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THE BORANA CALENDAR: SOME OBSERVATIONS

C. L. N. RUGGLES, University of Leicester

Introduction

The Gada system is the central institution of the Galla people of Ethiopia. It forms the basis of their socio-political framework and of their cognitive world view. As part of his impressive study of this system Legesse[1] undertook extensive fieldwork in the early 1960s with the Borana of southern Ethiopia. His account includes a detailed description of Borana time-reckoning,[2] the role of which is clear from the following passage:

> Borana have an unusually deep awareness of time and history... they have the same degree of involvement with time as we find in the Western world. They schedule their lives, their rituals, their ceremonies, their political and economic activities to a very high degree.[3]

The Borana calendar is based upon lunar synodic cycles. According to Legesse there are twelve named months. A new month is deemed to have begun when the new crescent moon is first seen following astronomical new moon: as a consequence months are either twenty-nine or thirty days in length. There are also twenty-seven named days. The cycles of days and months run independently and continuously, so that the starting day of a given month is two or three days later than that of its predecessor, and in any given month certain days appear twice, once at the beginning and once at the end. The permutation of the two cycles is completed in twelve months.

According to Legesse a Borana time-reckoning expert (*ayyantu*) can tell the day and month from memory; however, should his memory fail him, he examines the relative position of the moon and stars in order to determine the month astronomically (observations of the sun are not used). The strategy for doing this changes every six months. Apparently, for half of the year the *ayyantu* identify the new moon relative to one of seven stars or star groups — Triangulum, the Pleiades, Aldebaran, Bellatrix, Orion's belt and sword, Saiph, and Sirius. For the other half they identify the moon at different phases in relation to a particular star group, Triangulum. We shall refer, for convenience, to these two sixth-monthly periods as the "new moon reckoning period" (NMRP) and the "Triangulum reckoning period" (TRP) respectively, and to the seven stars or star groups as the "reference star groups" (RSGs).

A difficulty with Legesse's description, pointed out in a recent paper by Doyle,[4] is the following. Legesse refers to the reference star groups that identify successive months during the NMRP appearing "in conjunction with" and "side by side with" the new moon. This description seems to imply that the relevant RSG is roughly at the same right ascension as the moon when the observations are made.[5] However, the monthly advance in RA of the moon at a given phase (i.e. at a given time in the synodic month), 1^h56^m on average, is such that it will

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TABLE 1. The "reference star groups" of importance in determining the Borana months: astronomical data (epoch 1967).

Star	RA	Dec	Approximate Calendar Date of Conjunction with Sun
	h m	°	
α Tri	1 51	29.4	Apr 20
β Tri	2 8	34.8	Apr 25
γ Tri	2 15	33.7	Apr 27
η Tau (Pleiades)	3 46	24.0	May 20
α Tau (Aldebaran)	4 34	16.5	Jun 1
γ Ori (Bellatrix)	5 23	6.3	Jun 13
ε Ori (Centre of belt)	5 35	−1.2	Jun 16
κ Ori (Saiph)	5 46	−9.7	Jun 18
α CMa (Sirius)	6 44	−16.7	Jul 2

take only something like two-and-a-half months, rather than the six required, for the moon at a given phase to advance past the seven RSGS. This can be verified by examining the RAs of the star groups given in Table 1 and by looking ahead to Figure 1.

On examining Table 1 further it will be seen that the RSGS, which are roughly aligned in the sky, also cover a considerable range in declination. This leads Doyle to suggest that Legesse, when he talks of "rising in conjunction", might actually mean rising at the same horizon position, i.e. at the same declination. On the face of it this interpretation is unable to reconcile Legesse's account with the astronomical facts, since (for one thing) the declinations of β Tri and γ Tri are well to the north of the northerly declination limit of the moon. However, Doyle argues that a reconciliation can be achieved by precessing to a date of around 300 B.C. This leads him to suggest that the present-day calendar is a survival of one invented at the earlier date. As corroborating evidence he refers to the Namoratung'a II (or Kalokol) archaeological site in north-west Kenya, where standing stones have been discovered that could have been used to mark relevant horizon positions and hence to set up the calendar.[6]

This paper begins with a critique of what might be called Doyle's "archaeoastronomical hypothesis". Some alternative ideas are then suggested.

Namoratung'a and the "Archaeoastronomical Hypothesis"

The hypothesis that the present-day Borana calendrical system derives from one set up in around 300 B.C. can be broken down into four essential steps, as follows:

(A) In around 300 B.C. a calendar was set up, in which for half of the year successive months were identified by measuring the declination of the newly-sighted moon relative to the relevant RSG.
(B) Horizon reference points were marked using permanent stone markers.
(C) Standing stones at the Namoratung'a II site are examples of such markers.
(D) The original horizon positions, as marked at Namoratung'a and elsewhere, have continued to be used for monitoring the motions of the moon.

In support of (A), Doyle points out that the 300 B.C. declination of β Tri, about +23°, corresponds roughly to the mean northerly limiting declination of

TABLE 2. The declination of the moon at constant phase in successive months, given different starting parameters. Values are calculated assuming a simple sinusoidal variation.

Column headings: Starting parameters

1 Amplitude in degrees of the declination cycle (29° corresponds approximately to the moon at Major Standstill; 19° to Minor Standstill and 24° to the mid-point in the lunar excursion).

