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Research Article

The Ancient Cushitic Calendar: Deciphering the Namoratunga II Stone Configurations

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Abstract

The Namoratunga II archaeological site, radiocarbon dated to 2398 ± 44 BCE, is located on the western shore of Lake Turkana in northern Kenya. Discovered in 1978, it has been posited to function as an ancient astronomical observatory used by eastern Cushitic populations to track celestial movements for calendrical purposes. The site's significance was further amplified by its association with Asmerom Legesse's seminal work of 1973, which introduced the Gada system and the Oromo calendar to academic discourse. This link prompted interest in the site's archaeoastronomical relevance, - and the interest endured but short of definitive evidence supporting this assumption. The hypothetical interpretation persisted largely due to the non-random spatial arrangement of the site's 19 basalt pillars. Despite advances in understanding indigenous Cushitic calendrical systems, research specifically focused on Namoratunga II has been scant. This paper addresses the gap by employing computer-aided analysis of the stars and constellations associated with Cushitic time-reckoning, conducting spatial analysis of the pillar configurations, and correlating these findings with the indigenous traditional calendar as it has been practiced. The findings present new and conclusive evidence supporting the site's function as an ancient astronomical observatory.

Keywords: Namoratunga, ancient calendar, archeoastronomy site, Urjii, Eastern Cushitic, Oromo

Introduction

Asmerom Legesse's seminal publication of 1973, *Gada: Three Approaches to the Study of African Society* [1], introduced the Gada system - an indigenous democratic socio-political institution regulating religious, economic, and civic life of the Oromo people. The system is recognized by UNESCO as an Intangible Cultural Heritage of Humanity. Within this system, specialists are trained in various fields such as law and astronomy - and charged with preserving and transferring knowledge through a framework known as *argaa dhageetti*, which translates to "seeing and listening." This pedagogical framework serves as a seminary-like institution in which a select few are mandated to maintain crucial records and skills across generations. The Ayyantu(s), as specialists in the Oromo calendar, guide the community in determining the timing of social events, major political transitions such as elections, agricultural activities, and other societal milestones.

Following Legesse's work, Lynch and Robbins [2] reported their discovery of 19 basalt pillars in 1978 at Namoratunga II, a megalithic site in northern Kenya located along the D348 Lodwar–Kalokol road approximately 50 km northeast of Lodwar. The site features basalt pillars arranged within a stone enclosure. Lynch and Robbins suggested that Namoratunga II functioned as an archaeoastronomical site - possibly serving as a system to determine the calendar for the eastern Cushitic people. This interpretation was challenged by Soper [3], who argued that the pillars were likely gravestones. Soper also cited inconsistencies in Lynch and Robbin's angular measurements and raised concerns about the reliability of the carbon date which was initially estimated to be around 300 BC. However, more recent excavations led by Hildebrand have yielded even older radiocarbon dates, 2398 ± 44 years BC [4], much older than Soper surmised, placing the site within the Pastoral Neolithic period. This dating suggests that a sophisticated calendrical system may have existed in east Africa as far back as 4400 BP.

Figure 1: Nine *Urji* Dhaha used in Oromo calendar, early Aug., 6 AM.

Although Legesse's fieldwork did not include Namoratunga II due to geographic constraints, the site's discovery has since sparked interest in its potential links to the Oromo calendar. Building on Legesse's foundational work, scholars such as Bassi [5] have explored the utility of the pillars and proposed revisions to the list of the reference stars and constellations known as *Urji Dhaha* "stars of computation" to the Ayyantus, Fig. 1. The *Urji Dhaha* constitutes Saiph, which is the only single star, Aldebaran, Bellatrix and Sirius which are binary stars, Triangulum and Orion which are constellations, and Pleiades which is a star cluster. Mirzam, never mentioned previously as one of the *Urji Dhaha*, is also binary, but appears as one to a naked eye.

