RESEARCH ARTICLE

The Guiding Sky: Funerary Orientations and Nomadic Movements in Somaliland during Antiquity

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Abstract: This paper presents an astronomical study of a sample of ancient cairns, stelae and burials at the cairnfield of Xiis (Heis) in Somaliland, a historic centre of long-distance trade between different cultures. The analyses reveal a set of significant orientations that the paper relates to the seasonal movements of the region's nomads, which are believed to have remained unchanged for millennia. The structures, which date from the first to the third century AD, are also contextualised within the broader astronomical traditions of the Somali and other Cushitic peoples, many aspects of which predate the arrival of Islam to the Horn of Africa and constitute some of the most distinctive and complex aspects of Somali culture.

Keywords: antiquity; archaeoastronomy; cairn; funerary archaeology; Horn of Africa; nomads; Somaliland

Introduction

The Red Sea, which connects the Mediterranean Sea and the Indian Ocean, has for centuries linked some of the world's most economically, culturally and politically active regions,

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and even today it remains crucial to global trade. During antiquity, its shores brought empires, city states, minor polities and a myriad of tribes and ethnicities into commercial relations that were expressed within a highly sophisticated trade system (Tomber 2008; Seland 2014). From the second century BC through to the third century AD, the various powers that struggled to control and benefit from its various trade routes included Egypt, Rome, Axum, Himyar and many others. In the process, the Red Sea became one of the most vibrant and dynamic regions in the world. However, although the mechanisms and historical processes that led to the development and expansion of this trade are generally understood, there are still significant gaps with respect to our knowledge of the indigenous communities that participated in this trade. These were often nomads who travelled to the shores of the Red Sea from their desert environments to exchange goods and commodities at coastal fairs (González-Ruibal *et al.* 2022).

This was the case with the populations who inhabited the coast of the Horn of Africa. Although evidence of long-distance trade during antiquity has been found at several coastal places (Chittick 1979), almost nothing is known of the cultural, social and political background of the local nomadic communities. This paper aims to shed some light on a specific aspect of their cultural parameters: the use of astronomical knowledge both as a tool to organise movements throughout the territory and/or as a cultural or religious expression. In particular, it provides an astronomical study of the cairnfield near the village of Xiis (also named Hais or Heis), which was one of the main trading posts in the area now known as Somaliland (Figure 1). It analyses, for the first time in the region, the orientations of a sample of cairns and excavated graves, which date from between the first and third century AD. Such orientations could have a religious or cultural meaning, particularly related to the seasonal movements of nomads, which are believed to have remained unchanged for millennia. Finally, we analyse to what extent this information connects with Somali astronomical traditions, which have strong pre-Islamic roots and have been poorly studied so far. The final objective of this paper is to offer insight into this specific aspect of the nomadic culture of Somaliland, contextualising it within the wider environmental framework of this region, which required – and still does require – a sophisticated mastery of the flow of seasons.

The Somali Skies and the Management of Time

Unfortunately, little is known about the beliefs of the nomads who inhabited Somaliland prior to their Islamisation. It is widely accepted that the Somalis shared many aspects of Cushitic religion (Lewis 1956), including a sky god whose name (Waaq) has survived in the Somali language as one of the names of Allah (Abdullahi 2001, 65). Other terms that recall pre-Islamic beliefs can be tracked in the Somali language, but none of them are related to funerary traditions, which since at least the fifteenth century AD have followed Muslim traditions. Some relevant information, however, can be gathered from the ethnographic accounts of travellers who encountered nearby non-Islamic groups prior to modernisation. In particular, the Afar to the east have been in close relation with the Somalis since the medieval period (Paulitschke 1896; Thesiger 1996), and details recorded by the British explorer Wilfred Thesiger in the 1930s about their funerary traditions (Thesiger

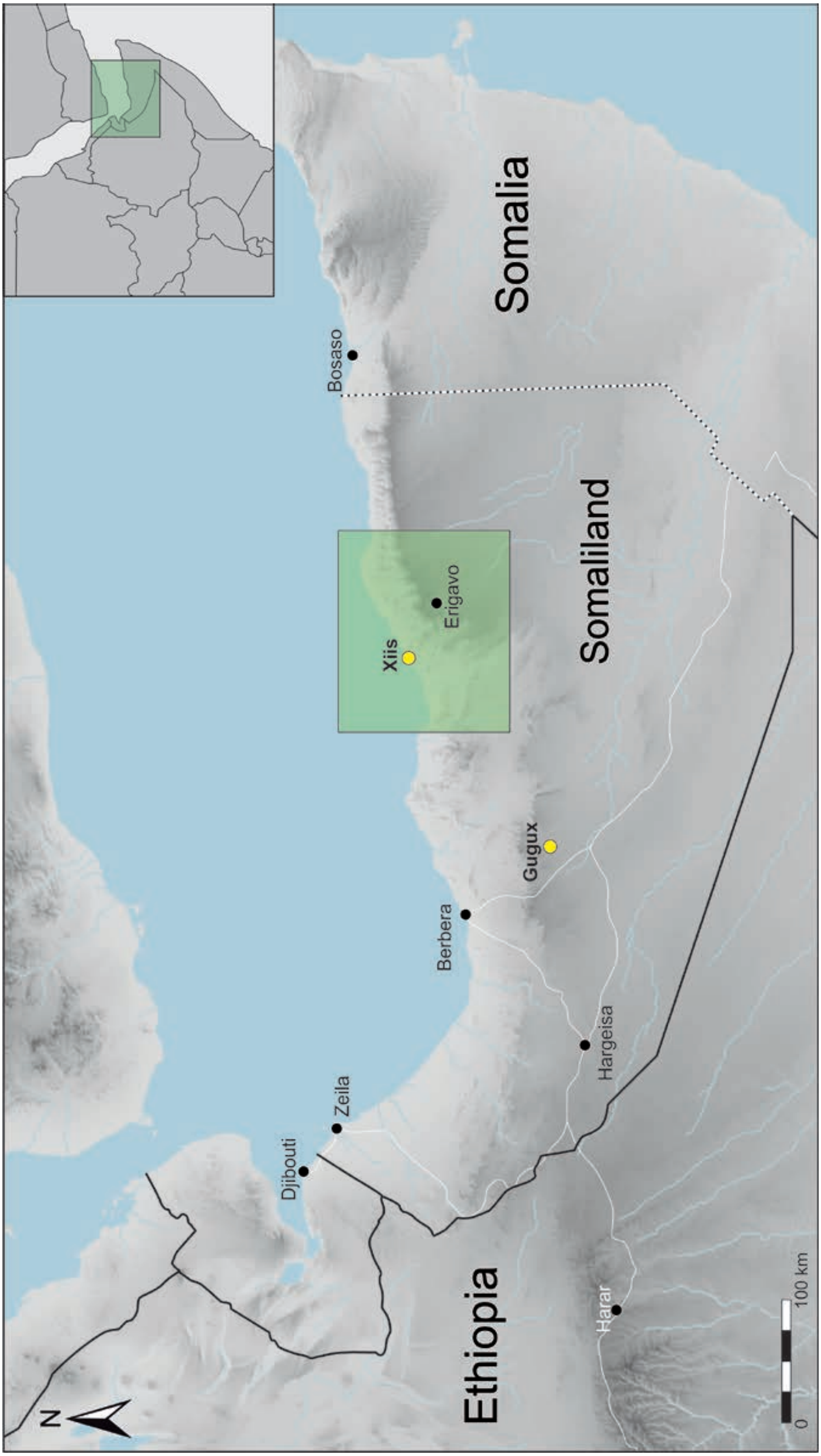

FIGURE 1. Location of the archaeological sites referred in the paper.

1996, 123–127) can be used to interpret elements of the funerary culture documented by archaeologists working in Somaliland, such as stelae or funerary banquets (González-Ruibal and Torres 2018). However, ethnographic accounts do not provide details about any preferences for a specific orientation for funerary structures or for bodies.

In this paper, we consider whether there might be evidence for orientations connected with the rising or setting of heavenly bodies and therefore, given the regularity of such events, connected with a social understanding of time (González-García and Belmonte 2019). We do not advocate any precise timing, whether in the case of solar, lunar or stellar events, but orientations could be related to appropriate times for performing certain activities (ritual or other).

Archaeoastronomical research in the area is almost completely absent. The only indication we have is a report by Mire (2020, fig. 6.2) on depictions of a possible Full Moon, crescents and a square with 28 holes on a rock-art station that she suggests might indicate a lunar calendar. Widening the scope, Lynch and Robbins (1978, 766) reported on a megalithic site, Namoratunga, in northern Kenya, with alignments towards stars that are still used by modern eastern Cushitic peoples to calculate the date. The site dates to 300 BC, and the authors suggested that a similar prehistoric calendar could have been in use elsewhere in eastern Africa.

