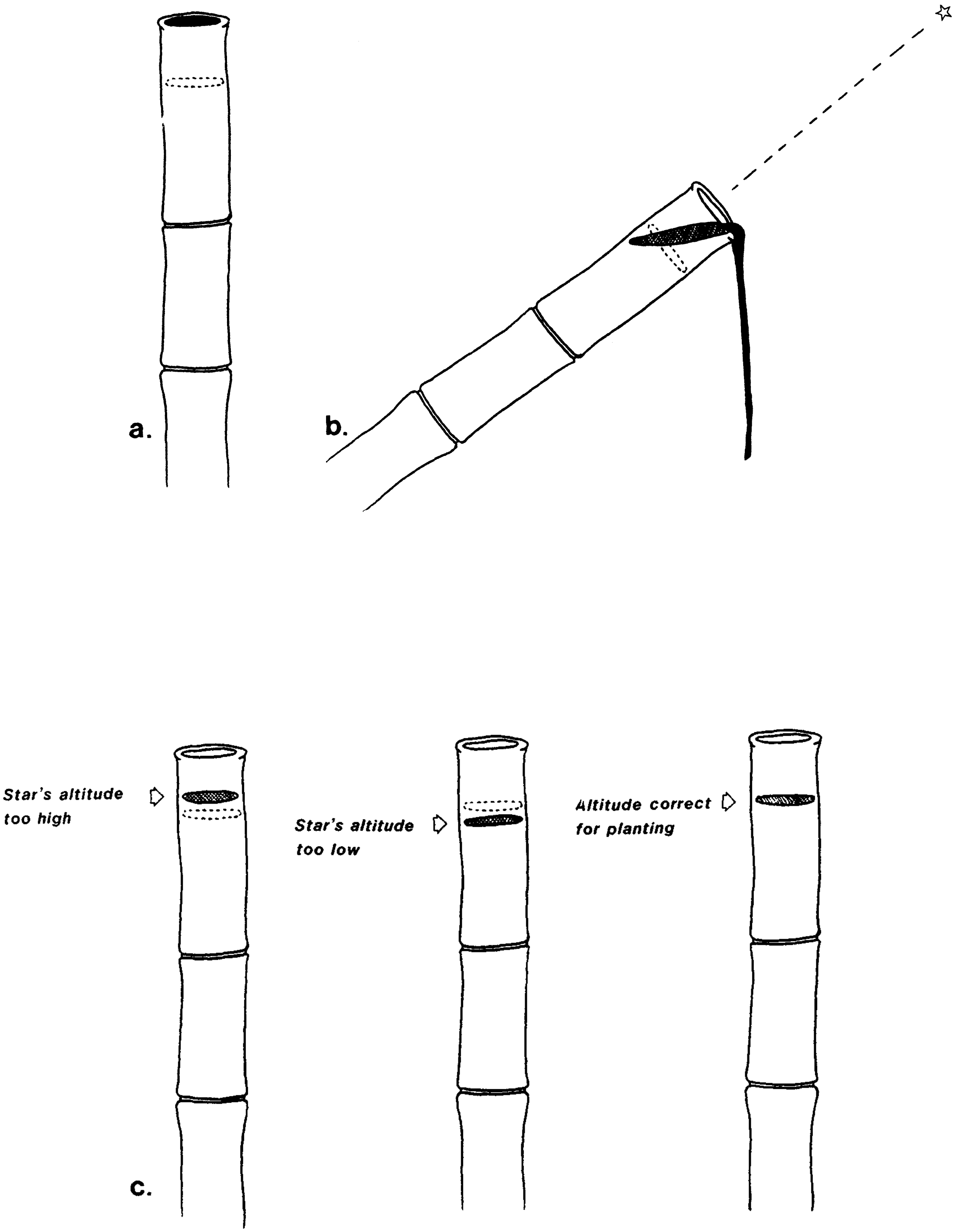

Figure 5. Bamboo device for measuring the altitude of a star from the Kenyah–Kayan complex. (Adapted from Hose and McDougall, *Pagan Tribes of Borneo*, p. 109.)

of their nightly climb in the sky (i.e., transit the meridian) just as they first appear at dusk (Fig. 4h) or just as they disappear at dawn (Fig. 4d).[15]

Heliacal risings and settings of stars have been systematically observed by traditional cultures worldwide. From the Indo–Malay region there are references in the literature, too numerous to describe in detail 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 at both sunrise and sunset of the Pleiades, Orion, and Sirius are noted in the literature.[16] Interestingly, the observation for calendrical purposes of heliacal culminations seems to be unique to peoples of the Indo–Malay archipelago.