While Legesse identified seven key stars, Bassi expanded the list to eight - a position that has gained some scholarly support [6]. While these studies have shed some light on the techniques used in Oromo time reckoning, to date there has not been an effort to interpret configuration of the 19 basalts to link it to the calendar system in an irrefutable manner. In this study, we use Redshift 9 Premium software and site maps to offer new interpretations of the pillar alignments, presenting irrefutable evidence that Namoratunga II served as a prehistoric astronomical observatory.

Conjunction and Proper Motion

For a visual observation of celestial reference objects to stand the test of time, i.e., be valid over centuries and millennia, both conjunction and their proper motions must be evaluated. A conjunction occurs when two celestial objects appear close to each other in the sky from the perspective of an earth-based observer, i.e., the objects share the same Right Ascension (RA) and declination. RA and declination are analogous to longitude and latitude on earth, respectively.

The time of observation determines the angle at which a star and a new moon are visible, thereby defining the calendar month. The *Urji Dhahas* appear in the evening, gradually rising higher before setting out of sight. It is crucial to establish both the time of observation and the RA coordinate of *Urji Dhaha* to collect meaningful and consistent data. A delay of even one hour in recording a star's position can shift the RA angle by approximately 9°, posing a significant challenge when mechanical clocks were not available to track nighttime hours. This obstacle was likely overcome by memorizing the star's RA position or by fixing its location relative to a tall landmark such as a pillar or a hill. A practical and repeatable method would have been to consistently begin observations immediately after sunset – a strategy particularly well-suited for equatorial regions, where seasonal variations in sunset time are modest.

In 1986, Doyle [7] examined the techniques of the Oromo calendar as presented by Legesse [1] and concluded that it is "a valid timekeeping system." However, regarding Legesse's use of the term "conjunction," Doyle argued that using RA would cause a monthly shift of about 11°, rendering the method unreliable. He maintained that the system would work only if interpreted in terms of declination. In contrast, Bassi [5] offered a different interpretation; he claimed that "only RA was taken into consideration, i.e., declination played no role." While Bassi interpreted the term "conjunction" as meaning "side by side," his conclusion contradicted Doyle's assertion that the system could not function using RA alone. This discrepancy is addressed and resolved in the simulated validation presented in this paper, which confirms that the Oromo calendar is indeed based on RA observations.

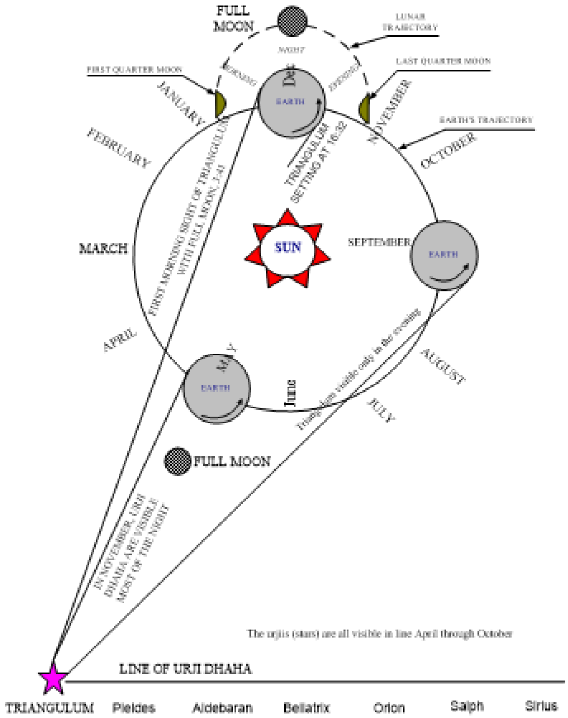

Figure 2: Schematic illustration of how the Oromo calendar works.

Proper motion refers to the astrometric measurement of changes in the apparent position of stars or celestial objects as they move relative to the solar system's center of mass. This measurement is critical in determining whether any of the *Urji Dhaha* may have shifted over the past 4,400 years (since the relevant carbon dating), potentially invalidating present-day observations. Since the Redshift software only allows simulations as far back as 999 AD, it is necessary to evaluate the historical RA and declination of the reference stars by consulting established data [8], summarized in Table 1.