Similarly, the Somali calendar and astronomical lore are also very poorly studied, although a few publications (Cerulli 1959; Hussein 2011; Galaal 2016) have assembled a significant amount of data concerning terminology and beliefs associated with astronomical events. However, there is not yet any comprehensive study of Somali astronomical knowledge and its use by nomad populations. It is, though, known that the Somali calendar combines solar cycles of seven days, weeks, years and cycles of years (Hussein 2011, 1–2) with a lunar-stellar calendar that pays special attention to the stations of the Moon and their relation to some stars and other celestial bodies (Galaal 2016, 33–52). The start of the lunar year was marked by the occultation by the Moon of the star Spica (α Vir), called *Dirir* (Cerulli 1959; see also Galaal 2016). However, although many aspects of the Somali calendar can be directly related to the southern Arabic lunar calendar (Snedegar 2000, 371), some instead indicate Cushitic cultural roots, including local myths about the movement of some key figures in the heavens, such as the sky-camel possibly associated to the Southern Cross and the Milky Way (Galaal 2016, 28–29). An underlying Cushitic prevalence is also visible in the existence of the *waadad*, a specialist who combines astronomical, astrological and religious and weather expertise and who plays a fundamental role in decisions related to the movements of nomads, the use of wells and the management of herds, and who in many cases acts as a judge in local disputes. Although the figure of the wadaad is currently associated with Muslim missionaries, it has a pre-Islamic origin (Abdullahi 2001, 65).

A significant part of Somali astronomical lore is related to the management of herds and the organisation of seasonal movement from the semi-desert coastal plains (Guban) to the plains in the interior of the Horn (Hawd), crossing the Ogo mountains. Unlike local religious beliefs, which were progressively and deeply transformed by Islam, the seasonal movements of nomads in the Horn of Africa are believed to have remained largely the same for millennia, reflecting the stability of the environment and climate. The survival of

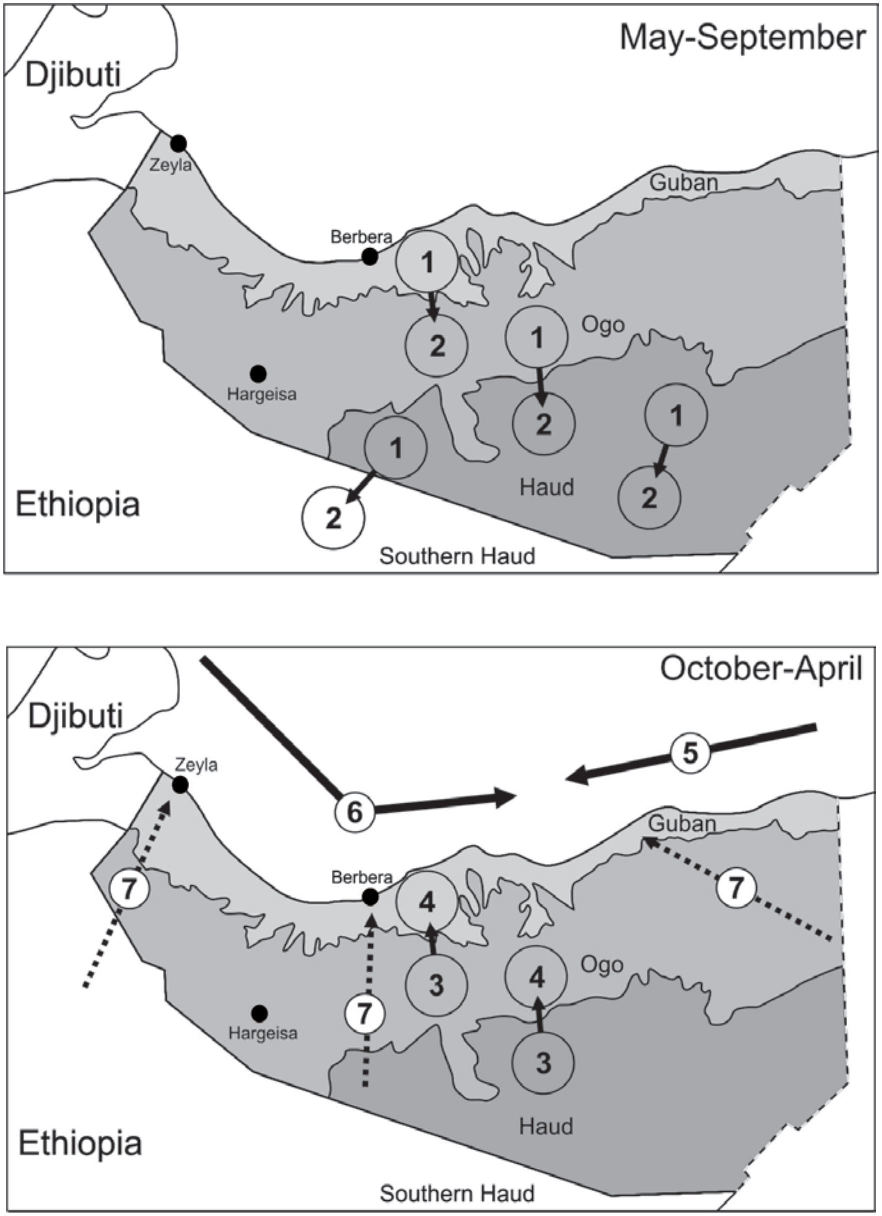

FIGURE 2. Maps of the seasonal displacements of nomads and merchants in Somaliland. May to September (top): *gu* (April–July) is characterised by heavy rain, mostly in the interior, and *hagaa* (July–October) features very dry, hot wind along the coast. A southwestern monsoon brings storms and strong winds; sailing is difficult and the coast is depopulated. October to April (bottom): *dayr* (October–December) is characterised by rain, mostly on the coast, and *jilaal* (December–April) consists of very dry, harsh conditions. A northeast monsoon means a generally steady wind. 1: groups move south to use the temporary grazing of the Haud and the Ogo (April–May); 2: groups combine grazing and watering as the pastures get progressively dry (June–September); 3: groups move progressively towards home-wells (October–November); 4: wintering at home-wells (December–April); 5: ships arriving from Asia (October–April); 6: ships arriving at Somaliland and leaving for Asia (May at the latest); 7: caravans arriving at the coast (September–April).

these nomadic communities depended on a complex plan that combined rainy and dry seasons, different ecological niches, permanent water sources and different tribal groups and types of animals (Figure 2). In this strategy, the ability to measure time and, to some extent, predict weather changes was more than a simple asset: it could be decisive for group survival.

This strategy is directly related to the annual cycle of rain distribution, which determines the places that can be inhabited at different times of the year. Somaliland has four seasons (Hornby 1907, 75): the main rainy reason of *gu*, which occurs around April and May; the dry season of *hagaa*, running from June/July to August/September; the autumn rains of *dayr* around September/October to December; and the harshest dry season of *jilaal* from January to April/May. The cycle starts with the *gu* rains of April, when groups wintering in the Ogo and northern Haud move to the south to take advantage of the new grazing which will shortly grow following these rains. At the same time, groups in the Guban move to the Ogo, filling the empty spaces left behind by the southern groups and benefitting from the comparatively cooler environment. After two or three months, the grazing areas start to dry as the hot season starts. The groups then start to move back north. This period of the hagga is potentially a conflictive one: if the rain has been scarce in the south, the groups will come back earlier and can find the northern groups still occupying the highlands. The pressure of these southern groups returning to their home-wells pushes the northern groups to the coast, at a moment in which the autumn rains start to fall (Lewis 1999, 41). By the end of the dayr season, most of the groups occupy their home-wells and prepare for jiilaal. At that moment, only the permanent wells still hold water; the Haud is deserted and depending on the total amount of rain during the year subsistence can be especially challenging (Lewis 1999, 41). With the arrival of the new rainy season in April the cycle recommences.

The seasonal movements that characterise life in Somaliland also have a profound effect on one of the key activities in the region since at least the first century AD: the caravan trade, which connected the Horn of Africa with Asia, the Middle East and the Mediterranean until well into the twentieth century. The trading season is set in the coast of Somaliland from October to April (Hornby 1907, 87), when the northeast monsoon allows easy access to the coast, and that is exactly the period in which the coastal population is concentrated in the coast to spend the winter.

The Cairnfield of Xiis

The coastal site of Xiis (see Figure 1, above) lies on the northeast side of the modern Republic of Somaliland, a *de facto* independent but unrecognised country that seceded from Somalia in 1991. It is located on a narrow strip of semi-desert that runs parallel to the coast, enclosed by the Golis Mountains to the south and lying at the feet of the long, steep Majilin Hill at the mouth of the El Usbale wadi, in front of a small island which has been a landmark for the merchants who have traded along the Somali coast since antiquity. Although Xiis is the most important cairnfield in the area (Figure 3), several other graveyards and isolated tumuli have been identified along the coast, especially to the east. So far, about 450 cairns and other tombs have been identified in just 11 km of coast, making this area one of the densest concentrations of cairns in all Somaliland.