2 Time in days by which the first figure in the list of declinations follows the maximum northerly declination.

Starting Parameters		Successive Declinations in Degrees							
1	2								
29	0.0	+29	+25	+14	−1	−16	−26	−29	−24
29	1.0	+28	+21	+8	−8	−21	−28	−28	−19
29	2.0	+26	+16	+1	−14	−25	−29	−25	−14
24	0.0	+24	+21	+12	−1	−13	−22	−24	−20
24	1.0	+23	+17	+6	−6	−17	−23	−23	−16
24	2.0	+22	+13	+1	−12	−21	−24	−21	−12
19	0.0	+19	+16	+9	−1	−10	−17	−19	−16
19	1.0	+19	+14	+5	−5	−14	−19	−18	−13
19	2.0	+17	+10	+1	−9	−16	−19	−16	−9

the moon. (The limits of the moon's declination each month vary by some 10° over an 18.6-year cycle — the so-called 'lunar excursion'.) If a new moon has this declination, then

> The next new moon rises at 14° ... which corresponds precisely to the 300 B.C. horizon rising position of [the] Pleiades, the next Borana star. The next four new moons (starting the next four Borana months) rise at +9 degrees, +1 degree, −11 degrees and −17 degrees declination. These positions correspond to the 300 B.C. horizon rising positions of the Borana stars Aldebaran, Bellatrix, central Orion-Saiph (taken together), and Sirius respectively ....[7]

Doyle's figures are taken from the *Nautical almanacs* for 1983 and 1984.

Two parameters however affect the sequence of declinations of the moon at successive occurrences of a given phase (such as new). The first is the current point in the lunar excursion, which determines the current amplitude of the monthly variation in declination. The second is the synchronization of the moon's declination cycle, approximately equal to the sidereal month of 27.32 days, and the phase cycle, the synodic month of 29.53 days. In Table 2 we calculate, assuming a simple sinusoidal variation about declination 0°, the declination of the moon at constant phase in successive months given different values of these parameters. This table is included merely to demonstrate the variation inherent in these values given the different starting configurations that can occur. It is immediately clear that while a particular starting configuration may yield the set of declinations quoted by Doyle, such a set of values will not be typical and the variation is wide. In fact, there is further uncertainty owing to the impossibility of observing exactly the same lunar phase in successive lunations. The time delay between astronomical new moon and the first sighting of the crescent moon must vary by at least 24 hours owing to the fact that the former may occur at any time of day, and probably by considerably more owing to varying atmospheric conditions. In Table 3 we show the moon's declination

TABLE 3. The declination of astronomical new moon in successive months, starting in July 1983. Values are taken from the *Astronomical ephemerides* for 1983 and 1984.

Time of New Moon			Declinations in Degrees		
			0^h this day	0^h next day	At New Moon
	d	h			
1983 July	10	12	+24	+24	+24
Aug	8	19	+23	+19	+20
Sep	7	03	+12	+6	+11
Oct	6	11	+2	−4	−1
Nov	4	22	−8	−13	−13
Dec	4	12	−20	−23	−22
1984 Jan	3	05	−25	−25	−25
Feb	2	00	−21	−18	−21

at astronomical new moon in successive months, starting in July 1983 (values are taken from the *Astronomical ephemerides* for 1983 and 1984). In addition the declination is given at 0^h Ephemeris Time immediately before and after each new moon. This gives an idea of the uncertainty in the declination of the newly-sighted moon in any particular month if there is any doubt about the evening on which first sighting will occur. In consequence this demonstrates the amount by which the declination sequence can vary between instances where the starting parameters are similar but astronomical new moon occurs at different times of day.

In deriving the sequence of declination values he quotes for these particular lunations in 1983/84, Doyle has clearly made assumptions (which are not elaborated in his paper) about the times when the new moon is first sighted. His quoted values fit extremely well with the 300 B.C. declinations of the Borana RSGs; however, there is no evident systematic correlation between Doyle's values and those for the corresponding astronomical new moon (see Table 4). Thus the justification for the assumptions that have been made (apart from the fact that they yield a close fit to the values required by the hypothesis) seems obscure.

In summary, it is clear that any "precise" correspondence that may be claimed between sequences of lunar declinations and the 300 B.C. declinations of the Borana RSGs is dependent upon particular assumptions about (i) the current point in the lunar excursion, (ii) the current synchronization of the sidereal and synodic months, and (iii) the synchronization of astronomical new moon and the time of day. By choosing other values for these parameters we could clearly obtain sequences of declinations fitting, equally well, any one of a multitude of possible sequences of star groups at particular dates. In other words, the data at hand give no independent support whatsoever to the claim that an equal-declination calendar, if one is hypothesized, must have originated around 300 B.C. using the Borana RSGs. Thus Hypothesis (A) must be considered, at best, questionable.

Nonetheless, let us assume (A) and examine the remaining components of the "archaeoastronomical hypothesis". Given (A), Hypothesis (B) seems not unreasonable. The newly-sighted crescent moon always appears in the evening sky shortly after sunset, close to the horizon. Estimating whether it is situated to the right or left of a given horizon point (remembering that it sets almost vertically at these latitudes) would avoid the problem that the relevant RSG might at the

TABLE 4. Comparison between the declination of astronomical new moon in successive months starting in July 1983, the sequence of declinations for successive sightings of the new moon quoted by Doyle for the same lunations, and the 300 B.C. declinations of the Borana RSGs, again as quoted by Doyle.

Time of New Moon		Declination at New Moon	Declination Quoted by Doyle	Star	Declination in 300 B.C.
	d h	°	°		°
1983 July	10 12	+24	+23	β Tri	+23
Aug	8 19	+20	+14	η Tau	+14
Sep	7 03	+11	+9	α Tau	+9
Oct	6 11	−1	+1	γ Ori	+1
Nov	4 22	−13	−11	ε Ori	−10
				κ Ori	−13
Dec	4 12	−22	−17	α CMa	−17
1984 Jan	3 05	−25			
Feb	2 00	−21			

time of observation be considerably higher in the sky than the moon, or not visible at all.