The first example in this category was practiced by a small Dayak 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. To do so, they nightly poured water into the end of a vertical piece of bamboo in which a line had been inscribed at a certain distance from the open end (Fig. 5a). 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 (Fig. 5b). It was then made vertical again and the level of the remaining water noted (Fig. 5c). When the level coincided with the mark, it was time to plant.[17]

The Maloh, living near the Kenyah–Kayan, used the time between the heliacal culminations at dawn of the Pleiades, called *Bintang Balunus*, and Orion, called *Bintang*

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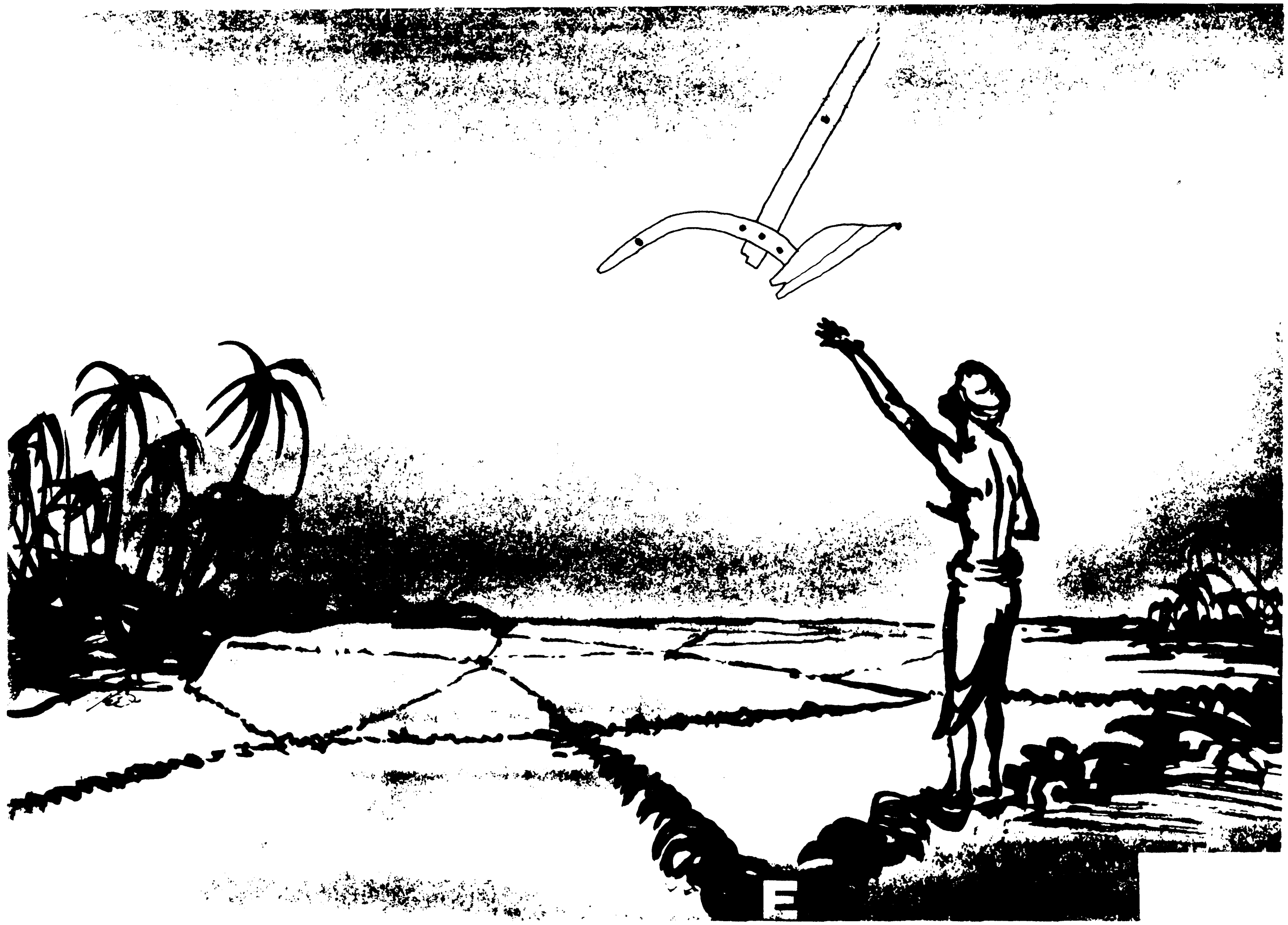
15. It is noted that these categories are taken from what is often referred to as the "exact science" of Western mathematical astronomy and are used here and elsewhere (see, for example, Anthony F. Aveni, *Skywatchers of Ancient Mexico* [Austin: University of Texas Press, 1980], pp. 109–17) as a way of organizing and presenting this material to the Western scholar. The reader is cautioned that the actual observations made by local Indo–Malay farmers may not always be as precise as their assigned astronomical categories might imply. The demand for such precision varies greatly between and within cultures and with local environmental conditions. Here it would not be unusual to find a local farmer, for example, first noting the heliacal rising of the Pleiades at dawn several days or more after its mathematically calculated reappearance.

