A Universal Islamic Calendar

Dr. David McNaughton
SERCO/IAL, P.O. Box 1897, Dubai, United Arab Emirates

> They ask thee concerning the New Moons. Say: "They are but signs to mark fixed periods of time in (the affairs of) men". Al-Qur'ān, II:189.

The Islamic world does not have a uniform policy regarding the acceptance of crescent sightings from neighbouring (or indeed from distant) countries when deciding whether to declare the onset of a new month. Many authorities will consider only observations made from within their own national boundary. At least once in the past, however, evidence from the Yemen has been cited for the commencement of *Ramaḍān* in the United Arab Emirates. Furthermore, many Ithnā' 'ashrī Shī'ites are happy to abide by reports made even in another continent – provided they can receive such evidence before their own dawn next morning.

However, there are sometimes disputes when calendars are based on crescent sighting. Although the sincerity of Muslim observers is unquestionable, it seems that there are still people who firmly believe that they have identified (sighted) the New Moon when in fact it was just a wisp of cloud or some other object, because the crescent was nowhere in the sky at the time. This is consistent with results from a moon watching program involving 2500 amateur astronomers in America between 1987 and 1990 A.D. – encouraging them to study and cultivate the practice of crescent spotting, which has become a highly refined science.[1] Despite that, a number of positive reports were received there on occasions when the lunar disc was well below the horizon – and sometimes even when the moon was still "old" so that it was actually on the wrong side of the sun!

Some Muslims feel that it would be advantageous to have a calendar designed to prescribe the same dates across the entire globe. The Bohra community does indeed have a predetermined calendar of that nature: it does not depend at all on New Moon visibility – but instead follows a well defined 10631-day cycle (which they take as being equal to 30 Islamic years, thereby accumulating a small error of about one hour per century). Unfortunately the Bohra dates can be as much as two (or on rare occasions even three) days at variance with those which are governed by crescent sighting. In 1412 H., for example, the Bohra *Ramaḍān* commenced on the morning of 4th March 1992, whereas throughout most of India (and also the Far East), fasting did not start until 7th March.

This article discusses a suggestion for a universal Islamic calendar based on a single, very simple rule:

> Identify the date on which the New Moon is born; the next month commences at sunset on the following day.

The *Sūrah* quoted at the head of this article could conceivably be interpreted to permit such a rule – because there is indeed a direct link between the instant of New Moon and the onset of the new month.

Birth of the New Moon is defined as the moment when its celestial longitude is exactly equal to that of the sun. (Celestial longitude is similar in many ways to geographic longitude, except that it is measured round the sky). Thus, to determine whether a new Islamic month is due, it is enough just to compare the longitudes of the moon and sun at midnight; if the lunar longitude is greater, then the next month must start with the coming sunset. If the moon has not yet "caught up" with the sun, on the other hand, then wait another 24 hours for the next midnight and apply the test again.

Coordination of Islamic and Gregorian dates

> It may be noted that while equating Islamic dates with Gregorian ones, it is actually more common to refer to the Gregorian date prevailing *at dawn*.

Such a convention will be adopted for the remainder of this article. Thus, *two* days should be added to the date of birth of the New Moon in order to calculate the Gregorian date on the morning of the new Islamic month.

It must be emphasised that the above rule should not necessarily be taken as a rigid guide to when the crescent will become visible. However, if midnight Universal Time (*UT*)* is used as the "moment of decision", then the onset of the new month will usually be heralded by the first clear appearance of the crescent in Asian, African and European skies.

Inevitably, there will be exceptions. Because the moon's orbit is elliptical (not circular), there are occasions when it migrates faster than normal; it is then possible for it to be born after midnight and still be spotted at dusk, say 14 to 17 hours later,[2] perhaps from northwest Africa. However, it will then become and remain visible only for a few critical minutes, passing unnoticed by the vast majority of people – and in places lying further east it will be even less obvious.

Conversely, it could happen that the New Moon occurs shortly before midnight *UT* but without being observed from anywhere east of the Atlantic during the coming evening, because a crescent aged only 18 to 19 hours is not always sightable.[3] However, it will certainly become visible from somewhere in America after a few more hours have elapsed and the separation between the crescent and sun has increased; (it will then be dusk in America but approximately midnight in Africa and Europe).

Modern astronomical techniques enable the time of birth of a New Moon to be calculated in advance, correct to the nearest few seconds. Such times are published every year in the Anglo-American *Astronomical Almanac* (as well as in the *Nautical Almanac*, and in the *Indian Astronomical Ephemeris* and others). Alternatively, the necessary calculations may be performed easily and quickly on any ordinary desk or laptop computer, assuming that good quality software has been installed.

When comparing the solar and lunar longitudes for this proposed calendar, it is of course possible to do so at midnight in a time zone other than Greenwich – effectively making the "decision moment" a few hours earlier or later. Occasionally that will alter the date of transition to the new month, because of the change in longitudinal distance between the sun and moon from one hour to the next – which could easily lead to a different answer to the question "Did the moon overtake the sun before midnight?"