FIGURE 3. View of main zone of the Xiis cairnfield.

Xiis was first identified as an archaeological site in 1881, when the French traveller Georges Révoil looked for shelter on the northern coast of Somalia during a storm. Stuck in the small village of Heis, Révoil found a group of ancient cairns in the surroundings, excavated three of them and donated materials he uncovered to the Musée d'Ethnographie du Trocadéro (later succeed by the Musée de l'Homme) in Paris (Révoil 1882). The study of these items (Stern 1987; Desanges *et al.* 1993; Pradines 1999) placed them in the first century AD. In 1975, the site was visited by the archaeologist Neville Chittick, who found Roman materials from the second to the fifth century AD and evidence of trade with Nubia and Persia (Chittick 1979, 1992). The site was soon identified with one of the coastal trading posts named in the *Periplus of the Erythrean Sea*, an anonymous Greek text of the first century BC which describes meeting points for trade along the Red Sea and the Indian Ocean. Xiis fits perfectly the description in the *Periplus* of the market town of Mundus, a place "where the ships lie at anchor more safely behind a projecting island close to the shore" (*Periplus* 9, trans. Schoff 1912, 25). This description, along with firmly dated archaeological materials, has made Xiis a recurrent site in the analysis of trade networks in antiquity (Chittick 1979; Horton 1996; Seland 2014). However, aside from the comprehensive study of Revoil's materials, there has been a near-absolute lack of information about the characteristics of the site; it was described simply as a huge cairnfield with no photographs or plans of the site ever published.

In 2018, the Spanish Archaeological Project in Somaliland conducted a preliminary survey and in the following year launched a full field campaign at the site, which included the survey and mapping of the whole area and an inventory of all the structures in the main cairnfield. In addition, four tombs of different types were excavated, in order to gather information about the funerary rituals and the physical characteristics of the nomad populations that occupied the region in the first centuries of the first millennium AD. After this comprehensive study of the site, Xiis was divided into six zones (Figure 4), of which four correspond to cairn concentrations. The funerary structures are distributed unevenly across the site: the majority (65%) are located in the plain around the main mouth of the El Usbale wadi (Zones A and F), with the other 12% located along a secondary mouth of this wadi immediately to the east. The rest of the tumuli are distributed along the shoreline on the slopes of Majilin Hill, with a small concentration at the head of the beach opposite the island. In addition to these funerary structures, some poorly preserved structures and archaeological materials have been found both at the island and on the northernmost summit of Majilin Hill, and a significant scattering of pottery has been found to the southeast of the site, close the base of the hill.

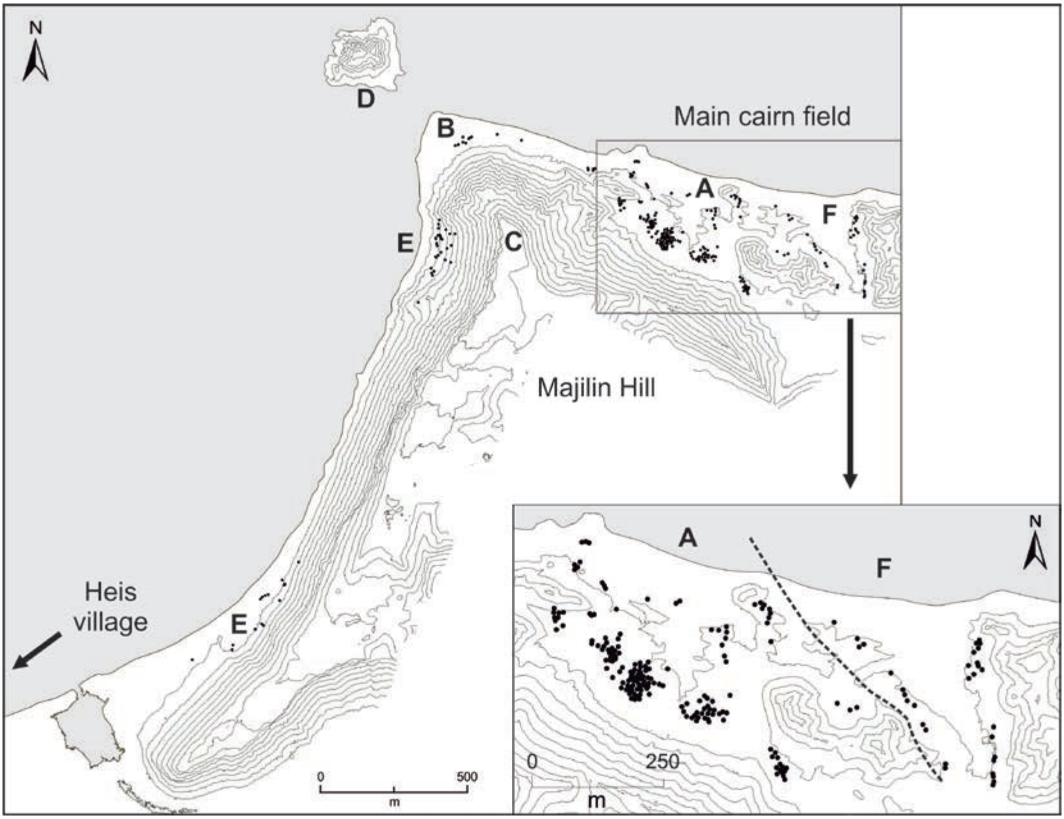

FIGURE 4. Plan of the Xiis cairnfield, noting the different zones (A–F).

The cataloguing process has inventoried 232 cairns and other structures in Zones A and F, with a further 63 in the other zones. Most of these are grouped in several clusters or distributed along the main branch of the wadi. The general impression is of a great uniformity, although a number of differences can be appreciated in terms of shapes and structural elements. Despite almost all the structures at Xiis undoubtedly being graves, not all of them are cairns in the strict sense of the word. Circular or slightly oval cairns represent the most common type of structures (78%); these are usually large, being 5–6 m in diameter × 2–3 m in height, although smaller cairns of about 2 m in diameter × 1–2 m in height are also common. There are slight variations in style and building techniques: some of the smaller ones (18 examples) present a pointed upper part, and approximately two thirds (130) of them have larger stones at their base. The second-most common kind of cairns are square (39, 18% of the total), being well built and with walls erected using flat stones roughly placed and with flat covers. Other types of tombs are far less abundant, consisting of simple stone rings of medium size, without any cover (only seven). Finally, at the central area of the site and close to the slope of Majilin Hill, a small number of poorly defined structures have been documented, most consisting of circles of stones which delimited tombs.

FIGURE 5. Circular cairn with two stelae.

The stones are piled without anything to hold them together, and in some cases different types of stones (slate, coral, volcanic black and brown) are mixed in the same cairn. Unlike other locations in Somaliland where stones of different colours are used to produce visual contrast and decorative patterns, in Xiis the presence of stones of different types and colours seems to be associated with their proximity to the cairn, without any clear pattern of use. Eight of the tumuli have small stelae standing near to the structures, a relatively common feature in Somaliland cairnfields close to large cairns. In the case of Xiis, the number of stelae range from two to 12, and significantly all but one (Figure 5) are related to square cairns. Their interpretation is unclear, although ethnographic parallels indicate they may have been a way to remember enemies defeated by the deceased (Thesiger 1996).

In addition to the surveys conducted in 2018 and 2019, during the 2019 season four tombs were excavated in different clusters of Zone A, corresponding to different types of tombs (Figure 6). Three of them corresponded to small cairns or stone rings and showed a remarkable variability of funerary practices ranging from wood platforms and layers of shells covering the body to simple depositions, in some cases with evidence of post-burial disturbances (Torres *et al.* 2019, 32–33). Grave goods were scarce and were only present in two of the tombs; the grave that yielded the most objects was completely disturbed and showed clear evidence of having been looted (Torres *et al.* 2019), the grave goods being severely fragmented.