There is, however, an immediate problem with (C). Since the newly-sighted crescent moon always appears in the evening sky, its declination will presumably always be measured by reference to points on the *western* horizon. All the claimed Namoratung'a alignments, however, are to the equivalent reference points on the *eastern* horizon.[8]

At the site Lynch and Robbins found nineteen basalt pillars "nonrandomly oriented toward [the horizon rising positions of] certain stars and constellations",[9] the stars and star groups in question being those used by the present-day Borana. While the choice of a date of 300 B.C. makes these stars fit exceedingly well to the seven azimuths quoted by Lynch and Robbins,[10] the selection decisions that caused these seven azimuths and no others to be listed must be questioned.[11] Even more seriously, a re-survey of the site by Soper has called into question the quoted azimuth values themselves, stating that "It would appear that Lynch's survey was distorted, perhaps by magnetic anomalies or instrumental error, and that the alignments [given] are in error by amounts ranging from 1° to nearly 17°".[12]

These arguments throw considerable doubt upon the "astronomical" dating of the Namoratung'a II site. Independent dating evidence cited by Lynch and Robbins has also been comprehensively reassessed by Soper, who concludes that the dating of the site may still be regarded as open within wide margins.[13]

It is clear that Hypothesis (C), like (A), seems at best questionable.

Hypothesis (D) presupposes the long-term survival of a calendrical system, not just in its general features, but down to the level of the particular stars being used and methods of correlating them with the motions of the moon. Such a system is likely to have its roots in the practical needs of the people and these may undergo rapid change as a result of external factors. A recent example is provided by the Mursi, a nearby group who since the early 1970s have experienced their worst period of drought and hunger in living memory. In response, a considerable proportion of them have migrated from their traditional territory to higher land, substantially altered their patterns of subsistence and settlement, and formed new and closer links with neighbouring groups.[14]

Their time-reckoning, which will be considered further later in this paper, may well recently have undergone significant and irreversible change.

The long-term survival of the Borana calendar is all the more remarkable as the reference star groups in question no longer rise and set at their former positions (and indeed have not done so for millennia). One means by which such a calendrical system could evolve in order to cope with this problem would simply be to move on to the use of different stars; yet we are asked to believe that this was not done.

It is clear that the idea of such long-term survival must be viewed with caution even if there is strong independent evidence of cultural continuity. Soper considers at some length the independent evidence for a cultural connection between the Namoratung'a site and the present-day Borana, concluding however that it is "suggestive but not conclusive".[15]

Finally, some form of permanent device would be necessary in order to mark the relevant horizon points. If this is in fact the system used by the present-day Borana then they must be using some form of permanent ancient marker. It is difficult to envisage how anything of this sort could have escaped the attention of Legesse.

It appears, in conclusion, that the idea that the Borana calendar is of an 'equal-declination' type, and that consequently it must represent the product of a system originating over two millennia ago, is founded upon a tenuous string of hypotheses that are unsupported by the weight of any firm evidence, statistical, astronomical or archaeological. The whole idea has come about, it seems, by focusing upon a particular astronomical anomaly in Legesse's account and a particular way of resolving it, but ignoring the wider accumulation of evidence bearing upon the subject. In what follows we shall revert to the assumption that 'conjunction' has the obvious 'same RA' interpretation, and seek other ways of resolving the anomaly pointed out by Doyle.

Difficulties in Legesse's Account of the Borana Calendar

A number of problems and ambiguities arise in Legesse's account when it is examined in detail from an astronomical point of view, of which Doyle's anomaly is merely one. A highly confusing passage, epitomizing the difficulties encountered, is the following:

> In six out of the twelve lunar months the seven constellations appear successively, in conjunction with the moon. During the remaining six months none of these six stars and constellations is visible at the rising of the moon. In this period the first star (Triangulum) is visible only in the second half of the lunar month and is used in conjunction with successive phases of the waning moon.[16]

Another passage states:

> For half of the year they identify the *different phases* of the moon against the background of one particular star, Triangulum. In the other half of the year they identify the *new* moon relative to a set of seven *different stars*....[17]

Let us consider observations during the period when the new moon is *not* at a similar RA to any of the RSGs. Looking ahead to Figure 1, it is clear that this occurs from about August to about March each year. In August Triangulum is some 120° west of the sun, so that it will rise about a third of the way through the night and be high in the sky at sunrise. In October it will rise at dusk and set at dawn. In March it is some 60° to the east of the sun; it will be high in the sky at sunset and set about a third of the way through the night.

In August the moon is between full and last quarter when it passes Triangulum. This conjunction, then, would be visible at the rising of the moon and for most of the night. In October the moon is full when it passes Triangulum, and the conjunction will be visible throughout the night. It is clear from other parts of Legesse's account that this event marks the beginning of the TRP.[18] During the subsequent months conjunction will occur at progressively earlier lunar phases; the moon and Triangulum will be visible in the sky at sunset and will set together at progressively earlier times during the night. By March the conjunction will occur in the early evening sky just after new moon.

Thus the first passage above is badly misleading on a number of counts. Firstly, the slow change in the nightly appearance of Triangulum (or any other star group) through this period is continuous and independent of the lunar phase cycle, so it cannot be said that Triangulum will only be visible in the second half of the lunar month. Secondly, the moon–Triangulum conjunction will occur at progressively earlier (not later, as the use of the word 'successive' might imply) phases of the waxing (not waning) moon. Thirdly, during the TRP Triangulum (and the other RSGs) *will* often be visible (i.e. in the sky) at the rising of the moon, though they will not normally be rising in conjunction with it.