16. Examples of the use of heliacal and other types of stellar apparitions, listed by culture, are found in the following sources: Iban: E. Jensen, *The Iban and Their Religion* (Oxford: Clarendon Press, 1974), pp. 156, 173; D. Freeman, *Report on the Iban* (London: Athlone Press, 1970), pp. 171–72; Anonymous, "Dayak Astronomy," in *The Sea Dyaks and Other Races of Sarawak*, ed. A. Richards (Kuching: Borneo Literature Bureau, 1963), p. 82; W. Howell, "Commencing a Padi Farm," in ibid., p. 96; Hose, "Various Methods of Computing Time," pp. 2–4. Maloh: V. T. King, *The Maloh of West Kalimantan* (Cinnamianso, N.J.: Foris, 1985), p. 156. Sasak: Judith Ecklund, "Marriage, Seaworms, and Songs: Ritualized Responses to Cultural Change in Sasak Life" (PhD dissertation, Cornell University, 1977), pp. 111–13. Javanese: Thomas Stamford Raffles, *The History of Java* (London: Black and Co., 1817), 1:474–79; F. van den Bosch, "Javanische Mangsakalender," pp. 248–82, contains many references to original sources. Kedang: R. H. Barnes, *Kedang* (Oxford: Clarendon Press, 1974), pp. 117–20. Toraja: Soebardi, "Calendrical Traditions in Indonesia," *Indonesia Journal of Cultural Studies* 3, 1 (1965): 50–51.

17. Hose and McDougall, *Pagan Tribes of Borneo*, p. 109. Unfortunately, the tribe is not identified, nor is the star or time of day.



Javanese farmer holding rice in open palm, pointing at dusk, toward the rising *Bintang Weluku* or "Plow Stars." On the day following the night when rice falls out, planting should begin. The stars of *Bintang Weluku* are part of the Western constellation of Orion. Drawing of the Javanese plow after Raffles, *History of Java*, 1:114.

Talu (September 3–30), 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![18]

Near Yogyakarta, Central Java, the ritual practitioner raised his hand toward the east in the direction of Orion (*Bintang Weluku:* Plough Stars) at dusk, rice seed in his open palm (Fig. 6). On the night that kernels of rice rolled off his palm, it was time to sow seed in the nursery. Using the planetarium star projector, the date has been found to be about January 4.[19]

On the north coast of Java another technique was employed that also depended upon the altitude of the Pleiades, variously known as *Kartika, Bintang Tujuh* (seven stars), *Wuluh*, and *Guru Desa* (Village teacher) at dusk. But rather than using an extended object or arm, this technique depended upon the practitioner's knowledge of the relative altitude of the sun at various times during the day. Such familiarity with the sun's daily path, incidentally, seems to be common throughout the region. Here, the water buffalo was usually put to pasture (*pecat sawad*) when the sun reached an altitude of about 50 degrees (about 10 AM) and this point in the sky became synonymous with this daily occurrence (Fig. 7). As a calendrical marker, it was observed that "when the Pleiades were as high as *pecat sawad,* (at dusk) it must be the 7th *mangsa*" and transplanting of the young rice plants from the nursery to the *sawah* must begin.[20]

Finally, we find in northern peninsular Malaysia, around Kedah and Perak, the same technique, described above, wherein the practitioner extended rice in his open palm eastward, this time toward the Pleiades, in order to determine when to plant seed in the nursery. In this case, however, the observation was carried out at dawn; in Kedah and Perak planting occurred in late July.[21]

Lunar Calendars. Lunar calendars comprise the third category. These calendars are based upon the 29.5 day synodic period, usually measured from new moon to new moon and often subdivided by phase. Because there is not an even number of lunar months in a solar year and because agricultural cycles are, after all, tied to the solar year, simple lunar calendars alone are of little use in farming. But when they are somehow pegged to the solar year by reference to the apparent annual changes in the positions of the sun or stars or to other phenomena in nature that regularly recur on an annual basis, a lunar calendar can be of use to the farmer.