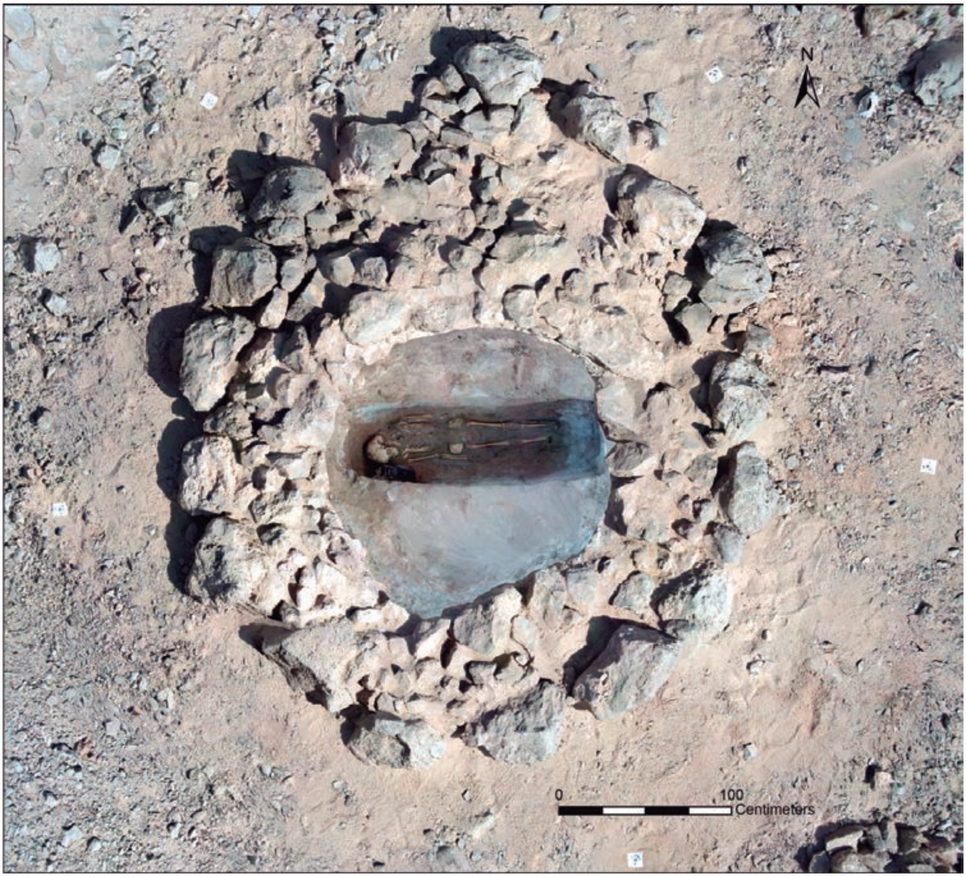

FIGURE 6. T120 after excavation.

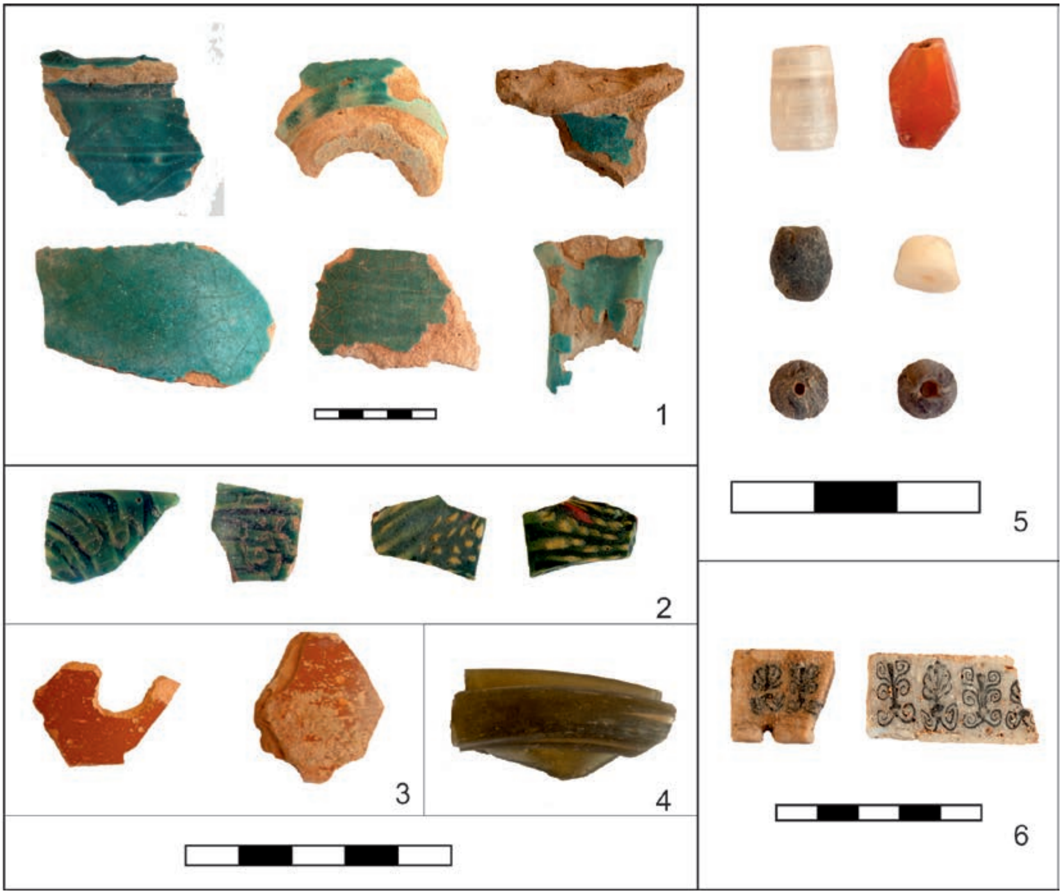

FIGURE 7. Materials found at Xiis. 1: Sassanid glazed pottery; 2: Milleifiori Roman glass; 3: Roman pottery (Terra Sigillata); 4: Roman rim of glass bowl; 5: stone beads; 6: glass inlays.

In general, the archaeological materials found during the surveys and the excavations (Figure 7) are very coherent and similar to those found by Révoil, and show a very consistent chronology between the first and third century AD, with a majority of objects belonging to the first century AD. The sample consists almost exclusively of imported materials from the Mediterranean, Middle East and southern Arabia, with a minority of artefacts from India. The most abundant type of pottery is Mesopotamian Glazed Ware, made in southern Iraq and very common in Red Sea sites from the Hellenistic to the early medieval period (Fernández *et al.* forthcoming). Mediterranean pottery is represented by Italian, Rhodian and Gaulish amphorae and Terra Sigillata, mostly from Italy but with some examples from the area of Antioch in Syria. Glass is also very abundant, usually related to tombs where it was deposited as an offering. Its provenance is Alexandria, one of the main exporters of glass during the first centuries AD, mostly to the Eastern Mediterranean and the Red Sea. The assemblage recovered in Xiis can be divided into three groups – monochrome and mosaic vessels, inlays and beads – and is dated between the first and third century AD, again with the earlier materials being far more common (Fernández *et al.* forthcoming).

The site of Xiis is representative of the characteristics and conditions under which trade was conducted in many areas of the Red Sea region during antiquity. The cairnfield would have been part of a larger site which would have included areas for temporary occupation either for nomads or merchants (such as the island and the summit of Majillin), and perhaps spaces for ritual and social activities (as suggested by the materials found at the feet of the hill; Fernández *et al.* forthcoming). The lack of permanent structures and the scarcity of domestic pottery and other objects relating to daily life support the idea of seasonal occupations, consistent with the seasonal system based on the monsoon winds, rains and the movements of nomad populations that characterised trade in Somaliland into the nineteenth century (González Ruibal and Torres 2018). However, leaving aside their nomadism, we know almost nothing about the social organisation, the identity and beliefs of these communities – a world which is as yet unexplored and to which the astronomical analysis presented in this paper represents a first approach.

Methodology

The location and orientation data presented below (see Table 2, below) was obtained through an analysis of the archaeological survey and excavation work carried out by the Spanish Archaeological Project in Somaliland between February and March 2019. We have employed general field orthophotos taken with drones, as well as several individual orthophotos for some of the mounds. For the archaeoastronomical analysis, we have also used the drawings generated by the excavation team and the documentation photos. These have been especially useful in identifying the stelae in the zenithal images. The orthophotos were previously georeferenced with UTM coordinates using a GPS, and properly oriented towards geographic north. Two general orthophotography images were made with a DJI Phantom 3 Pro drone and a gimbal-stabilised 2.7K camera with a maximum resolution of 12 megapixels. The overlapping area of the photographs was 60% and two rounds of photographs were taken. The two final images of the main cairnfield were taken at heights of 150 m and 80 m, with resolutions respectively of 8.49 cm/pixel and 2.65 cm/pixel. The DJI Phantom 3 Pro drone uses the GPS and GLONASS satellite constellations and the orthophotos were processed with Agisoft Metashape (2020) and oriented to geographic north using the WGS84 coordinates system (EPSG 4326) through the use of local on-ground topographic and GPS control points.