While it seems possible to clarify what happens during the TRP by considering the astronomical facts and correcting Legesse's account accordingly, the NMRP is more of a problem. During the first half of the month, the moon is in the sky at sunset and sets during the night. Only during the second half of the month does it rise during the night. When it is first sighted at the beginning of a month the moon is low in the western sky and, together with any nearby star or star group, is about to set after the sun in the western sky. In view of this, the reference to "constellations appearing successively" and the "rising of the moon" are perplexing.

A possible explanation might be that Legesse uses 'rising' and 'appearance' in the heliacal sense, i.e. to mean progressively drawing away from the sun in the sky. However, the passage then makes no sense astronomically, since the stars heliacally rise in the eastern sky before dawn and heliacally set in the western sky after dusk, whereas the moon does the opposite.

A second explanation might be that Legesse does not appreciate that the new moon must always be sighted in the early evening sky shortly following sunset, and uses the term 'rising' misleadingly as a result. Some other passages tend to support this idea. Thus

> Let us say that the expert has decided that the beginning of the month [*Obora Dikka*] occurred on [the day] *Salban Balla*.... The twenty-ninth day will be *Salban Dullacha*. Somewhere between the twenty-ninth and thirtieth nights the new moon will be sighted again....[19]

and

> ... the day of *Bita Kara*, in the month of *Bittottessa* ... is a rather special day because the first one of the star series that the Borana recognize appears in conjunction with the *new* moon on that particular day. It is therefore very important for Borana experts to make astronomic observations on the first night of that month. If atmospheric conditions do not allow them to make an observation and if the cloud cover persists throughout the night, the observation is postponed....[20]

It is not, of course, necessary to observe throughout the night in order to determine whether the new moon will appear through a break in the cloud. There is no need to wait for more than an hour or two beyond sunset.

A third possible, though perhaps more radical, explanation of what happens during the NMRP might be that conjunctions observed do not in fact necessarily involve the newly-sighted moon, and that the use of the term 'new moon' in many passages must be interpreted rather more freely. There are some indications, apart from the vaguenesses referred to above, that this might be reasonable. For example, the diagram of the seven star groups drawn by Legesse shows them as they would appear rising in the eastern, not setting in the western sky.[21]

None of the three explanations stands out *per se* as clearly the most convincing. In his article Doyle obscures the problem by stating on the one hand that "The first six months can be identified at the beginning of the month with a particular astronomical observation..."[22] and thus appearing to agree that observations are made after astronomical new moon and hence in the early evening, while stating on the other hand a paragraph later that "The term 'new moon' here will be taken to be within two days of zero phase...", i.e. *on either side* of astronomical new moon. He then allows that "....the new moon can be seen only just before sunrise or just after sunset...". Yet observations made at dawn just before astronomical new moon would take place at the end of the previous month to which the observation referred.

Making Sense of the Borana Calendar

We make an important step towards resolving Doyle's anomaly by examining the Borana 'year', which, according to Legesse

> consists of twelve [lunar synodic] months or 354 days – eleven days shorter than the solar year.... In many Near Eastern societies the solar year is made to equal the lunar year by adding an intercalary month to the latter. The Borana are unusual in that they seem to be the only people with a reasonably accurate calendar who ignore the sun. That is where the strength of their system lies. The only disadvantage of the system is that the year does not correspond to "seasons".[23]

In fact, the Borana calendar, even as described by Legesse, is not actually divorced from the sun. The reason is that the phase of the moon is a consequence of its RA relative to that of the sun. Where observations require a star to be observed in conjunction with the moon *at a particular phase*, this carries the implication that the sun must be at a particular RA relative to the moon. Thus, since the RA of the star is fixed, and that of the moon is similar to that of the star at the time of the observation, the observation can be made only when the RA of the sun is near to a particular value. Since the RA of the sun is related to the time of year, the observation can be made only at a certain time of year.

A perusal of Figure 1 may clarify this explanation. Consider first the identification of the month *Birra*, which falls when the full moon is observed in conjunction with Triangulum. Since the RA of Triangulum is about 2^h, the moon must have a similar RA. In order for its phase to be full the RA of the sun must be about 14^h. This fixes the date as around October.

Now consider the identification of the month *Bittottessa*, which falls when the newly-sighted crescent moon, say at about 2^h east of the sun, is observed in conjunction with Triangulum. On this occasion the RA of the sun must be about 0^h, which fixes the date as around March.

If the Borana calendar were allowed to drift out of step with the solar year, a conflict would soon become obvious between the month expected and that determined from astronomical observations. *Pace* Legesse, the Borana calendar *must* somehow resolve this conflict and keep in step with the solar calendar.

Let us leave aside for the moment any consideration of how this correlation is achieved. The point is that we have now fixed the NMRP and TRP roughly within the solar year; the former spans the months from about March to October and the latter the remainder of the year. The lengths of these periods are more or less those we would expect from Legesse's account, and by examining the motions of the sun and moon relative to the RSGs during March to October we should be able to cast considerable light upon the nature of the NMRP observations described by Legesse.

Given our assumption that "side by side with" has the obvious 'same RA' interpretation, we ask whether this leads to a credible account of the NMRP. At what times in each month would the relevant moon-star observations need to be made?

Figure 1 shows the motions in RA of the sun and moon in a year when a new moon occurs on Apr 20, the approximate date when the sun has the same RA as α Tri. The RAs of the principal stars in all the RSGs are shown in the figure, and the approximate dates when these coincide with the RA of the sun are given in Table 1.