Based on the suggestion made in this article (and using the Greenwich midnight), Table 1 presents the Gregorian dates of the Islamic months up until 1419 H. The corresponding birth-times of the New Moon are included so that occasions may be identified when the moon just succeeded in overhauling the sun before midnight *UT* – and indeed when it just failed to do so. Our knowledge of celestial dynamics is detailed and accurate enough to continue such a calendar certainly for the next 60 years, and probably beyond that.

The Problem with Earth's Changing Speed of Rotation

The main limitation preventing indefinite future extension is the question of how Earth's spin-rate will vary. This is gradually slowing down – but with irregular fluctuations apparently induced by geophysical changes occurring deep within our planet's interior. Earth's rotation is therefore not a good time-keeper: the discrepancy between it and an accurate clock is known as the "Delta-T" value for the year (or even the day) being considered: (see the Glossary for a more detailed discussion).

Present variations in Delta-T (as well as those in the recent past) may be deduced or monitored quite accurately, but future values can only be estimated approximately.

It is therefore not possible to be sure whether *Ramaḍān* 1511 H. will begin on the 24th or on the 25th of March 2088 in this proposed calendar. A widely used formula suggests that the Delta-T correction might become 3.9 minutes by that month.[4] If that turns out to be true (or if Delta-T is greater) then the New Moon will be born on 22nd March – just before midnight *UT*, so fasting should commence on 24th March.

However, if by late March 2088 Delta-T becomes only 3.0 minutes (which is quite possible) then midnight *UT* on the 22nd/23rd will occur 0.9 minutes earlier, altering the date of birth of that same New Moon to 23rd March – thereby requiring the date of 1st *Ramaḍān* to be the 25th.

Such uncertainty over the beginning of *Ramaḍān* 1511 H. will have absolutely no effect on the confidence

---

**UT* is virtually the same as *Greenwich Mean Time* (GMT), i.e. normal local clock-time in Britain.

with which the dates of subsequent months of 1511 H. may be predicted, because their New Moons are not due to be born near a *UT* midnight. Similarly, accurate calendars for 1512, 1513 H. etc. can easily be published well in advance (even right now, in fact). Another problem month will not be encountered until *Ṣafar* 1518 H.

Table 2 presents those and a few other Islamic dates when unexpectedly high or low values of Delta-T may cause the proposed calendar to be incorrect by one day. It should be emphasised that the occasions it lists before 1511 H. will require a very substantial disruption in Earth's spin-rate in order to move the appropriate midnight *UT* to the other side of the instant of the New Moon.

As we approach closer to those critical dates, we should acquire a better idea of their likely value of Delta-T. Thus, there is very little chance of the Table 2 uncertainties remaining until the beginning of the years concerned: in fact they should be resolved much earlier than that.

It must be mentioned that it is only in this particular calendar system that Table 2 dates are problematic. Calendars based on midnight in another time-zone (or in fact any calendar constructed according to rigorous, well-defined criteria) will also have to contend sometimes with uncertainty regarding Delta-T, but in months quite different from those listed in Table 2.

Four Successive 30-Day Months

Because the proposed calendar system operates through a decision process which is quite clear-cut, with no grey area, it is interesting to see what light it throws on the possible occurrence of several consecutive 30-day months. (When asking how often that happens in a calendar which is based on crescent visibility, criteria for a first sighting need to be adopted – after making debatable assumptions about the effects of atmospheric scattering and absorption).

Month-length is an important subject because it will indicate how much error may be expected in a simplified precalculated Islamic calendar (like the Bohra one) in which there is strict alternation of 30-day and 29-day months. So, how many consecutive 30-day months are theoretically possible due purely to astronomical factors: e.g., occasions when the moon takes longer than normal to circuit the Earth?

Detailed long-term analyses of the length of a lunar month (known as a "lunation") reveal that it may sometimes be as short as 6.28 hours below its mean value (which is 29 days 12.73 hours), or it may be up to 7.35 hours more.[5] That asymmetry helps to explain why runs of consecutive "long" Islamic months are more likely than sequences of "short" ones: three 30-day months in a row are quite common, and occasionally there may even be a fourth. It is never possible to have more than three successive 29-day months, however.

Fluctuations in lunation-size are cyclic. There is a fast cycle averaging about 412 days which is just under 14 lunar months;[6] this is associated with changes in eccentricity (or shape) of the lunar orbit. That fast cycle is embedded within a slower one whose mean wavelength is 8.85 years[7] (equal to one complete revolution of the axis of the moon's elliptical orbit). In addition, there are other oscillations, some causing variations extending over many hundreds of years – when it may not even make sense to look for an average wavelength.

Longer than normal lunations tend to occur between October and March because of faster movement by the Earth in its orbit round the sun.[8] In February and March, this delays the instant when the moon appears to overtake the sun (i.e., the moment of birth of the New Moon). It also means that the sun lies closer to a new-born crescent than it would if Earth's speed was uniform – thus postponing the onset of New Moon visibility. In October and November, on the other hand, the sun's position on the ecliptic line is "behind schedule" – so the Moon overtakes it earlier.