First, we selected the mounds that would constitute the sample to be analysed (Table 1). As indicated above, the majority of the tumuli have a round or oval shape. However, at this stage, and without excavating the structures to see if there is pit or grave present, it is difficult to identify a privileged direction for these mounds. As such, we focused on the square structures, selecting tumuli that could be measured through orthophotos and planes and those that present stelae. Out of our sample of 20 square tumuli there were six (T38, T57, T126, T163, T177 and T187) that together included 29 stelae in varying numbers. Along with these we included the four excavated tumuli (T49, T75, T120 and T153), which presented a privileged direction through their elongated shape, and/or due to the direction of the body deposited within.

TABLE 1. Summary of the characteristics of the tumuli included in the sample.

Tomb	Square/rectangular	Stelae	Excavated	Orthophoto	Dimensions (W–E/N–S axes)
T38	Yes	Yes		Yes	9.542 × 9.535 m
T49			Yes	Yes	5.289 × 4.922 m
T57	Yes	Yes			6.827 × 7.437 m
T75			Yes	Yes	2.309 × 2.280 m
T109	Yes				9.541 × 4.335 m
T120			Yes	Yes	4.038 × 3.907 m
T126	Yes	Yes			8.788 × 7.417 m
T153			Yes	Yes	7.344 × 6.708 m
T158	Yes			Yes	8.523 × 9.013 m
T162	Yes				8.449 × 8.551 m
T163	Yes	Yes			7.828 × 7.352 m
T175	Yes				9.792 × 10.137 m
T176	Yes				8.934 × 6.939 m
T177	Yes	Yes			9.836 × 9.807 m
T179	Yes				9.778 × 9.465 m
T180	Yes				7.265 × 7.452 m
T181	Yes				5.932 × 4.208 m
T182	Yes				4.345 × 4.071 m
T187	Yes	Yes			6.345 × 6.208 m
T191	Yes				5.845 × 5.741 m
T196	Yes				6.537 × 6.657 m
T197	Yes				4.823 × 4.365 m
T199	Yes				2.897 × 3.478 m
T201	Yes	Yes			3.851 × 3.478 m

The sample size is admittedly low at 24 tumuli, ~10% of the total number of the mounds in Zones A and F. Our 20 measured square tumuli amounted to 51% of all the square tumuli; they were chosen because the others were in too poor condition to derive reliable data from measurement. Including the stelae, this sample provides 53 data points. Initially, we performed independent analyses for the different types of structures. As is shown below, the stelae data allowed us to identify a privileged direction. From this, we were able to aggregate sufficient data to provide enough statistical signal for our analysis.

Square tumuli might not be representative of the whole population. We are also aware that until the excavation process advances, we cannot be certain if the differences in style reflect differences in content, period or social status. As such, the approach followed here must be seen as a preliminary one. However, the tumuli with stelae and the excavated tumuli (which are round) may provide a way to verify if orientations differ between different types. On the other hand, the distribution of the measured tumuli does not cluster at particular areas; on the contrary, they appear rather evenly distributed along the site, indicating that there is no spatial segregation in types within the area of research. We should add that the chronology of the material recovered in the survey done at the site indicates a rather narrow range of dates. Aside from the shapes of the tumuli, we do not see any distinguishing features between the spatial characteristics nor among the surface material that would make it possible to separate them into typologies. At this moment, and given the above considerations and possible caveats, we consider this a zero-order approximation to our problem.

The mean size of the mounds is 6.86 m, based on the diameter of the four circular cairns or the length of the 20 square structures. With the lowest resolution in our images being 8.49 cm/pixel, this means that we have a mean resolution of 0.7° to 1° in azimuth. We estimate this to be good enough for our general purposes

For mounds T38, T49, T75, T120, T153 and T158 we have individual orthophotos, as well as images overlaying archaeological drawings of the distribution of the rocks in the structure on the original photo (Figure 8). The resolution of these images is between 1 and 1.35 cm/pixel in the case of tumuli T38 and T158, and 0.5 cm/pixel for three excavated cairns (T49, T75 and T120) For the rest of tumuli in the sample, we identified their shape from the general orthophoto.

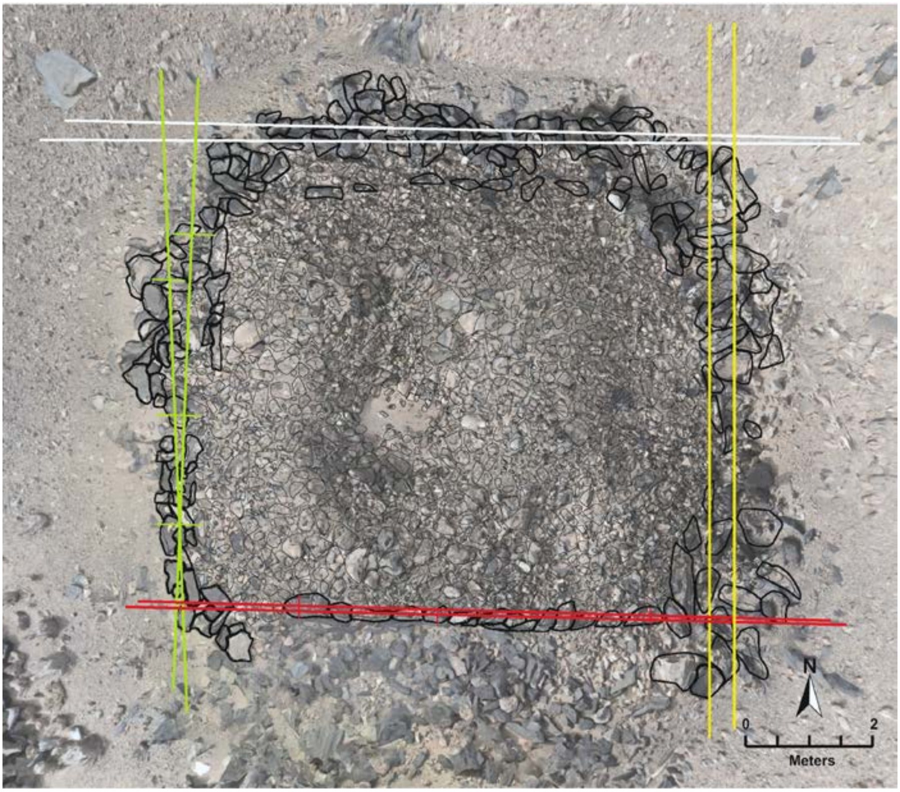

FIGURE 8. Orthophoto of T38. The boundary stones of the square tumuli, originally placed in straight sections, have undergone a process of decay. To obtain the orientation of each side we have identified the inner and outer edges. We then drew lines nearly perpendicular the edges of two sides, indicated as short light strokes for the green and red sections. The edges for each side were then drawn to pass though the centre of two of these short lines. In this way, each pair of colour lines is an attempt to establish the straight sections at either end of the line of boundary stones.

As shown in Figure 8, we took eight measurements on each square tumulus in the sample. For each straight section we defined the inner and outer edges. Each of these lines provides a slightly different value for each of the four sides. The values for the orientation along the four directions of the square are the mean of these eight directions reduced towards one of them; if for example we have values of 4°, 95°, 183° and 274°, we put them all in the same direction by adding 90° or subtracting 90° or 180° to generate 94°, 95°, 93° and 94°. We then calculated the mean over the eight values so obtained, and then provided the corresponding perpendicular values. However, this does not imply that straight sections allow one to draw and project lines along the sides that intersect at a particular point that can be identified as a "corner": corner identification is difficult if not impossible in most cases. For the mounds with stelae, we also measured the orientation from the centre of the mound towards the central position of each stelae. The centre was identified by tracing between four and eight diameters and verifying the closest point to the most common intersection among them. Finally, for the excavated mounds, we measured the orientation of the body and/or pit (for T153 only the pit) from both ends. Each piece of data is here explored separately first, to see if they are distinct or whether common patterns can be discerned that may help us in extracting appropriate inferences.

The values obtained are the orientations or azimuths corresponding to each mound. These values, due to the data collection process itself from images already referenced to true geographic north, do not require further calibration. We can estimate an average error for our measurements of approximately 1.5° as the root mean square of the image accuracy indicated above, the standard deviation of the measurements at each site and the minimum value measurable with the digital tools employed to obtain the angles in each case. Such indeterminacy can be translated, in the case of comparing orientations with sunrises at the latitude of Xiis, into an error of ±2 days near the equinox, while it would be closer to 9 to 10 days for the solstices.