Several varieties of lunar calendar are found in the region. The Balinese ceremonial calendar, still in use, and the old Javanese *Saka* calendar, used from the eighth to the sixteenth century, are examples of lunar–solar calendars, or those which are synchronized by reference to a particular annual apparition of the sun, either observed or calculated. Both are apparently of a common Hindu origin and are primarily lunar;

18. King, *Maloh of West Kalimantan*, p. 156.

19. Van den Bosch, "Javanische Mangsakalender," p. 257. I have conducted experiments that show that the angle of repose (that is, the minimum angle of a heap of anything that must be attained to cause particles to roll down the heap) of rice is about 36 degrees from the horizontal. It is, thereby, inferred that this farmer waited until Orion appeared at about 36 degrees above the eastern horizon, heliacally, at dusk. This would have occurred on about January 4 in the year 1900, the information having been gathered sometime before 1925.

20. Ibid., p. 257.

21. R. Winstedt, *Shaman, Saiva and Sufi* (London: Constable, 1925), pp. 77–78.

both employ complex mathematical techniques to provide the intercalary days which periodically synchronize the lunar with the solar year.[22]

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.[23]

A third type of lunar calendar is found spread throughout the region. Best described as sidereal–lunar, calendars of this type use the heliacal apparitions of stars and groups of stars as well as the appearance of other signs in nature (such as winds, birds, and flowers) 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 the agricultural season), thereby obviating the need for codified schemes for realigning the lunar with the solar/stellar year. Such "short" lunar calendars are employed by the Sasak, Iban, Nias, Kantu', Meratus Dayak, and Kedang.[24]

Celestial Knowledge as Local Knowledge

The diversity of observational techniques employed by the peoples of the Indo–Malay region is thus apparent. It is the purpose of the remainder of this article to illustrate some of the ways in which individual societies within this region have made appropriate use of different celestial phenomena in different environments and for different purposes. The Iban, the Savunese, and the Kenyah–Kayan will serve to show, albeit incompletely, how knowledge of the sky can be seen as an integral part of a culture's overall environmental knowledge and how this knowledge is used in the particular social and cultural setting.

The Iban Calendar. The Iban are a riverine people practicing swidden agriculture in the low hills of Sawarak and West Kalimantan. They live in widely separated longhouses, each constituting an autonomous local community. An average longhouse houses about eighty–five individuals in fourteen separate households, each with its own separate quarters; private doorways enter onto a common area. Each household in the longhouse is an independent unit, free to join other longhouses where there are blood kin. Most of the households in a longhouse are related and all share joint responsibility for spiritual affairs; there is in each longhouse, however, a specialist in augury, the *tuai burong*.

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22. Discussions of the Balinese and Javanese lunar calendars can be found in: Clifford Geertz, *The Interpretation of Cultures* (New York: Basic Books, 1973), pp. 392ff.; M. Covarrubias, *Island of Bali* (New York: Knopf, 1937), pp. 313ff.; and van den Bosch, "Javanische Mangsakalender," pp. 261ff.

23. The Savunese lunar calendar will be described in greater detail below.

24. The Iban lunar calendar is described below, and further examples of sidereal–lunar calendars, listed by culture, can be found in the following sources: Sakak: Ecklund, "Marriage, Seaworms, and Songs," pp. 111–13. Iban: Anonymous, "Dayak Astronomy," in *Sea Dyaks and Other Races*, pp. 81–82; Howell, "Commencing a Padi Farm," in ibid., p. 96. Nias: Soebardi, "Calendrical Traditions," pp. 49–50. Kantu': Michael R. Dove, "Subsistence Strategies in Rain Forest Swidden Agriculture: The Kantu at Tikul Batu" (PhD dissertation, Stanford University, 1981), pp. 421ff. Kedang: Barnes, *Kedang*, pp. 117–20. Meratus: G. Ammarell and A. Tsing, "Heavenly Discourse: Notes on the Cultural Production of Skylore in Indonesia," unpublished.