For those reasons, every eight or nine years during northern hemisphere autumn and winter there will be perhaps two instances when four successive lunations span more than 119 days: it is then possible for all four of them to yield a long Islamic month.

Table 3 shows occasions in the past and future when the proposed calendar will produce four consecutive long months. However, if the decision moment is moved from the Greenwich midnight to that in some other time zone, then completely different years will have four successive 30-day months. The phenomenon is sensitive to choice of time zone because in order to work it needs a longitude where the moon just succeeds in overtaking the sun before local midnight, thereby ensuring an early closure of the (29-day) month immediately prior to the desired 120-day stretch.

Successive 30-day months in crescent-based Calendars

With calendars based on crescent sightability, other factors influence the date of transition to a new Islamic month. If the moon lies high above the ecliptic in October, for example, then its vertical height will be enhanced at sunset at northern hemisphere locations (see figure 1) – favouring an early start to the next month[9] and making four consecutive 30-day months more likely. (The moon's position above or below the ecliptic is defined by a parameter known as the "celestial latitude").

In the southern hemisphere, positive lunar latitude tends to *decrease* the moon's altitude because of the "upside down" appearance of a southern sky. In February/March that will often delay a sighting[10] (figure 3) and maximise the chance of obtaining four long months.

Incidentally, even if the lunar latitude is ignored, southern hemisphere observers find it easier to record four (or even five) successive 30-day months – because of the shallow angle between the dusk ecliptic and the horizon there between February and April, which tends to reduce the crescent's height and therefore to delay the onset of its first visibility. Just after sunset in September and October, furthermore, the ecliptic's steep angle facilitates early sightings of the New Moon in southern latitudes[11] (see figure 4).

In the northern hemisphere those calendric relationships between the ecliptic and dusk horizon are reversed, making it more difficult to experience four 30-day months in the Mediterranean countries and throughout most of Asia whenever calendars are determined by crescent-spotting.

The above difference between our two hemispheres originates from the tendency (explained earlier) for long lunations to occur during northern autumn and winter – while the opposite seasons (spring and summer) are being experienced south of the equator.

In both hemispheres the noon ecliptic is highest and steepest at summer solstice, whereas at winter solstice its maximum altitude is attained at midnight. Thus, in both northern and southern latitudes the dusk ecliptic is steepest at spring equinox, which happens to occur in September in the south (just before Earth speeds up), but in March in the north (when our planet slows down).

Summary

The Islamic calendar described in this article is proposed on the assumption that it might be deemed useful to have a system yielding the same dates throughout the entire world. In addition, its dates will correspond reasonably well with the first clear appearances of the crescent in many countries.

More important, perhaps, is the attempt made here to illustrate and discuss factors which will often need to be addressed in lunar calendar systems — for example Earth's varying rotation rate, lunation cycles, and the effects of lunar latitude and ecliptical inclination.

Glossary:
Some Astronomical Terms

Celestial Firmament (or Celestial Sphere)

The inside surface of an enormous imaginary sphere surrounding the Earth. Positions of stars and planets etc. can be projected on to this surface as if it were a screen — just as in the interior of a gigantic planetarium. (Indeed, early astronomers thought that there really was a solid surface like that, a very great distance away, to which the stars were fixed).

Ecliptic

The plane containing the orbit of the Earth round the sun. This plane can be extended indefinitely in all directions, so it is possible to describe the position of any planet, moon, star or galaxy in the universe according to whether it lies above, below, or on the ecliptic plane.

The ecliptic *line* is formed where that plane intersects the celestial firmament. This line therefore occupies a well defined position in the sky — during the day as well as the night. It is usually marked on star charts.

The sun, moon and planets always remain relatively close to the ecliptic line during their apparent migration across the sky.

Celestial Latitude (or Ecliptical Latitude)

The distance, in degrees, of the moon (or a planet) mediments.

above or below the ecliptic line when viewed from Earth. Measurement is perpendicular to the line with north positive.

The moon can sometimes be as much as five degrees above or below the ecliptic. The sun's latitude may be taken as zero for most purposes (it never exceeds 1.2" of arc).[12]

Celestial Longitude (or Ecliptical Longitude)

A scale marked off along the ecliptic line from 0 to 360 degrees (i.e. a complete circuit round the Earth). Thus, the celestial longitude and latitude of a solar system object unambiguously pinpoint its location in the sky. The sun moves about one degree of longitude every day. However, the moon travels much faster, gaining an average of 13 degrees per day (the longitude is fixed with reference to the *stars,* so circuits are completed in just over 27 days).

The sun's position at the March equinox is taken as zero on the scale. The sectors of the zodiac (and their constellations) are often delineated in terms of celestial longitude.

Although the celestial longitude and latitude usually refer to a "geocentric" arrangement (with Earth occupying the centre of the circle), a "heliocentric" system is used occasionally — when the graduated longitude scale is measured round a circle centred on the sun.