In such a year *Bittottessa* would most probably be identified as the month following the new moon on Mar 24: the moon, when first sighted two or three nights later, would be at approximately the same RA as the principal stars of Triangulum. The next new moon would be spotted two or three days after Apr 20, and would be side by side with the Pleiades, as required for the month *Camsa*. The next new moon again, however, would be spotted two or three days after May 18 and should mark the beginning of the month *Bufa*. This month should be characterized by the moon appearing side by side with Aldebaran, yet it will already have advanced to Orion's belt by the time it is seen.

However, at the *end* of this month, just before it finally disappears in the morning twilight, the moon *will* be roughly side by side with Aldebaran. In subsequent months the moon will be seen side by side with the appropriate RSG

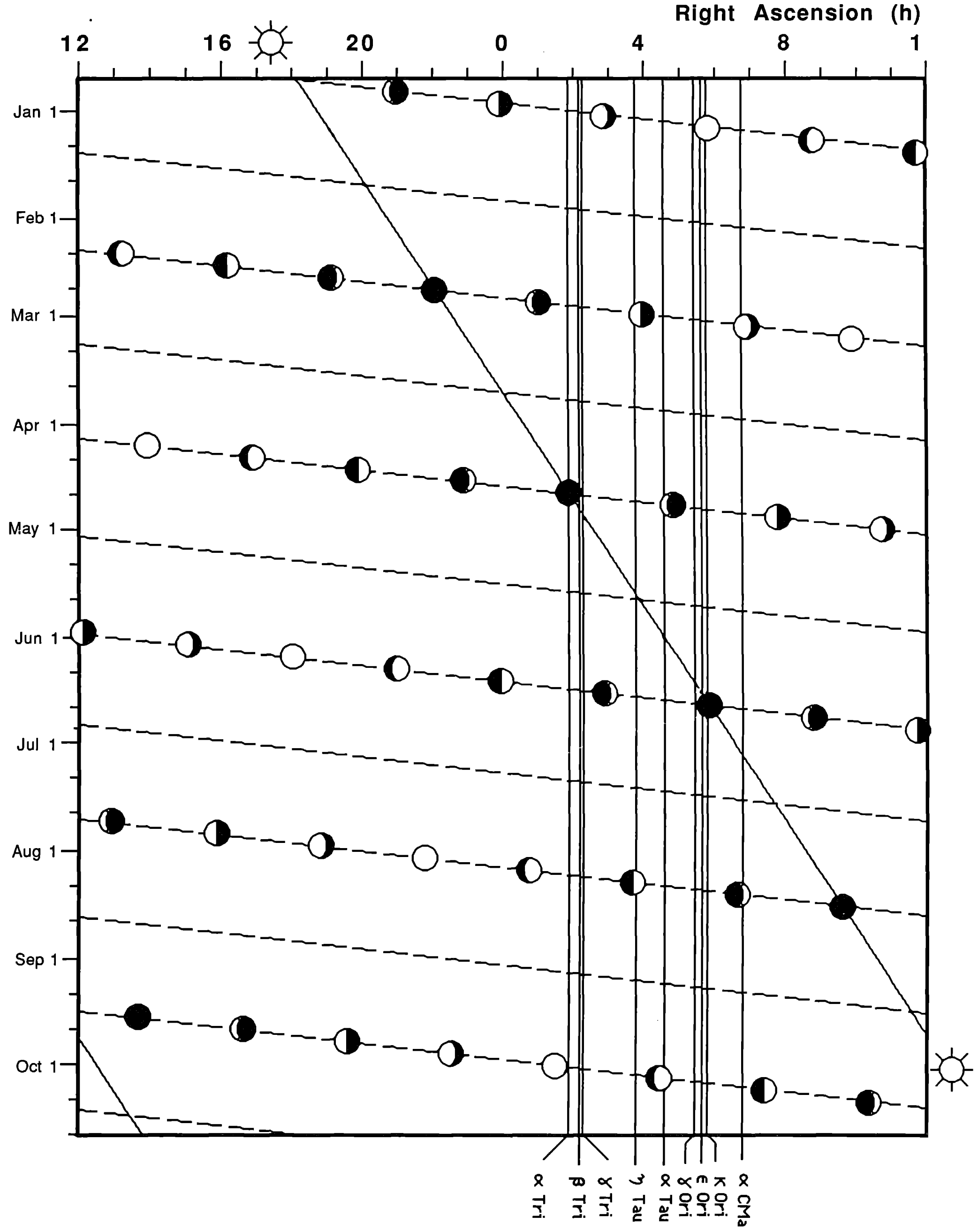

FIG. 1. The motions in right ascension of the moon and sun in a year when a new moon occurs on Apr 20.

towards the end of the month, though at an earlier phase in each case, until in the seventh month, following the new moon on Sep 7, the moon will be at approximately last quarter when it is side by side with Sirius. The half moon and Sirius will rise together about halfway through the night and will be high in the sky at dawn.

Thus it would be possible for the relevant RSGs to be observed side by side with the moon if the newly-sighted crescent moon was used for the first couple of months during the NMRP but late phases were used in the remainder. In different years, when the phase cycle falls differently within the solar year, the switch from observations at the beginning of the month to the end of the month might be made at a slightly different time, say after three months instead of two.

If our explanation is anywhere near to the truth then it is perhaps surprising that Legesse makes no reference to a switch from observations at the beginning to observations at the end of the month. One could however argue that perhaps Legesse never fully understood the system. Indeed, this might help to explain why Legesse's account is so unclear as to whether observations of moon/star group conjunctions in the NMRP necessarily refer to the newly-sighted crescent moon at the beginning of the month.