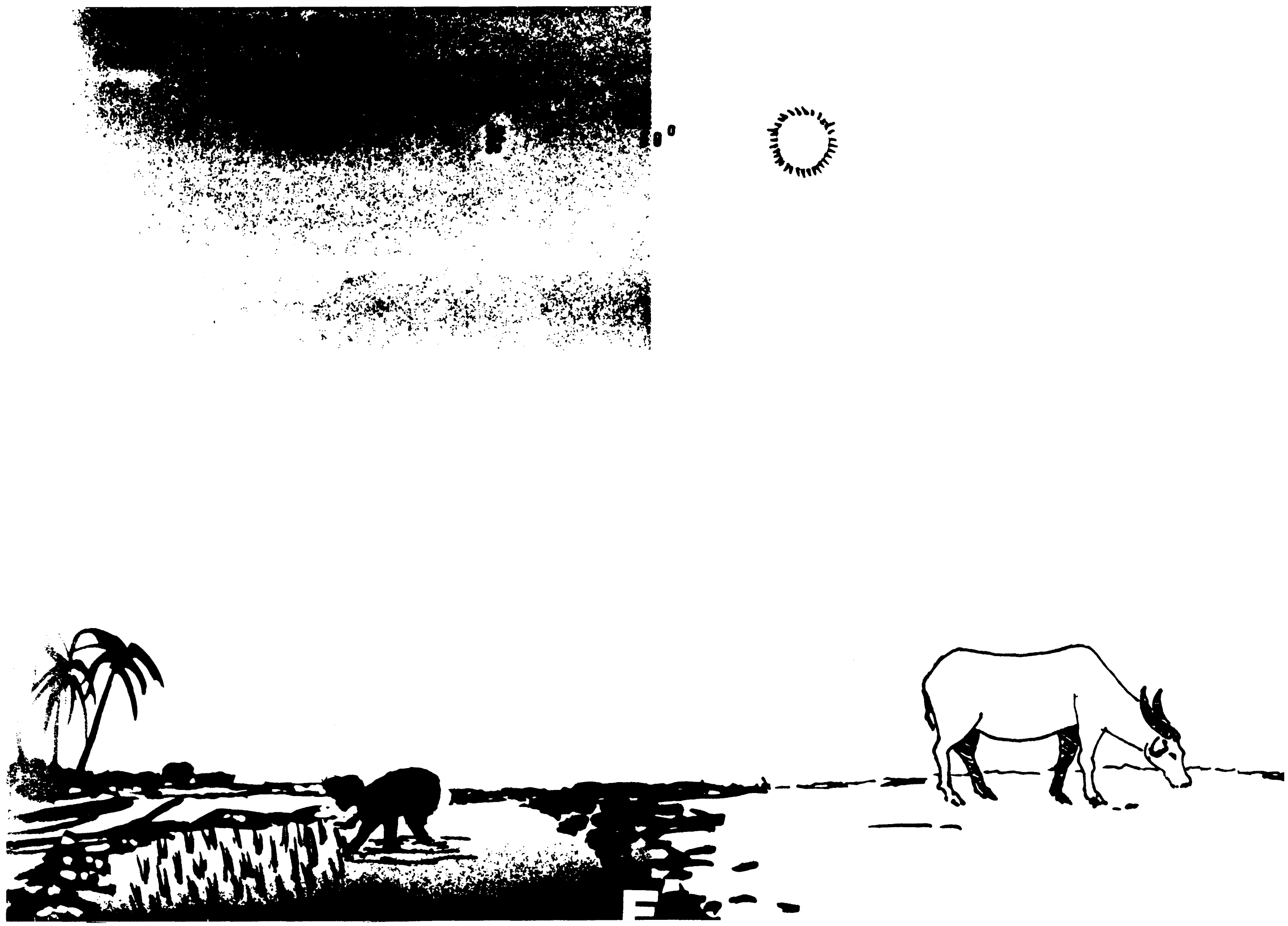

Figure 7. Among some Javanese the sun is said to be *pecat sawad* when its altitude above the eastern horizon is such that it is too hot to continue to work in the field and the water buffalo is discharged for the day. When the Pleiades is similarly situated at dusk, it is the time for transplanting of rice to begin. (From van den Bosch, "Javanische Mangsakalender," p. 257.)

Land is acquired by clearing primary forest and is not held in common. Each household constitutes an economic unit and farms its own fields except during periods of clearing and harvest when cooperation between closely related households occurs. Status is measured by the accumulation of a few material possessions made possible by the production of surplus rice.

The land around the longhouse is soon exhausted, and farms are eventually strung out over several miles of river valley. At this point several households will join together to build a field house, called a *dampa*, to exploit the distant valley. This progression continues until the land near the original longhouse has remained fallow for from ten to twenty years. The households then move back to the main longhouse and the cycle begins once again. Since the agricultural period lasts up to ten months, households spend more time at the *dampa* than they do at the main longhouse.[25]

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[26] 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.:[27] The Iban use a sidereal–lunar calendar, one which is annually adjusted to the heliacal apparitions of two groups of stars: the Pleiades (*Bintang Banyak:* "many stars") and the three stars of Orion's belt (*Bintang Tiga:* "three stars").