Star	RA		Declination	
	Ascension Arcseconds/yr	Degrees change in 5k years	Ascencion Arcseconds/yr	Degrees change in 5k years
Beta Triangulum	+0.15	0.2083	-0.04	-0.0555
Pleiades	+0.00002	0.000027	+0.00004	0.00005
Aldebaran	+0.063	0.0875	-0.189	-0.2625
Bellatrix	-0.009	-0.0125	-0.014	-0.0194
Orion (avg)	+0.064	0.0888	-0.007	-0.0097
Saiph	+0.002	0.0027	-0.002	-0.0027
Sirius	**+0.55**	**0.7638**	**+1.2**	**1.6666**

- Annual Proper Shift of *Urji Dhaha* and their cumulative shift over 4400 years, [8].

As Table 1 illustrates, Sirius exhibits the largest translational shift, with a change of approximately 0.76° in RA and 1.67° in declination over 4,400 years. However, these shifts are still within a reasonable error margin for naked-eye observations, and thus, for the purposes of this analysis, the proper motion of the *Urji Dhaha* can be considered negligible.

The Oromo Calendar System

During specific months of the year, the *Urji Dhahas* appear in a nearly linear formation in the sky (Figs 1 and 2), beginning with Triangulum (*Lami*), which rises first, and ending with Sirius (*Basaa*), which appears last. The linear variation in the stars and constellations' ascension and declination, combined with the earth's orbit around the sun and the moon's orbit around the earth, play an intricate and essential role in the Oromo timekeeping system. This alignment establishes a sequence of stellar appearances - daily, monthly, and annually - which, when synchronized with the appearance of the new moon, forms a unique coordinate system used to identify specific days of the year to structure the calendar.

The annual conjunction (appearing side by side) of the new moon with Triangulum occurs only once annually, marking the beginning of a new solar year composed of twelve lunar months bearing an inherent 11° shift. This day is known as *Bita Qara*, one of the ceremonial days [1]. Triangulum becomes visible in the evening around mid-April at northwest and fades from view around late August at northeast, remaining unseen for the rest of the year. Conversely, Sirius, at the tail end of the alignment, appears in the evening around the end of May on the west/ southwest horizon, and stays visible until the beginning of December, setting on east/ northeast horizon. The entire *Urji Dhaha* alignment (Fig. 2) is visible between late May and late August - assuming observations occur around 8:00 PM. Observing an hour later shifts this visibility window to span from mid-May to mid-August.

It is worth mentioning here, that the Oromo calendar exhibits notable parallels with the *Tzolkin*, the ceremonial calendar of the Maya. The 27 ceremonial days in the Oromo calendar are intricately integrated into social planning, governing auspicious and inauspicious times for activities such as warfare, marriage arrangements, and risk-taking.

Overall, the calendar is founded on consistent observations and analysis of the complex motions and relative positions of the moon, earth, sun, and 7 to 9 key stars and constellations. It requires meticulous calculation and documentation of these celestial relationships, along with the dynamic permutation of lunar days over a fixed set of ceremonial days.

Ceremonial months: The Moon completes one orbit around Earth relative to the background stars and vernal equinox in approximately 27.32 days, a cycle known as the tropical month. However, due to Earth's motion around the Sun, the Moon requires about 29.53 days to return to the same position relative to the Sun, defining the synodic month. The Ayyantu (Oromo astronomers) recognize and distinguish between these two lunar cycles without modern instruments. Each of the 27 tropical days is assigned a unique ceremonial name [1, 5], while the remaining 2–3 days of the synodic cycle inherit the names of the initial days of the tropical cycle. This ingenious method prevents cumulative drift between the lunar cycles and maintains calendar integrity.