Celestial longitude and latitude must not be confused with "Right Ascension" and "Declination", which are alternative coordinate systems for the sky, but related instead to the Earth's equatorial plane and spin axis. This second system is used for stars (and sometimes for the moon, sun and planets).

Lunation (or Synodic month)

The interval between successive New Moons, presently averaging 29.530589 days. A thousand years ago this value was 29.530587 days; in a thousand years time it will probably be 29.530591.

Uncertainty as to more precise values does limit our ability to calculate exact times of lunar phenomena in the distant past and far future (although this is not as serious as the problem with Delta-T).

Delta-T

The discrepancy between time measured in relation to Earth's rotation and that kept by an accurate clock.[13]

Earth's rate of spin is not constant, but is gradually slowing down, mainly due to tidal friction. To make matters worse, there are irregular fluctuations in this deceleration, imposed by volcanic and tectonic convulsions as well as by changes in magnetic coupling effects deep within our planet's interior: sometimes they even force the spin-rate to increase temporarily. Because the overall trend is one of retardation, an accurate clock started 3000 years ago would now show the instant of noon to be "wrong" by several hours: this is consistent with recorded times and positions of the ancient eclipses.

It is therefore necessary to have two parallel time scales, one in which the Greenwich sun really does attain its zenith at 12.00 noon (on average), and another scale determined by an atomic clock which is completely "unaware" of (or unaffected by) variations in Earth's rotation.

An arbitrary decision was made to regard the two time scales as synchronized in A.D. 1902. Since then, they have drifted slowly apart, with the atomic clock moving ahead as expected.

It is of course impossible to know what the discrepancy will be in future. The best one can do is to assume that Earth's rotation will continue to decelerate at a similar average rate to that of the past, whilst ignoring the unknown future random fluctuations. If we do that, it is reasonable to estimate that the difference between the two time systems will be between 3.5 and 5 minutes in A.D. 2100 (depending on which of several possible formulae is adopted). At the beginning of A.D. 1995 the discrepancy was 61 seconds. These corrections are known as the "Delta-T values" for the year concerned.

For everyday purposes, it is obviously better to keep time according to the sun's apparent movements, so ordinary clocks are deliberately maintained in tune with Earth's rotation. On occasions, an extra second therefore needs to be added to (or maybe subtracted from) the end of December — and perhaps other months too if the error becomes worse. Those extra seconds constitute the year to year changes in the accumulated value of Delta-T. Current readjustments allow for the fact that our day-length is now a few milliseconds more than 24 hours.

Acknowledgments

My thanks go to Cal Archer of Pretoria, South

Africa, for all he has taught me about lunar behaviour and solar system dynamics. Without that, this paper would probably never have been written.

Useful correspondence was also undertaken with Jean Meeus of Erps-Kwerps, Belgium, with Brad Schaefer of NASA, USA, and with Ala'a Jawad of Kuwait.

NOTES and REFERENCES

1. Doggett, Leroy E., and Schaefer, Bradley E., "Lunar Crescent Visbility", *Icarus* 107, pp. 388-403, 1994; see sections 6, 9, and 5.
Also relevant is the chapter on "Calendars" in the *Explanatory Supplement to the Astronomical Almanac*, University Science Books, Mill Valley, California, 1992; see section 12.411. Schaefer has developed a good algorithm for assessing prospects of crescent visibility at specific sites, allowing for the degree of haze in the atmosphere, and other factors; his *LunarCal* (1990), is available from Western Research Co., Tucson, Arizona.
Another algorithm has been constructed in Malaysia, *A Modern Guide to Astronomical Calculations of Islamic Calendar, Times and Qibla*, by M. Ilyas, Berita Publishing, Kuala Lumpur, 1984.
2. Doggett and Schaefer, *op. cit.;* M. Ilyas, *op. cit.*
3. *Ibid.*
4. Meeus, Jean, *Astronomical Algorithms*, Willmann-Bell Inc., Richmond, Virginia, 1991, see ch. 9 whose equation 9.1 was proposed by Leslie V. Morrison and F. Richard Stephenson. See also – Leslie Morrison's article, "The day time stands still" , *New Scientist*, 27 June 1985, pp. 20-21; also John Wahr, "The Earth's Inconstant Rotation", *Sky & Telescope*, June 1986, pp. 545-549. A very detailed discussion appears in "Terrestrial Coordinates and the Rotation of the Earth" in the *Explanatory Supplement to the Astronomical Almanac*, where figures 4.51.2 to 4.51.4 depict historic values of Delta-T.
5. Jawad, Ala'a H., "How Long is a Lunar Month?", *Sky & Telescope*, November 1993, pp. 76-77. He also cites an earlier investigation by F. Richard Stephenson and Bao-Lin Liu, which uses a longer period for its calculations. This article displays the two lunar cycles graphically. Also important are resonances between lunations and anomalistic months, i.e., the mean time between successive perigees.
For a discussion of the 206-day cycle in the shape of the lunar orbit, see Meeus, Jean, "Extreme Perigees and Apogees of the Moon", *Sky & Telescope*, August 1981, pp. 110-111. Low perigee values occur alternately at Full Moon and New Moon, so it is the double-cycle (412 days) which is associated with variations in lunation-length. For the longer 8.85-year cycle see Meeus, "Les durees extremes de la lunaison", *L'Astronomie* (Societe de France) 102, pp. 288-89 (July-August 1988).
See also Meeus, *Astronomical Algorithms, op. cit.*, chapters 47 and 48.
6. Jawad, *op.cit.;* Meeus, *op. cit.*
7. *Ibid.*
8. *Ibid.*
9. For the relationship between vertical height and crescent visibility see Fotheringham, J. K., "On the smallest visible phase of the Moon", *Monthly Notices of the Royal Astronomical Society* 70, pp. 527-531, 1910.
See also *Sky & Telescope*, September 1989, diagram on p. 323, which suggests that sun-moon azimuth differences of up to 12 degrees make little difference to crescent sightability.
10. Fotheringham, *op. cit.; Sky & Telescope*, September, 1989, p. 323.
11. *Ibid.*
12. Meeus, *Astronomical Algorithms, op. cit.*, p. 152.
13. Meeus, *Astronomical Algorithms, op. cit.*, ch. 9; Morrison, *op. cit.*, Wahr, *op. cit.*