The first observation is probably the most difficult. It is the reappearance of *Bintang Banyak* on the eastern horizon just before dawn after two month's absence from the night sky (June 5). This sighting informs the observer that the month, taken from new moon to new moon, that is current is the fifth month (*bulan lima*). It is during this month that two members of the longhouse go into the forest to seek favorable omens so that the land selected will yield a good crop. This may take from two days to a month, but once the omens appear, the members return to the longhouse and the work of clearing the forest begins. If it takes so long for the omens to appear that Orion's belt rises before daybreak (June 25), 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 sixth month, time to begin clearing the land.

The remaining observations of the stars are more easily accomplished. They are all heliacal culminations, occurring "overhead," and are seen to be approaching for several weeks. When *Bintang Banyak* culminates at dawn (September 3) and *Bintang Tiga* is about to do so (September 26–30), it is the eighth month and time to burn and plant. For good yields the burn should occur between the time that *Bintang Banyak* and *Bintang Tiga* reach the meridian at dawn, usually when the two are in balance or equidistant from the meridian (September 16). Padi sown after the star Sirius, called *Bintang Tangkong Peredah*, has completed its heliacal culmination at dawn (October 15) will not mature properly. Planting may carry into the tenth 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 five

25. F. M. Lebar, ed., *Ethnic Groups of Insular Southeast Asia* (New Haven: Human Relations Area Files, 1972), pp. 180–83.

26. Accounts of these Iban stories can be found in Howell, "Commencing a Padi Farm," pp. 96–97; Freeman, *Report on the Iban*, p. 172; and Jensen, *Iban and Their Religion*, p. 155.

27. Freeman, *Report on the Iban*, p. 171.

through ten are numbered and fixed while the remaining months vary according to how quickly the crop matures (e.g., *bulan mantun*, the "weeding month"). The lunar months from November to April are simply not numbered; it is difficult to see the stars during the rainy season and unimportant in any case.[28]

There are several important ways, it is seen, that Iban knowledge of the sky is integrated into their knowledge of the natural environment as a whole and how this knowledge is further integrated into social practice. The use of a heliacal rising as a calendrical device requires the same good view of the horizon from year to year. Such a view is more likely from the main longhouses of the Iban. But once the households have gone off to the *dampa* where, especially in an uncut area, the horizon might be quite difficult to see, heliacal culminations would make better calendrical markers. In addition, the calendrical system is both simple to use and, employing no material artifacts, easily transported when families are far from the longhouse. It seems reasonable to speculate that, after *bintang banyak* rises heliacally and the *tuai burong* finds the proper omens, one or more members of a *dampa* could and would assume responsibility for locating *Bintang Banyak* and *Bintang Tiga* overhead in the sky. And so it seems appropriate that *bintang banyak, bintang tiga*, and *bintang tangkong peredah* are used to mark the remaining lunar months, those months during which the Iban are most likely to be far from the main longhouse.

The Savunese Calendar. In contrast to the relatively egalitarian and highly mobile Iban, the Savunese are confined to two small islands and live in permanent villages in five separate centralized states. Formerly each state had its own hereditary ruler who was assisted by the village heads. There were also highly respected ritual practitioners who, among other things, controlled the calendar.[29]

Savu is rather barren and water is inadequate for productive agriculture. Food crops are sparse and the Savunese depend almost entirely on intensive cultivation of the mung bean or green gram (*Phaseolus lunatus*) and lontar palm (*Borassus flabellifer* Linn.) for their subsistence.[30]

The Savunese are acutely aware of the moon's cycle, its relationship to the sun, directions, tides, and several dramatic and economically important events which recur on a regular annual basis. These events, including the periods of transition between monsoons, the growing season of the mung bean, the annual swarming of sea worms, and the second blossoming of the lontar palm, are used to name the months of the lunar calendar in which they occur, and the entire system serves to reinforce Savunese beliefs regarding the importance of the moon within their cosmology.[31]

Cultivation of the mung bean is carried out to coincide with the months of *Koo Ma, Naiki Kebui*, and *Wila Kolo* when the westerly monsoon brings its meager moisture to the island. Tapping the inflorescence of the lontar palm at the beginning and end of the dry season, which occurs around the months of *A'a* and *Ari*, the Savunese cook the juice into a dark syrup, some of which they ferment into beer.

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28. See references under "Iban" in footnote 14, above.