With the location for each of the measured mounds, we obtained the value of the altitude of the horizon for the corresponding azimuths using HeyWhatsThat (Kosowsky 2020). This platform uses SRTM data to generate a DTM and, from the coordinates of a given point, produce a visible horizon profile. The SMRT images for Xiis have good enough resolution to identify each individual tumulus in our sample and to be able to derive the altitude of the horizon on the corresponding azimuths. Given the characteristics of the DTM, the horizon profile will be good for the case of horizons farther than 2–3 km, while for closer horizons the resolution worsens (see Reijs 2015 for an assessment of different procedures to obtain horizon profile data and their reliability). Given the latitude of Xiis, the rising and setting angles are very close to perpendicular, minimising the effects of such poor resolution in the worst cases (a difference of 1° in altitude for the same azimuth at this latitude translates into a difference of 0.27° in declination).

Finally, with the azimuth, altitude of the horizon and the latitude of each mound, we calculated the astronomical declination with the formula

$$\sin \delta = \sin h \sin \varphi + \mathrm{con}\, h \cos \varphi \cos A,$$

where A is the measured azimuth, h the altitude of the horizon corrected by refraction (see below), φ the latitude of the site and δ the calculated declination. Such quantity allows a direct comparison of the orientation data to the rising and setting of heavenly bodies at particular moments at the time of use of the mounds. Finally, to obtain the declination we considered the semi-empirical atmospheric refraction correction by Schaefer (1993).

As one of our analysis tools we employed a curvigram showing the relative frequencies of the different values of declination. This meant that each piece of declination data was considered as an Epanechnikov kernel and summed up to produce a final "probability density function". The bandwidth for each piece of declination data has been considered as twice the uncertainty in declination given above. As reference lines, the vertical dashed lines in Figures 10 and 11 below correspond to the boundary points of the lunar range, and the vertical continuous lines represent the limit points of the solar range, approximately –24° and 24°. In addition, we include a dotted line representing the value of the equinox, 0°.

To determine the statistical significance of the accumulations that may appear, and ultimately to establish their intentionality or not, we carried out a test similar to those introduced by González-García and Sprajc (2016; see also Silva and González-García 2018; Silva 2020; González-García *et al.* 2022). This involved running a Monte Carlo simulation where out of 86,000 evenly distributed points in the horizon, we selected 100 distributions with the same number of orientations as in our sample in order to check whether the distribution of our data also meets random criteria or, conversely, is the result of a specific intentionality. With the 100 simulations we were able to assess to a statistical *p*-value below the 0.05 customarily set as a threshold in the humanities for significance (Fisher 1926).

For this assessment, another curvigram was calculated by subtracting the mean (f(unif)) from the observed distribution (f(obs)) and dividing the result by the standard deviation of the random samples. Concentrations above a value of 3 in the *y*-axis were deemed incompatible with a random sample at the 99% confidence level. However, while Silva (2020) employs a *p*-value approach to assess intentionality, we used the approach of González-García *et al.* (2022 and references therein) with a *z*-score to assess such.

Finally, to compare the results to the heliacal rising of stars at the epoch of use and for the given latitude of the sites discussed in the text, we used bespoke code that follows Schaefer (1985). The results were cross-checked with the commercial software Planetary, Lunar and Stellar Visibility by Alcyone Software (2021).

Results

The results are presented in Table 2. This includes the identification of the structures measured, the values of azimuth and altitude of the horizon measured and the declination. Figure 9 presents four orientation charts of the data. On the outside are represented the four cardinal points, along with the sunrise and sunset points in the summer solstice (SS) and the winter solstice (WS), while inside each chart the astronomical orientations obtained on the mounds of Xiis are represented. Continuous lines represent the declinations of the measured points of each mound (in this case, of the four vertices of those sample mounds that are quadrangular). The dashed lines correspond to the orientations associated with the stelae. Finally, the dotted lines correspond to the orientation of the body axis of those structures that were excavated and in which human remains and/or a burial pit were found.

TABLE 2. Summary of measurements from Xiis. The columns include the identification of the item, the azimuth (A), the horizon altitude (h) and the astronomical declination (δ). For the square tumuli, only the eastern orientation is given here. The other sides would be obtained by adding 90°, 180° and 270° respectively; for the body/pit the complementary orientation would be obtained by adding 180°).

	A(°)	**h(°)**	**δ(°)**
Tumulus			
T38	91.9	1.9	−1.5
T49	88.5	1.8	1.8
T57	117.1	3.5	−25.8
T75	91.0	2.0	−0.6
T109	44.6	−0.14	44.3
T120	89.2	2.8	1.3
T126	84.0	1.4	6.2
T153	84.0	2.9	6.4
T158	90.5	1.9	−0.1
T162	74.1	1.1	15.8
T163	51.6	−0.09	37.5
T175	68.1	2.5	21.9
T176	101.0	7.8	−9.2
T177	90.1	5.6	0.9
T179	60.0	4.0	30.2
T180	80.2	6.7	10.8
T181	85.6	8.5	5.9
T182	63.6	8.4	27.3
T187	65.5	4.7	24.9
T191	46.4	4.5	46.6
T196	37.5	0.35	51.3
T197	52.7	9.1	38.1
T199	91.6	5.4	−0.6
T201	80.5	5.4	10.3
Stelae and tumulus			
A T38	47	−0.1	42.0
B T38	105	3.1	−14.1
C T38	134	8.4	−40.3
A T57	99	2.6	−8.3
B T57	131	5.8	−38.5
A T126	51	−0.11	38.1

	A(º)	h(º)	δ(º)
B T126	57	–0.09	32.3
C T126	61	–0.02	28.4
D T126	74	1.1	15.9
E T126	78	1.1	12.0
F T126	86	1.5	4.2
G T126	92	2.4	–1.5
H T126	110	3.5	–18.9
A T163	59	–0.04	30.4
B T163	57	–0.09	32.3
C T163	61	0.00	28.4
D T163	70	1.15	19.9
E T163	88	2.0	2.3
F T163	89	2.0	1.4
G T163	96	3.0	–5.3
H T163	108	4.0	–16.8
I T163	105	4.0	–13.9
J T163	113	4.0	–21.7
A T177	80	3.6	10.5
B T177	97	5.6	–5.8
A T187	79	4.7	11.7
B T187	84	4.7	6.8
C T187	94	8.5	–2.3
D T187	100	8.5	–8.1
Body/pit			
T49	185	17.9	–60.8
T75	177	16.0	–62.9
T120	89.2	2.8	1.3
T153	169	17.5	–59.6

All dashed lines representing stelae are concentrated in the eastern sector of the charts. Seventy percent of them fall within the solar range (i.e., within the sunrise marks in SS and WS as calculated for the time of use), and this rises to 75% of the lunar range. For the eastern side of the square mounds these numbers correspond to 63% and 75% respectively. Figure 9d presents a correspondence between the distribution of the orientations of the mounds and the stelae, even when we talk about mounds that do not have associated stelae. According to the result of a t-test on the orientation of these two groups with SPSS (2019), we cannot exclude that the stelae and the eastern side of the square tumulus follow a similar distribution (p-value = 0.813). However, this alone does not mean that the two distributions are equivalent; to check, it is necessary further to run an equivalence test (see e.g. Lakens *et al*. 2018), and when we did so we found that the 90% confidence intervals were within the equivalence bounds of one standard devia-