Special Note:

Software

EclipseMaster (Zephyr Services, Pittsburgh) was used for most of the calculations. It outputs celestial longitudes and latitudes of the sun and moon even when no eclipse is taking place. Its precision is very good (better on an Apple IIe than on an IBM 486, as it happens).

The program also allows the value of Delta-T to be varied at will, so as to make new comparisons of the positions of the sun and moon; this was essential for the construction of Table 2.

Zephyr Services have now replaced *EclipseMaster* by *Sun-Tracker* and *Moon Tracker.*

AstroCalc (also from Zephyr Services) does provide useful cross-checks as long as its strengths and weaknesses are recognised. Its Julian Day calculations can conveniently be related to Islamic dates, helped by its "Age of Moon" output. However, those ages are derived directly from the moon's location, so they can be slightly inaccurate, particularly around perigee.

AstroCalc does not take Delta-T into account. Furthermore, its computed solar and lunar heights need to be adjusted to allow for refraction, and for the topocentric diurnal parallax of the moon.

TABLE 1

Proposed Islamic Calendar, AH 1416-1419

Islamic Year & Month		Gregorian Start Date	Birth of New Moon	
			Date	*UT*
1416	1	31.05.95	29.05.95	9.27
	2	30.06.95	28.06.95	0.50
	3	29.07.95	27.07.95	15.13
	4	28.08.95	26.08.95	4.31
	5	26.09.95	24.09.95	16.55
	6	26.10.95	24.10.95	4.36
	7	24.11.95	22.11.95	15.43
	8	24.12.95	22.12.95	2.22
	9	22.01.96	20.01.96	12.50
	10	20.02.96	18.02.96	23.30
	11	21.03.96	19.03.96	10.45
	12	19.04.96	17.04.96	22.49
1417	1	19.05.96	17.05.96	11.46
	2	18.06.96	16.06.96	1.36
	3	17.07.96	15.07.96	16.15
	4	16.08.96	14.08.96	7.34
	5	14.09.96	12.09.96	23.07
	6	14.10.96	12.10.96	14.14
	7	13.11.96	11.11.96	4.16
	8	12.12.96	10.12.96	16.56
	9	11.01.97	9.01.97	4.26
	10	9.02.97	7.02.97	15.06
	11	11.03.97	9.03.97	1.14
	12	9.04.97	7.04.97	11.02
1418	1	8.05.97	6.05.97	20.46
	2	7.06.97	5.06.97	7.03
	3	6.07.97	4.07.97	18.40
	4	5.08.97	3.08.97	8.14
	5	3.09.97	1.09.97	23.52
	6	3.10.97	1.10.97	16.52
	7	2.11.97	31.10.97	10.01
	8	2.12.97	30.11.97	2.14
	9	31.12.97	29.12.97	16.57
	10	30.01.98	28.01.98	6.01
	11	28.02.98	26.02.98	17.26
	12	30.03.98	28.03.98	3.14
1419	1	28.04.98	26.04.98	11.41
	2	27.05.98	25.05.98	19.32
	3	26.06.98	24.06.98	3.50
	4	25.07.98	23.07.98	13.44
	5	24.08.98	22.08.98	2.03
	6	22.09.98	20.09.98	17.01
	7	22.10.98	20.10.98	10.09
	8	21.11.98	19.11.98	4.27
	9	20.12.98	18.12.98	22.42
	10	19.01.99	17.01.99	15.46
	11	18.02.99	16.02.99	6.39
	12	19.03.99	17.03.99	18.48