29. Lebar, *Ethnic Groups*, p. 77.

30. Ibid.

31. James Fox's description of the highly complex Savunese lunar calendar is part of a larger study relating Savunese social structure to ritual ceremony. James J. Fox, "The Ceremonial Systems of Savu," in *The Imagination of Reality*, ed. A. L. Becker and A. Yengoyan (Norwood, New Jersey: Ablex, 1979), pp. 145–73.

At another time of year, sea worms (*Leodice viridis*), locally called *nyale*, appear along the shore in vast numbers and are harvested as a great delicacy. This swarming occurs during the high tide of the third quarter phase of two consecutive lunar months, named *nyale*, near the end of the westerly monsoon each year.[32]

Figure 8 shows a lunar month adapted from an old Savunese drawing by James Fox. There are thirty divisions, although the last day of the waning moon or the first day of the waxing moon may be dropped in order to account for the $29^1/_2$–day lunar synodic period. In addition, each state has its own version of the Savunese lunar calendar, a version in which the months coincide with local seasonal activities. As can be seen from the 1890–1891 calendar year, the same activity/month may vary as much as three months from state to state. For instance, each begins with the same month/name: *Koo Ma* (to clear the fields), although it is staggered over three months for the four states. In another instance, the first appearance of *nyale* is signified in the calendar of the state of Mesara while the second appearance is observed in the Liae calendar. Not shown in the table is the intercalary month of *Heola*, inserted, as needed, to synchronize the lunar calendar not with the sun but rather with one of the most reliable and important occurrences of the year: the second blossoming of the lontar palm.[33]

The Savunese thus provide a second and rather elegant example of the successful use and integration of celestial knowledge with other environmental knowledge and with social and cultural practice. The Savunese have long recognized the intimate relationship between the lunar cycle, the arrival of the sea worms, the cycle of the lontar palm, and the coming of the sparse rains for planting. And, from this recognition, the Savunese fashioned a calendar which, in its complexity, appears to have served them well.

The Kenyah–Kayan Calendar. The last example is that of a similarly stratified and centralized society, but one which utilized, historically, observations of the sun rather than the moon to create a calendar. The culture is that of the Kenyah–Kayan complex, described by Hose in 1905 and Hose and McDougall in 1912.[34] Although the Kenyah–Kayan are, like the Iban, swidden farmers, they have been found to differ from their neighbors to the northwest in very fundamental ways. Each longhouse or group of longhouses was traditionally ruled by an aristocratic chief who, with his relatives, occupied the apartments at the center of the longhouse. The chiefs claimed descent from deities and had control over heirloom property, ceremonies, and the etiquette surrounding these ceremonies.

The gnomon, described previously, was clearly complex and required great care in its use. In addition, it was under the care of a member of the aristocratic class, usually an old man who was not required to do any job but watch and record the progress of the sun at noon each day. It is noted that the guardian of the gnomon carved other marks or notches in the base of the gnomon the meaning of which was known only to himself; his procedures were surrounded with mystery and kept secret even from the chief.[35]

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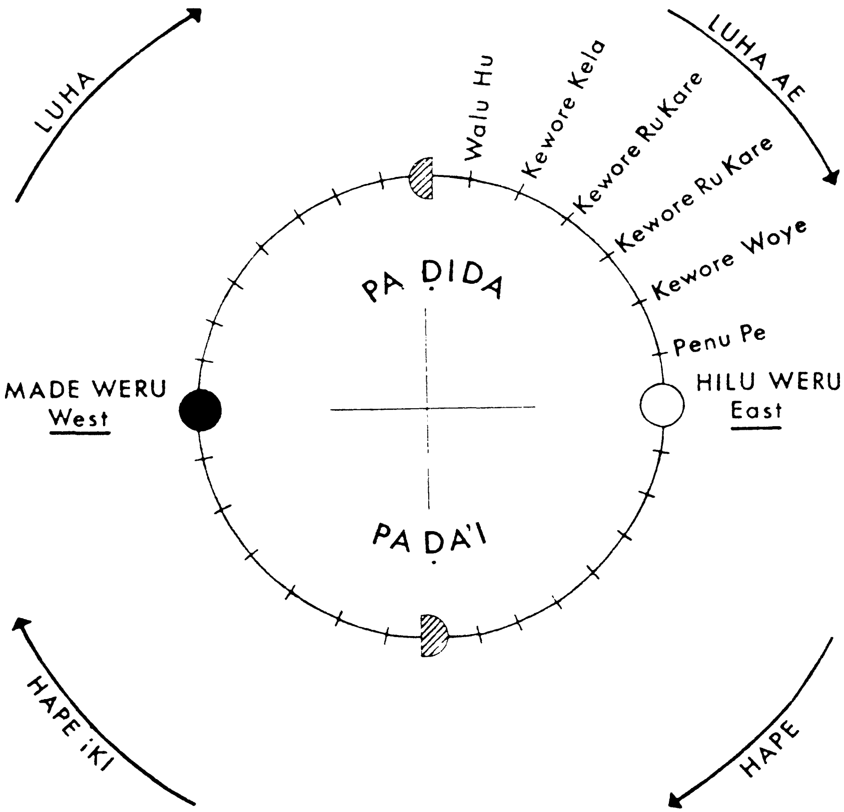
32. Ibid., pp. 152–56.