It is not our aim to suggest that this explanation is necessarily the correct one, but merely to point out that at least one explanation exists which fits the astronomical facts and is generally consistent (as far as is possible in the circumstances) with Legesse's account. Furthermore, it does not resort to equal declination models which, as we have seen, introduce a whole range of secondary problems.

Correlation and Inexactitude

The problem remains of how the Borana calendar keeps in step with the solar year. In order to answer this question it may be of value to examine, alongside Legesse's account of the Borana, the calendrical system of a nearby group which has been studied by Turton and the present author.[24]

The Mursi live some 250km west of Borana country in the vicinity of the Omo river north of Lake Turkana (Rudolf). They are not Cushitic speakers and are not closely culturally related to the Borana, but there are nevertheless a number of similarities between Legesse's account of Borana time-reckoning and Turton and Ruggles's account of Mursi time-reckoning, which may throw some light on the former.

Legesse states that "in an area such as Borana, where the seasons (long and short 'rains') are so thoroughly unpredictable, a seasonal calendar would be worthless".[25] This could not be claimed in the case of the Mursi. Their economy rests upon the integration of three separate subsistence activities, rain and flood cultivation and herding, each of which makes a vital contribution to subsistence. Transhumance movements take place across two ecological zones, and are largely dictated by climatic and other seasonal events, the most significant of which are the onset of the main rains and the flooding of the Omo six months later. These are of the utmost significance for the subsistence activities of the people.

The Mursi seasonal cycle of events, or *bergu*, like the Borana year, is regulated by lunar rather than solar cycles. By numbering in sequence the intervals between sightings of the new moon, it is possible to state the 'age' (in months) of the *bergu* at any particular moment. Any Mursi more than about twelve years old is able to recite a list of seasonal activities which are associated with the numbered subdivisions of the *bergu*. The cycle of seasonal activities is seen as completed after the passage of twelve lunations, although there is a named month, *gamwe* (equivalent to *bergu* 0), before it is *bergu* 1 again. In other words, the Mursi 'year' consists of thirteen months, which makes it 18 days longer than the solar year, rather than 11 days shorter as in the case of the Borana.

The Mursi calendar keeps in step with the seasonal year not by the occasional insertion or omission of a month[26] but by a process of institutionalized disagreement with continual adjustment and correlation. While every Mursi *believes* that there exist experts who know what month it is at any given time, in practice there is always more than one opinion prevalent. Most people do not regard themselves as experts on the *bergu*: they may form an opinion on the basis of current discussion, but they will happily revise this opinion in the light of new evidence. Disagreements are never removed at a stroke; the balance of opinion merely adjusts itself according to various seasonal markers such as the appearance of birds and the flowering of plants, and also by horizon observations of the sun carried out by a few interested 'amateurs' (although the sun is not recognized to be any more reliable a seasonal indicator than the others). In this way the Mursi unknowingly solve the correlation problem. Indeed, in their cultural framework the problem simply does not exist.

Another feature of the Mursi system is the possibility of retrospective adjustment. Consider the mechanism by which the new month is determined:

> Some people, for example, claim to have seen the new moon before others. They may actually have caught a fleeting glimpse of it on a cloudy evening, or they may have only thought they saw it. Indeed, it is possible that, even if he did not actually see the new moon, someone might yet find himself the only one in step later on, when the full moon occurs a day earlier than the weight of opinion had suggested. In such an event it is decided that the new moon must have been missed because of cloud on the first night.[27]

While the cultural framework is different, it is clear from the example of the Mursi that the Borana 'year' and the solar year could also be kept in phase by a process of institutionalized disagreement and periodic resolution of conflicts.

There is certainly ample evidence for inexactitude and retrospective correlation in Legesse's account. To begin with: "Borana are never absolutely sure about the name of any one day in the year. Each month they develop pools of consensus under the influence of local observers and experts."[28] The Borana permutation calendar is inherently inexact. The day round and the month round do not permute exactly once every year; thus twelve lunar months (12 × 29.53 days) are on average 3.36 days longer than thirteen day-rounds (13 × 27 days). Furthermore, since months may be 29 or 30 days long, a given day cannot always be associated with the beginning of a particular month.

Legesse tells us that any particular *ayyantu* has an acceptable margin of error for the days upon which a given month can begin. This acceptable margin cannot however be exceeded, and retrospective adjustment occurs in ensuring that this is the case.

Take for example the days *Salban Balla*, *Salban Dullacha*, *Gardaduma* and *Sonsa*, which form a sequence within the round of days. If the month *Obora Dikka* begins on *Salban Balla*, then the thirtieth day of reckoning will be *Gardaduma* and the thirty-first will be *Sonsa*. If the new moon is sighted on *Gardaduma*, then the month *Obora Dikka* will have had twenty-nine days and *Gardaduma* will be the first day of the following month *Birra*. On the other hand if it is not sighted until *Sonsa* then *Obora Dikka* will have had thirty days and the first day of *Birra* will be *Sonsa*.

In practice:

> If the new moon is sighted on the twenty-ninth day, that day is *Gardaduma*. If it is sighted on the thirtieth day, that day is *Sonsa*. Of course, if we had decided that the previous month began on *Salban Dullacha*, we should now have to say that the month begins on *Sonsa*.[29]

In other words if the *ayyantu* had decided that *Obora Dikka* had begun a day later, and yet it was found to have thirty days, then instead of letting *Birra* begin on the day following *Sonsa*, a retrospective adjustment would be made in order to ensure that *Birra* nonetheless began on *Sonsa*.