TABLE 2

Date Changes Caused by Variations in Earth's Spin-Rate

Islamic Date	Predicted Gregorian Date	Delta-T (mins)		Resulting Modified Date
		Assumed	Hypothetical	
1 *Ramaḍān* 1511	24 March 2088	+ 3.9	+ 3.0	25 March 2088
1 *Ṣafar* 1518	15 June 2094	+ 4.1	+ 6.5	14 June 2094
The following examples will require quite a drastic change in Delta-T:				
1 *Shawwāl* 1481	16 March 2059	+ 3.1	+ 7.6	15 March 2059
1 *Muḥarram* 1507	14 September 2083	+ 3.8	+ 10.0	13 September 2083
1 *Dhū al-Qa'dāh* 1524	1 January 2101	+ 4.3	– 0.5	2 January 2101

Note: The above alterations in date (due to Delta-T) apply only in the calendar proposed in this article; i.e. one which is based on lunar longitude at *midnight UT*.

TABLE 3

Four Consecutive 30-Day Months

Islamic Dates		Gregorian Dates	
Start	Finish	Start	Finish
1 *Dhū al-Hijjāh* 1365	30 *Rabī' al-Awwal* 1366	26 October 1946	22 February 1947
1 *Ramaḍān* 1421	30 *Dhū al-Hijjāh* 1421	27 November 2000	26 March 2001
1 *Dhū al-Qa'dāh* 1429	30 *Ṣafar* 1430	30 October 2008	26 February 2009
1 *Sha'bān* 1485	30 *Dhū al-Qa'dāh* 1485	2 December 2062	31 March 2063
1 *Shawwāl* 1493	30 *Muḥarram* 1494	4 November 2070	3 March 2071

Note: These are 120-day periods only in the calendar proposed in this article; i.e. one which is based on lunar longitude at *midnight UT*.

corrected diagrams, with sun & moon inserted: "Hamdard Islamicus" XX(3), p.101.