33. Ibid., p. 154, fig. 1.

34. Hose, "Various Methods of Computing Time," and Hose and McDougall, *Pagan Tribes of Borneo.*

35. Hose and McDougall, *Pagan Tribes of Borneo*, pp. 106–8.

THE LUNAR CYCLE
(based on a Savunese sketch)



THE CALENDAR YEAR OF SAVU
(according to Wijngaarden, 1890-91)

Months	*Seba*	*Mesara*	*Liae*	*Timu*
October	Koo Ma			
November	Naiki Kebui	Koo Ma	Koo Ma	
December	Wila Kolo	Nyale	Kuja Ma	Koo Ma
January	Honga Dimu	Wila Kolo (Pe Netta)	Kelila Aji Lai	Naiki Kebui
February	Daba Eki	Hora Kaba	Nyale	Wila Kolo
March	Daba Ae	Daba	Daba	Hanga Dimu
April	Banga Liwu	Daba Ae	Banga Liwu Gopo	Daba
May	A'a	Banga Liwu	Banga Liwu Rame	Rame
June	Ari	A'a	A'a	A'a
July	Kilila Wadu	Ari	Ari	Ari
August	Wadu Ae (Tunu Manu)	Hobo	Kelila Wadu	Kelila
September	Baga Rae	Kelila Wadu	Wadu Ae	Wadu Ae
October		Hae Rae	Hae Rae	Wadu Kepete
November				Hae Rae
December				

Figure 8. Savunese calendar for 1890–1891. (After Fox, "Ceremonial Systems of Savu," p. 157.)

Here we see a calendrical system that it kept out of the reach of all but a few in a society that is built on specialization, hierarchy, and the concentration of power.[36] And here is yet another calendrical technique that is well suited to the natural environment in which it is employed. That is, the device is in use from the June solstice to the time of the next Zenith Sun (locally in October). This is a period when the local weather is relatively dry, with only partially cloudy skies—weather conditions that are quite favorable for observing the sun's shadow. And it is used in an environment where the forested horizon is unreliable for sighting variations in the rising or setting points of the sun, but where the sun can easily be observed and the length of its shadow measured high in the noon sky each day.

Summary and Conclusion

This article began by defining ethnoastronomy and placing it within the more general field of ethnoecology. It was then observed that, although Southeast Asianists have made important contributions to the study of ethnoecology and although regional literature is replete with references to traditional knowledge of the celestial environment, it appears that very little comparative work in Indo–Malay ethnoastronomy has been published. The present article has sought to begin to rectify this situation by presenting what appear to be typical examples of traditional Indo–Malay agricultural calendrical systems and describing the celestial observations upon which they are based. It has also attempted to provide categories, drawn from the field of astronomy, into which these observations may be placed. Finally, it has provided examples of how celestial knowledge works within three cultures.

With regard to the study of indigenous astronomical systems worldwide, there appear in the calendrical systems of the Indo–Malay peoples two types of celestial observations that may be unique to this cultural region. They are: 1) observations of "heliacal culminations" (or meridian transits at dusk or dawn) of groups of stars; and 2) observations of the lunar month for a limited number of months each year, creating discontinuous sidereal–lunar calendars.

Implicit in the discussion of agricultural calendrical systems is the understanding that celestial observations do not stand alone. That is, many other environmental markers—changes in wind and moisture and the appearance of birds, insects, sea life, and flowers, to name a few—also inform agricultural decision making. It is suggested that, by noting more carefully these and other signs in nature to which members of traditional societies attend, we may gain a deeper appreciation of the true richness of local knowledge. Studies of traditional culture, from folklore to human ecology, have begun to pay particular attention to how human populations interact with and conceive of the natural environment. They might do well more often to attend to the stars.

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36. It is even, perhaps, reasonable to infer that the secrecy that surrounded the use of the calendar was one way by which the rulers of the Kenyah maintained power.