Identifying the *Urji Dhaha*: The red lines shown in Fig. 3 intersect with two or more pillars. For instance, pillars numbered 19, 2, and 3 form one line, 5, 6, 7, and 8 form another line. These lines point at the precise location of nine constituents of the *Urji Dhaha* during morning observations. The following important remarks can be noted to prove that the pillar configurations indeed match the positions of the *Urji Dhaha*:

i. The pillar alignments, as mapped by Soper and depicted in Fig. 3, form unequivocal straight lines that align directly with the positions of the *Urji Dhaha*. Every visible star or constellation between Triangulum and Sirius corresponds with a line formed by at least two pillars.

ii. No other stars are marked by these lines running from southwest to northeast except Mirzam, which aligns with the line formed by pillars 12, 13, and 15 - pointing toward the bright star not yet named in *Urji Dhaha* literature.

These facts strongly imply deliberate astronomical design. The site map also indicates two observation posts, one in the north and the other in the south, marked as Platforms 1 and 2 within the stone enclosure, Fig. 3. These likely served as fixed observation decks for different types of celestial surveillance.

The southern observatory: to explore the function of the southern platform, we simulate observations on May 26 at approximately 8 PM, coinciding with the new moon and the beginning of a new month.

Asmerom writes that the sidereal position of the moon is evaluated by checking the RA position of the moon for eight consecutive nights (evenings) in conjunction with the *Urji Dhaha*. If conjunction doesn't occur on the expected night due to the 0.53-day lunar digression the name of the day is adjusted [1,6]. Legesse mentions the reappearance of Triangulum after not appearing for six months, and this is possible only if he was referring to the evening observation. This is when Triangulum's daytime appearance (not visible) was followed by its early morning (visible) appearance as discussed above. If an evening rising time is selected for observation, the critical Bita Qara would be around Bitotessa (March), as affirmed by Legesse and Bassi.

The simulation process: *Figure 4* shows the simulation process used to capture the beginning of new months from April through September via the southern platform at 8 PM. The method mirrors the technique applied to interpret the Nabta Playa stone circle. In fact, the reference stars - Triangulum, Pleiades, Orion, and Sirius - used at Nabta Playa to mark the inundation season also appear in the Cushitic/Oromo calendar [9]. This presents a striking cross-cultural parallel that warrants further study. In Nabta Playa, the position of Triangulum is tracked, and a new moon is marked when one of the three stellar objects appears on the horizon when Triangulum appears at the marked pillar. In Namoratunga, the position of each of the *Urji Dhaha* is tracked independently, Triangulum marking only the first month.