What, then, of the identification of the current month? Legesse recounts the case of the informant who

> started out with the typically erroneous numerical assumption that the lunar month consists of thirty days. Consequently, he started his reckoning with the full moon/Triangulum conjunction on the fifteenth day of the month. He then deducted two (rather than 2.5) days each month and concluded that seven months later the new-moon/Triangulum conjunction would occur in the month of *Camsa*. In other words he was off by one month. He was quite embarrassed to find that his conclusion did not agree with his own earlier statement and the statements of others about the date of that conjunction.[30]

It is fairly easy to see how, in the absence of the anthropologist, the TRP in a given year might, by a process of retrospective adjustment, end up as seven rather than six months long. This would only need to happen in approximately every other year for the Borana year to keep in step with the solar year.

Inexactitude could also play a vital rôle in calendrical observations during the NMRP. Consider, for example, our idea that a switch might take place during the early part of the NMRP from observations at the beginning to observations at the end of the month. If, for example, the newly-sighted moon at the beginning of a month has progressed further than had been expected by a particular *ayyantu*, then it might well appear in the correct place in the morning sky at the end of the month. Being able to adjust when the switch takes place would introduce extra flexibility into the identification of months during the NMRP and could help preserve the expected sequence of astronomical events despite the uncertainties caused by the different correlations of the lunar and solar cycles in different years.

In summary, inexactitude and retrospective correlation may well account for the Borana calendar keeping in step with the solar year. They may also account for the correlation between the day round and the month round in the Borana calendar, which is itself inexact.

In one instance the Mursi adopt a totally inductive stance. This is the case of the progress of the annual flooding of the river Omo, which is monitored directly by the heliacal setting of four stars.[31] This is, however, independent of the *bergu*. In contrast there is at least one point within the Borana calendar where, according to Legesse, disagreement can be removed at a stroke:

> There is one day in the year in which ... the astronomic observation becomes decisive. This is the day of *Bita Kara*, in the month of *Bittottessa*. ... It is therefore very important for Borana experts to make astronomic observations on that particular day.[32]

Legesse tells us that "The cumulative errors that build up during the year are ironed out on the basis of these observations".[33] However

> If atmospheric conditions do not allow them to make an observation ... the observation is postponed. In such a case they look at the stars on one of the nights following the expected date of the new moon, and they reckon backward to the critical date. Sometimes they will also get news from other parts of Borana where the new moon was sighted. In either case there is room for error.[34]

Even at this point there is room, it seems, for institutionalized disagreement and retrospective adjustment.

The Day Cycle

One essential difference between the Mursi and Borana calendars is in the reckoning of days. The Mursi count off the days of the *balai* (waxing phase) and *mur* (waning phase); the first evening on which the new moon can be detected is the first of the *balai* sequence (*balai* 0). Thus while the Mursi identify the first day of the new month in a way that is similar to that of the Borana, the Mursi days, unlike those of the Borana, are simply correlated with the sequence of lunar phases.

A possible explanation of the permutation calendar used by the Borana stems from the fact that the length of the day-round is the nearest whole number of days to the length of the sidereal month (27.32 days). The latter is the time taken by the moon to complete a passage (in RA) relative to the stars. Thus if the moon appears side by side with (i.e. at the same RA as) any star on a particular day, it will again appear side by side with the star on the same day in the next cycle. In order for this to remain true in an exact system, an extra day would have to be inserted in approximately every third cycle; however, in an inexact system the adjustment could pass unnoticed. The result is that the sequence of

TABLE 5. Comparison of Borana star names, day names, and the motions of the moon relative to the stars in question. The RA of the moon is given at 24-hour intervals assuming it to be level with α Tri at a given time of day on *Bita Kara*. These figures may be compared with the RAs of the RSGs.

Star	Borana Star Name	RA of Star	RA of Moon at Given Time of Day	Borana Day
		h	h	
			2.0	Bita Kara
α Tri		1.8		
β Tri	Lami	2.0		
γ Tri		2.2		
			2.9	Bita Lama
η Tau (Pleiades)	Busan	3.8		
			3.8	Sorsa
α Tau (Aldebaran)	Bakkalcha	4.6		
			4.7	Algajima
γ Ori (Bellatrix)	Algajima	5.4		
			5.6	Arb
ε Ori (Centre of belt)	Arb Gaddu	5.6		
κ Ori (Saiph)	Urji Walla	5.8		
			6.5	Walla
α CMa (Sirius)	Basa	6.7		
			7.3	Basa

days simply reflects the moon's motions through the stars, and, except for the few days when it is not visible around the time of astronomical new moon, a simple observation of the moon's position relative to the stars will be sufficient (at least in theory) to determine the current day.

Note that the phase of the moon is not involved; this only enters when we consider the synodic months. The way in which the lunar phases permute with the moon's motions relative to the stars is exactly reflected in the way that the Borana months permute with the day-cycles.

Some interesting coincidences in Legesse's description lend credence to this interpretation. We know that the moon appears side by side with Triangulum on the day *Bita Kara* at the start of the month *Bittottessa*. Thus if the day names and stellar motions of the moon are correlated as we suggest, the moon will always pass the RA of Triangulum on or very near to the day *Bita Kara*. The approximate difference between the RA of Triangulum and that of Sirius (see Table 1) is $4^{h}45^{m}$; the moon's daily advance in RA is some $0^{h}53^{m}$. Thus five to six days after *Bita Kara*, on about the day *Basa Dura*, it will pass Sirius. *Basa* is the Borana name for Sirius.

Once this coincidence is noticed, other coincidences of names become evident. For example, the days preceding *Basa Dura* are *Algajima*, *Arb* and *Walla*; the Borana names of the RSGs preceding Sirius (Bellatrix, Central Orion and Saiph) are *Algajima*, *Arb Gaddu* and *Urji Walla*.