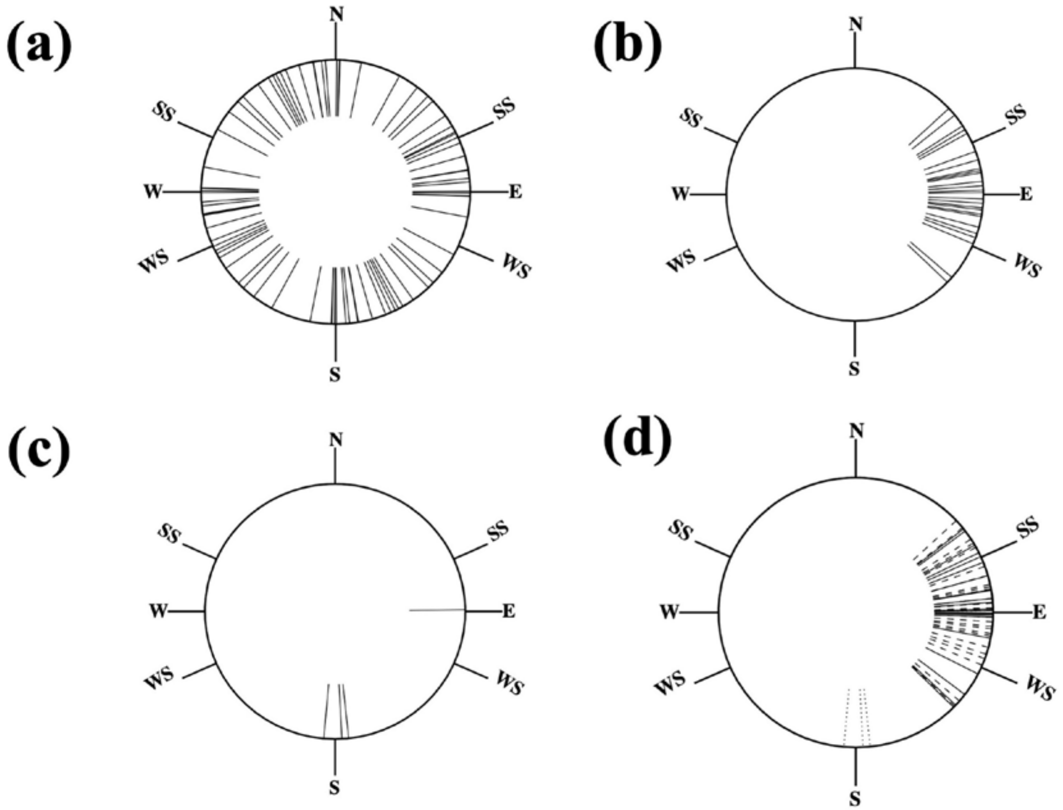

FIGURE 9. Orientation charts for the orientations of (a) the square mounds, (b), stelae and (c) bodies and/or pits in the sample from Xiis. The mounds include all data points measured, meaning that for the square tumuli four measurements for each one are included. The bottom right chart (d) includes data for only the eastern side of the mounds in solid lines, for the stelae with dashed lined and for the bodies and pits with dotted lines.

tion. Under these criteria the two samples are statistically equivalent and not statistically different. Therefore, in the following, we focus our analysis of the orientation data for the square tumuli towards an eastern direction.

In this case, the orientations seem to accumulate in a specific sector of the chart, three out of four being inside the luni-solar limits. However, the lines corresponding to the bodies and/or pits are oriented on a north–south axis, lying in a supine position with the arms lying along the body. Of the three excavated tombs, at T49 the skeleton's head was oriented to the southwest, at T49 the head was oriented to the northwest and at T120 the head pointed west. In this sense, it is interesting to note that the bodies are oriented perpendicular to the direction indicated by the stelae, thus reinforcing the cardinal directions.

Figure 10 presents the curvigram for the declination towards east of our sample. Two large accumulations can be seen in this graph: first, the larger concentration corresponds

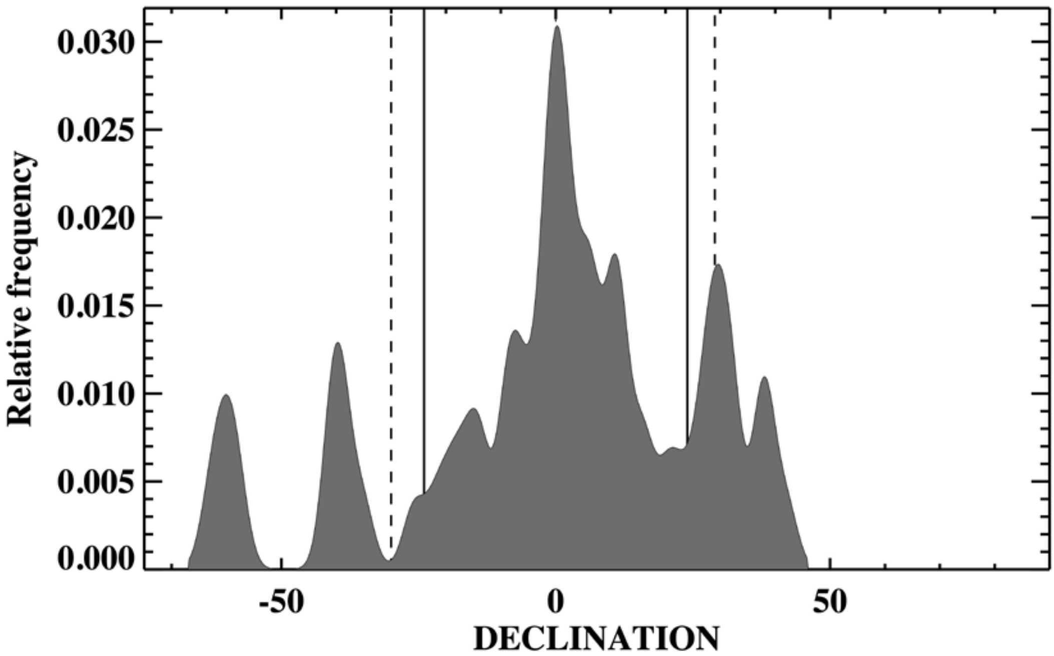

FIGURE 10. Curvigram for the orientations of the tumuli of Xiis. The vertical solid lines indicate the solstices and the vertical dashed lines the lunar extremes.

to declinations with values close to 0° – that is, with values close to the equinox on a broad sense. A secondary concentration might appear attached to this one at nearly 11°. The second accumulation occurs around 29°, meaning around the maximum value of the lunar range to the north.

Figure 11a is the curvigram of our data (in cyan). The different black curves are the 100 distributions randomly obtained. From these random realisations, we calculated the values of the mean and the standard deviation (σ) for each declination, allowing us to exclude the randomness or not (to a given level) of the series of accumulations that we can observe in our measured distribution. These are indicated in the figure as the solid white and dotted white lines.

In Figure 11b we find three peaks above such value of 3-σ for declinations of 0.6°, 28.9° and 11.9° (±2.5° as the full-width half-maximum). For the sake of comparison, the first value is compatible, given the uncertainties in our sample, with the sunrises on the equinoxes. It could also be compatible with some bright stars (notably Spica) as well as perhaps the Moon at some instances. However, the spring Full Moon, for instance as defined by Da Silva (2004), peaks at −3° and would be out of, or very marginally consistent with, this range. This is the largest peak. The second value is very close to the major lunar standstill. Finally, the last value would be compatible with sunrise on the day of passing through the zenith for the latitude of Xiis.