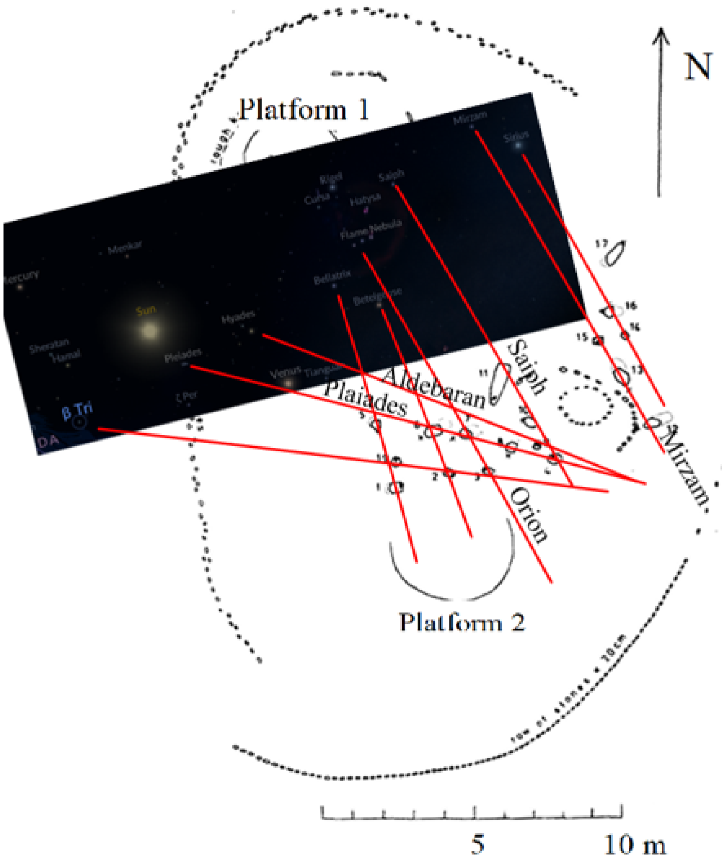

Figure 3: The configuration shows that 2 or more pillars forming a line point at one of the *Urji Dhaha*. February 2025, 5 AM. The position of the *Urji Dhaha* is copied from the simulated output of Redshift and superimposed on site map adopted from [3].

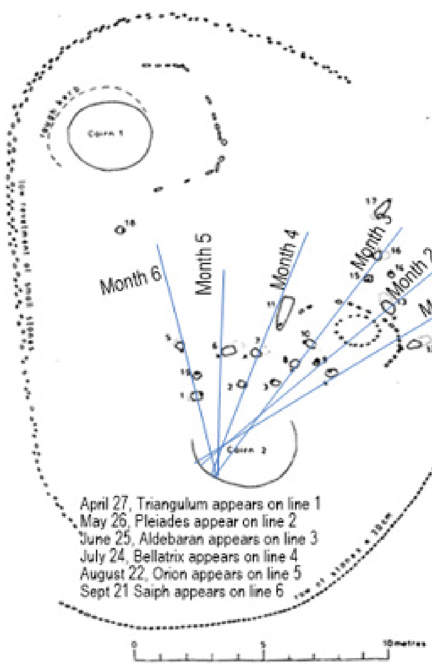

Figure 4: Capturing the beginning of new months (April through September) from the south deck around 8 PM, 2025; site map adopted from [3].

Using Redshift 9 Premium, the simulation follows these steps:

i. **Location and Timing:** Set the location to Yabelo, Ethiopia, where Ayyantus are still active. Observations are oriented northward. The simulation date is set to April 27, 2025 (new moon), and the time to 8 PM. At this hour, only Triangulum is visible in the northwest; the new moon appears around 6 PM.

ii. **Line Mapping:** Freeze the Redshift screen and draw a straight line from the "N" (north) marker to Triangulum. Paste this line onto the site map from Soper without rotation, aligning it with the southern platform. This line intersects pillar 4 (*Line 1* in Fig. 4).

iii. **Successive New Moons:** Repeat this process for each subsequent month as different *Urji Dhaha* become visible at 8 PM:

- Pleiades (May 26) → Line 2: crosses pillars 9 and 13
- Aldebaran (June 25) → Line 3
- Bellatrix (July 24) → Line 4
- Orion (August 22) → Line 5
- Saiph (September 21) → Line 6

Each of these lines confirms the arrival of a new month, marked by a new moon appearing in proximity to the respective star. The precision of these alignments, each formed by at least two pillars - demonstrates that the pillar configurations are intentional and functional, not random.

Legesse's mention of Triangulum's reappearance after six months supports this model. Observing it in the morning would place *Bita Qara* in September (*Bitotessa*), which is unlikely since most *Urji Dhaha* would then be invisible during the next six months [10]. This confirms the preference for evening observations using the southern platform. Simulation results show the southern platform aligns with *Urji Dhaha* stars only in the evening, while the northern platform aligns with them in the morning. Notably, only the southern platform is used to determine new months.

The northern observatory: Southward observations from the northern platform at approximately 6 AM during July and August, under full moon conditions (Fig. 5),also reveal precisely aligned pillars pointing to the *Urji Dhaha*. Each of the 19 pillars appears to serve a distinct purpose when viewed from either platform.

One notable observation is that pillars 5, 19, and 1 align perfectly with Mirzam - a star not commonly mentioned in Oromo calendar literature. The precision of this alignment is striking and suggests intentional inclusion of Mirzam in the original calendar system.