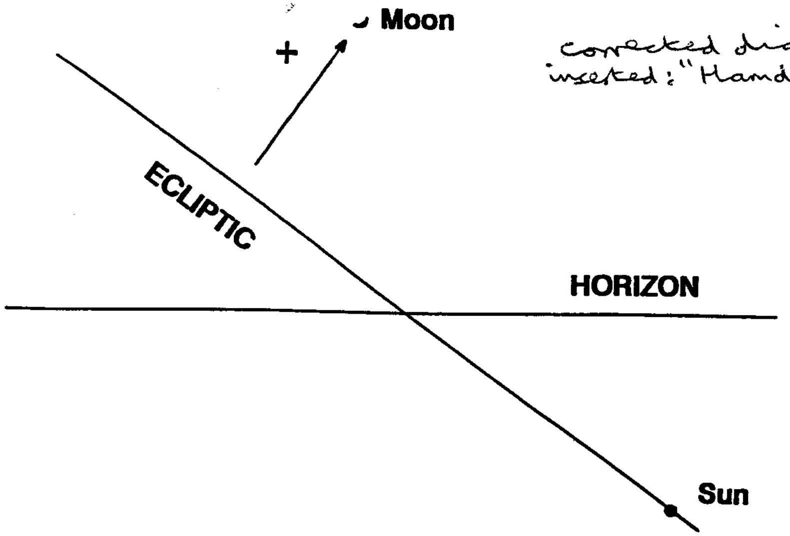

Figure 1. DUSK IN THE NORTHERN HEMISPHERE, SEPTEMBER/OCTOBER

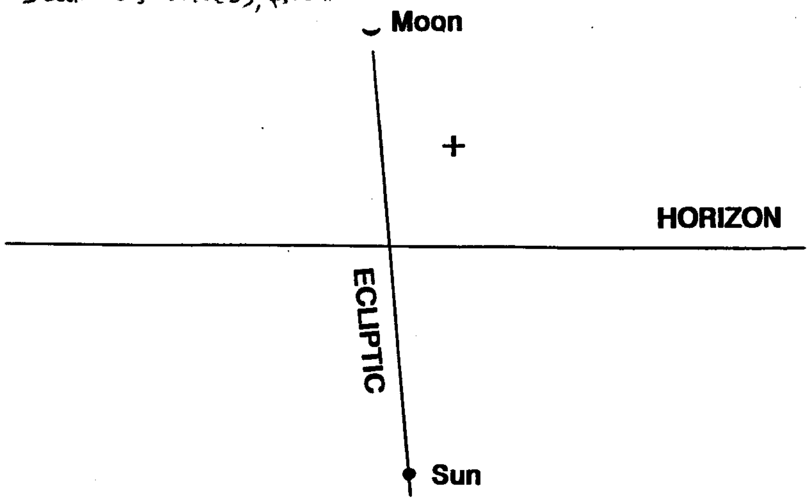

Figure 2. DUSK IN THE NORTHERN HEMISPHERE, FEBRUARY/MARCH

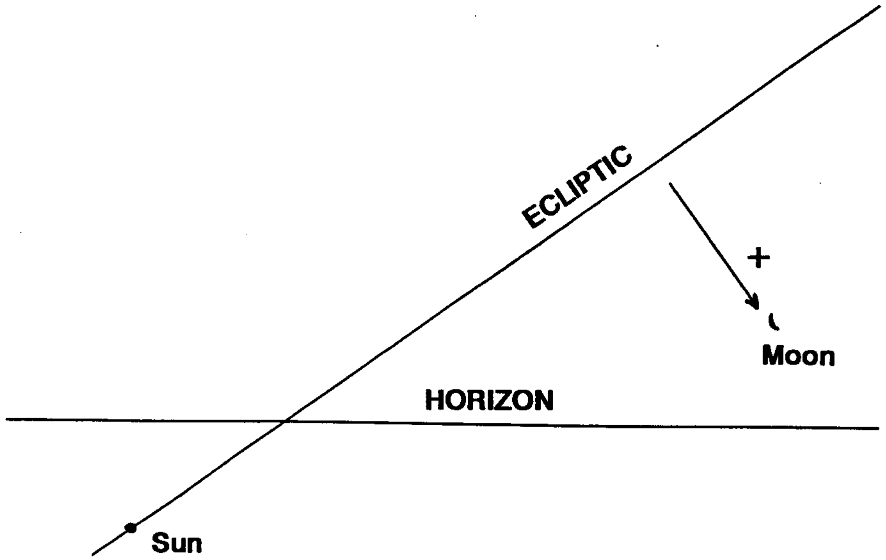

Figure 3. DUSK IN THE SOUTHERN HEMISPHERE, FEBRUARY/MARCH

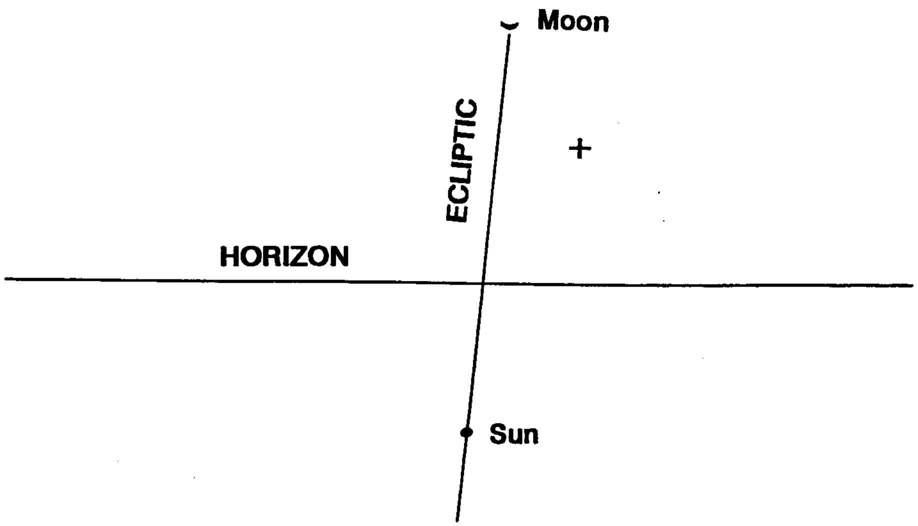

Figure 4. DUSK IN THE SOUTHERN HEMISPHERE, SEPTEMBER/OCTOBER

In this p

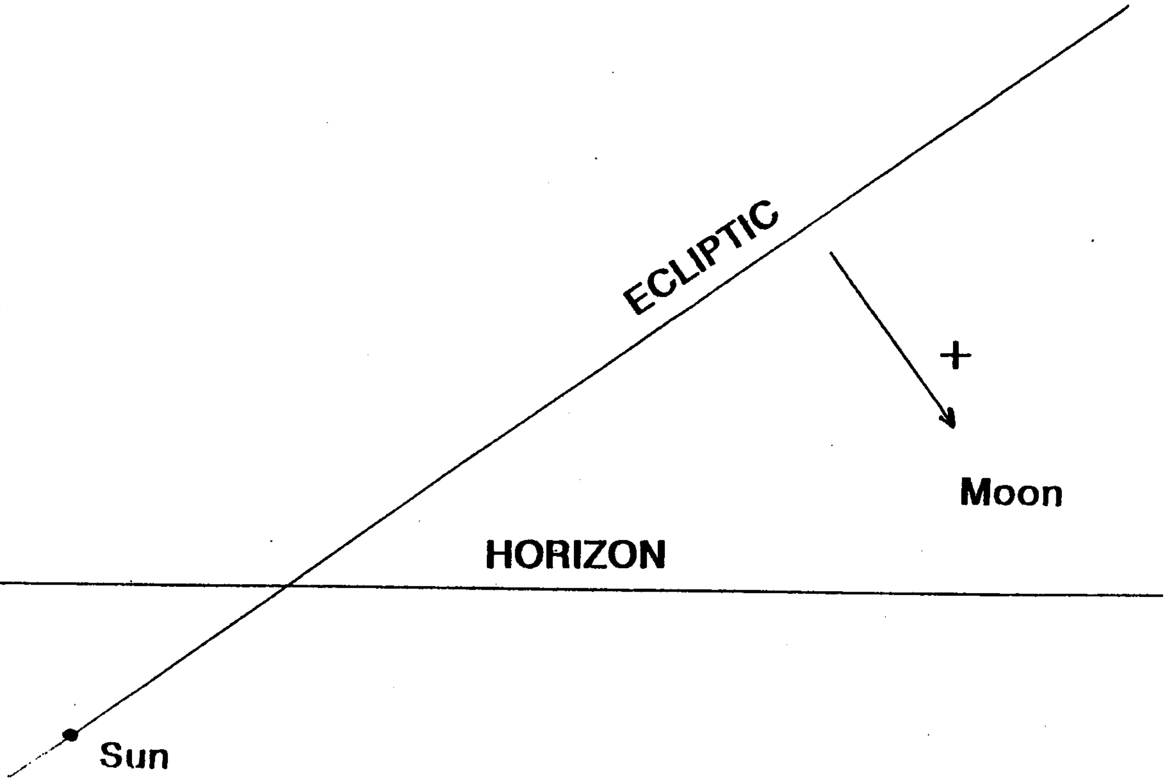

Figure 3