In Table 5 we show the RA of the moon at 24-hour intervals assuming it to be level with α Tri at a given time of day on *Bita Kara*. These figures may be compared with the RAs of the RSGs. The fit is not exact, but this would not be expected since

(i) the motion of the moon in RA is continuous and observations (in different months and in different years) could be made at any point in the linear progression; and

(ii) a bright reference star will not always be available for a particular day at exactly the same level in the sky as the moon, since the distribution of stars is non-uniform.

However, there is a clear relationship between the Borana day and the position of the moon relative to the stars — one which, it might be noted, is obscured by the layout of Legesse's table.[35] It would be of great interest to know if all the Borana day names correspond to particular stars or star groups; if this is the case then the *ayyantu* have the means to determine the current day astronomically at any time in the day cycle. This would be quite independent of the determination of the current month.

Discussion

It seems extraordinary that Legesse's account of the Borana calendar has been in the literature for some fifteen years without any detailed astronomical critique being published (at least to the present author's knowledge) before that of Doyle. Legesse is (to put it mildly) somewhat vague on astronomical matters, and while some difficulties can be resolved and errors eliminated by recourse to astronomical arguments, there remain a number of anomalies in his account of the Borana calendar whose resolution is not a clear-cut matter. The point deserves to be made not so much as a criticism of Legesse (whose aims were very much wider than merely to document the finer details of Borana astronomy *per se*), but rather as a warning to those who might wish to use his description of the Borana calendar as a basis for further conclusions.

At the same time, astronomical investigations cannot proceed in isolation from their cultural framework. In addition to the obvious dangers of ethnocentrism there also seems to be a lingering tendency amongst archaeoastronomers to concentrate on horizon-based astronomy. Horizon-based observations, such as those involved in the 'equal declination' model of the Borana calendar, have the considerable drawback that they must be made from a fixed spot or spots where known horizon markers (natural or otherwise) are present for reference. Many observations of direct calendrical use, such as the lunar phases, luni-stellar conjunctions and heliacal risings and settings, do not involve such a restriction. Horizon-based astronomy often seems to be the product of a sort of 'archaeoastronomico-ethnocentrism' owing its existence to the roots of archaeoastronomy in British megalithic sites and to the Thom legacy, whereby ideas similar to those of Thom are projected rather blindly into totally unrelated situations and cultures.[36]

It is disappointing that in some of the recent discussions of the Borana calendar little mention has been made of the cultural framework of the Borana and none at all of the ethnoastronomical data from neighbouring and related groups. This paper has perhaps done a little to redress the balance, but it has made mention of only one other community whose links with the Borana are not direct. Much fruitful work could result from detailed investigations of other Cushitic-speaking groups and indeed from other studies of the Borana themselves.

In the case of the Mursi

> Time reckoning ... is an eminently social activity. The standard of measurement used by one individual is the product of his day-to-day interaction with many others in a single local community. Knowing what month of the year, or what day of the month, it is turns out to be as much a matter of social consensus and public opinion as of applying a set of objective criteria of measurement. There is consequently, no "system" of Mursi time reckoning, in the sense of a self-contained set of propositions which, once stated, can be made to yield unambiguous determinations.[37]

Is the Borana permutation system significantly more sophisticated? Legesse appears to think so:

> Borana time-reckoning is unique in eastern Africa and has been recorded in very few cultures in the history of mankind. The best-known examples of this type of time reckoning are the Chinese, Mayan and Hindu calendars....[38]
>
> The Borana calendar is a permutation calendar. It is as though we coupled two cogwheels ... it is [the] periodic realignment of corresponding "cogs" on two unequal series that defines the longer time units. This is the astonishingly sophisticated principle that Borana are utilizing.[39]
>
> The entire system of Borana time reckoning is so complex and so strange....[40]

However, Turton and Ruggles are more cautious:

> Anthropologists, in their enthusiastic crusade against all forms of ethnocentrism, are often at pains to emphasise the complexity and sophistication of ways of measuring duration in the cultures they talk about. ... Sometimes this may lead to the uncomfortable feeling that there has been revealed a system more complex than the practical needs of the people would seem to require, which feeling may then lead to an attempt to account for this "unnecessary" complexity.[41]

In this paper we have tried to demonstrate, using the Mursi example for inspiration, that inexactitude and retrospective correlation may play an important part in the Borana calendrical system; and that when this is combined with Legesse's data and some astronomical arguments, a reasonably coherent and uncomplicated picture can emerge.

We believe that we can account for the Borana permutation calendar in reasonably straightforward, practical terms. The system of two permuting cycles — one relating to the position of the moon relative to the stars and the other to its phase — is noteworthy for its elegance and simplicity.

Perhaps there is a tendency amongst both anthropologists and archaeoastronomers, for entirely different reasons, to postulate an unnecessarily rigid or complex 'system' in order to explain the astronomical observations and calendrics of remote communities. Increased communication between anthropologist and astronomer might help to curb this tendency.

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17. *Ibid.*, 185.
18. *Ibid.*, 186 and Fig. 7–2.
19. *Ibid.*, 184.
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21. *Ibid.*, Fig. 7–1.
22. Doyle, *op. cit.* (ref. 4).
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25. Legesse, *op. cit.* (ref. 1), 180.
26. Legesse (*ibid.*), like many others, seems to assume that the only way that the 'lunar year' can be kept in step with the solar year is by the use of intercalary months. This assumption betrays ethnocentrism, as Turton and Ruggles (ref. 23) show.
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