Importantly, every southward line, formed by the pillars, lands on one of the *Urji Dhaha*, and no unrelated stars are aligned. This level of accuracy is statistically improbable by chance and reinforces the hypothesis of a designed astronomical observatory.

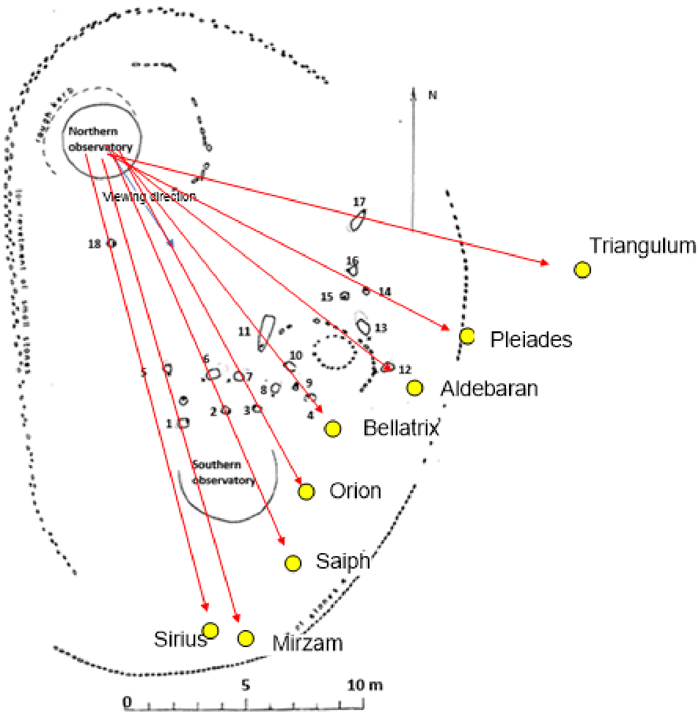

Figure 5: A view from the northern platform, July through August, 5 AM observation time; the position of the *Urji Dhaha* is copied from the simulated output of Redshift and superimposed on site map adopted from [3].

Figure 5 shows the apparent positions of the *Urji Dhaha* during morning visibility. Sirius appears east of Triangulum due to the apparent westward motion of stars - a result of earth's eastward rotation.

Some key observations:

I. The linear alignments of the basalt pillars with specific stars repeat monthly in sync with the new moon. The precision of these alignments, occurring consistently across millennia, cannot be attributed to randomness.

II. The correlations between new moons and pillar alignments demonstrate predictive calendrical planning - each month corresponds to a unique configuration of stars and pillars.

III. All new moons from April through September are accounted for with distinct pillar alignments. No visible *Urji Dhaha* is left without a corresponding line.

IV. No pillar within the stone circle is left unused. Mirzam, the new star within the *Urji Dhaha* may have been part of an earlier version of the calendar.

Conclusion

Namoratunga II comprises a deliberately constructed and multidimensional arrangement of basalt pillars, incorporating both northern and southern observation platforms. Each platform serves a distinct calendrical function: the southern platform facilitates evening observations for marking the new moon and beginning of months, while the northern platform is suited for morning observations, especially for identifying stellar RA coordinates.

Simulation analyses using Redshift 9 Premium have revealed clear and consistent alignments with the *Urji Dhaha*, confirming that the Oromo calendar is based on Right Ascension rather than declination. The observational precision embedded in the site, alignments that remain valid after 4,400 years, speaks to a high level of astronomical sophistication among ancient Cushitic societies.

The compelling evidence presented here strongly supports the conclusion that Namoratunga II served as an archaeoastronomical observatory. Its design remains functional even today, enabling Oromo *Ayyantu* to continue timekeeping traditions that originated millennia ago. This remarkable cultural and scientific continuity underscores the enduring legacy of Indigenous African knowledge systems.

Acknowledgment

None

Conflict of Interest

None

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