Dusk in the Southern Hemisphere, February/March
Here, the moon s positive latitude puts it below the ecliptic, thereby reducing its vertical height above the sun. Even with zero latitude a very young moon cannot be spotted easily, being comparatively low above the horizon.

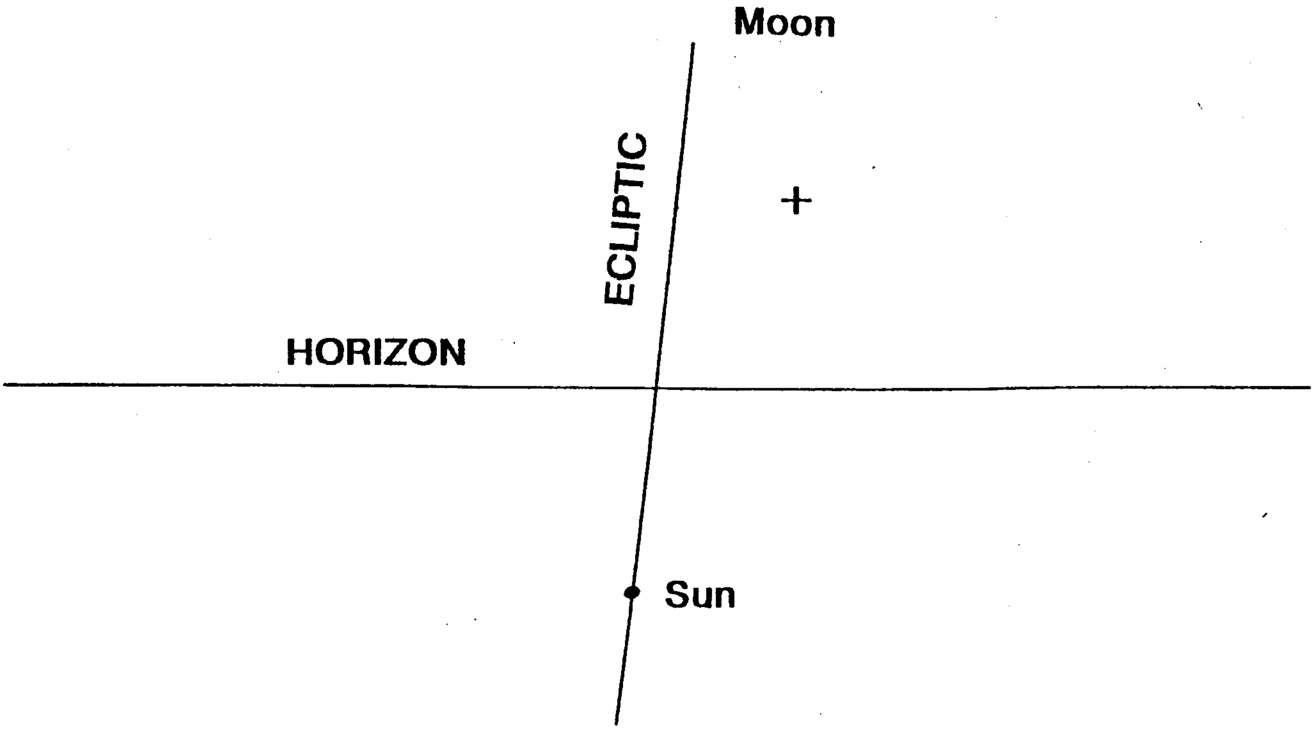

Figure 4
Dusk in the Southern Hemisphere, September/October
The ecliptic is steep, making it easier to spot a New Moon. Lunar latitude makes only a small difference to its height at 25 deg S.