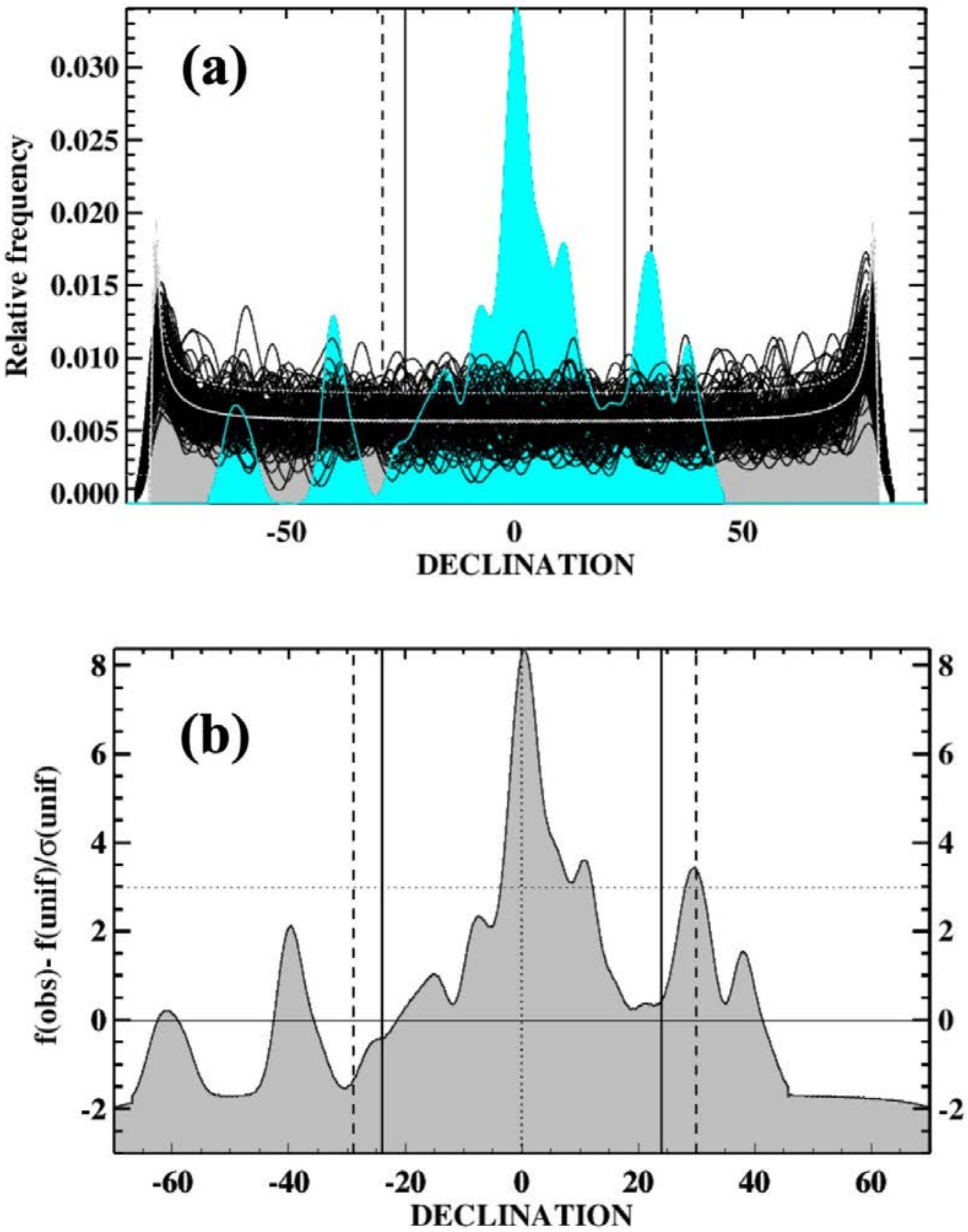

FIGURE 11. (a) Stochastic analysis to compare 100 random distributions (black solid curves) with the distribution of the Xiis sample (cyan). The white lines show the mean value of the 100 random curves and the standard deviation (dotted white line). Vertical lines are those that appear in Figure 10. (b) Z-value curvigram of our measured data. The curvigram is calculated by subtracting the mean (f(unif)) from the observed distribution (f(obs)), divided by the standard deviation of the random samples. Those concentrations above a value of the in the *y*-axis can be deemed incompatible with a random sample at the 99% confidence level.

Discussion: Tracing the Astronomical Lore of the Somali Nomads

Although the sample studied in Xiis is admittedly small, and the results preliminary, they nevertheless present concentrations in the orientations that may have cultural significance. Indeed, not all of the orientations of our measurements are included in these three peaks (although they amount to roughly 63% of the data), but we address these data first. We thus argue that the statistical accumulations presented above could be the result of intentional decisions based on a set of cultural practices, possibly religious, which are especially remarked in funerary contexts. The purposeful orientation of cairns, stelae and bodies likely reflected important aspects of the afterlife beliefs of the nomadic populations of the pre-Islamic Horn of Africa. However, the interpretation of these patterns detected in our analyses is complex, due to two factors: the lack of other similar excavated sites in the Horn of Africa's coast with a similar chronology; and the fragmentary nature of information about the characteristics of the pre-Islamic religion of the nomads in the territory currently inhabited by the Somali people. The only other site with a similar chronology to that of Xiis is Ras Hafun, a peninsula on the northeast coast of Somalia where Neville Chittick documented two archaeological sites in the mid-1970s (Chittick 1976). Although several cairns were found during the fieldwork (Chittick 1976, 122), no plans were ever published and therefore we have very little information about their characteristics and orientation.

This is similarly the case as regards our knowledge of the religion of this part of the Horn of Africa before the arrival of Islam and its impact on funerary beliefs, as indicated in the introduction. Therefore, the ritual significance of the accumulations detected in Xiis remains, for the moment, unknown. There is, however, another hypothesis, through which the data gathered at Xiis can be interpreted in the light of our knowledge of Somali nomadic traditions and lifestyle. This relates in particular to the seasonal movements explained above. These are especially important for our interpretation of Xiis structures: although we cannot directly translate recent movement into that of antiquity, the monsoon regime and the strict environmental conditions of Somaliland provide a quite stable – and suggestive – framework in which Xiis would have been occupied between October and April, and was therefore more obviously the time of year when the funerary structures would have been erected.

Figure 12 relates the seasons in Somaliland with the nomadic movements throughout the territory described above and the astronomical events documented at Xiis. Assuming some level of uncertainty due to annual variations, there is a suggestive relation between the dates of the astronomical events detected in our analysis and the periods when Xiis was actively occupied. That association is especially evident with the equinoxes, being a solar event or a stellar-related one (see below).

We must include here a cautionary note. The concentration we have found is clearly centred on nearly 0° of declination. It is certainly possible that the ancient Somali calendar had a luni-solar or luni-stellar character as we have, or purely lunar as in other calendars known in neighbouring regions as the Mursi or Borana calendars (Ruggles 2015). Indeed, there are cases where a lunar phase close to the equinox indicated the start of a relevant month (like the start of the year in Mesopotamia, for instance). If the tumuli were oriented

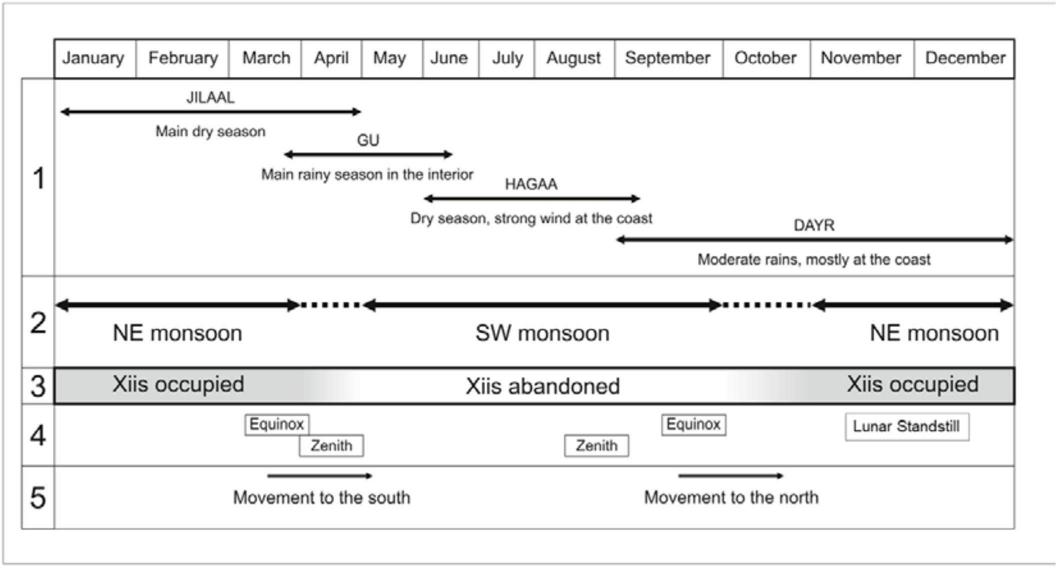

FIGURE 12. Summaries of (1) seasons, (2) monsoon winds, (3) potential period of occupation of Xiis according to ethnographic data, (4) astronomical events documented in Xiis (note that "equinox" includes several possibilities, including lunar and stellar ones; see text) and (5) main nomadic movements.

towards a particular lunar phase (the Full Moon, for instance) locked to a solar or stellar event (like the first Full Moon after spring or autumn equinox, or the third Full Moon after the solstice, or the occultation of a given star), this would result in a characteristic distribution with a singular maximum and a rather broad spread. This maximum would be in all cases close to, but not centred upon, 0° of declination. This fact seems to suggest that the Full Moon is not the likely target for this particular concentration. An alternative possibility would be the Sun or the heliacal rising of a particular star. Given the peak of this maximum the only star coincident with such a declination for the epoch of construction would be Spica, which as we have seen above is very important for present-day nomads and for Somali culture in general. The heliacal rising of this star for the epoch of tomb construction would be the end of September or beginning of October, while the acronychal rising would happen at the beginning of March. It might also be significant that the lunar conjunction with Spica happened around mid- to the end of April. Of course, a final possibility would be the equinox itself.

For the concentration at nearly 10°, the Moon again appears as a less likely possibility in this case, while the first visibility of Aldebaran (declination 10°15' by the first century AD) would be by the end of May and the acronychal rising by the end of October.

The spring equinox (however defined; see e.g. Ruggles 1997; Belmonte 2021), the acronychal rising of Spica or even the lunar conjunction with this star roughly coincide with the moment when the nomads would have been leaving Xiis in advance of the rains that would shortly fall to the south: in order to maximize their stay in the grazing areas, they would have had to leave before the rains started. The autumn equinox and the helical rising of Spica would coincide with the opposite movement: the period when nomads would have arrived at Xiis to winter and to prepare the area for the trading season.

For the second maximum, the relationship is not so clear with the sunrise on the day of zenithal passage for the latitude of Xiis: of the two possible dates (mid-April and end of August), the second can almost certainly be disregarded, as at that moment the site was most certainly abandoned. The same can be said of the first visibility of Aldebaran in late May. Finally, the broad concentration that peaks at the major lunar standstill fits well with the moment when Xiis would have been inhabited. Provided the importance of the Full Moon, the southernmost rising of the winter Full Moons along the years, defined as the Full Moon before and after winter solstice, would coincide with this standstill.

It is notable that two of these concentrations would have had a parallel on the other side of the Red Sea during the same period. In a pioneer paper on the subject, Belmonte (2005) explains that temples in Yemen show concentrations at declinations 0° and 29°, very similar to those we find for our cairnfield.

This suggestive hypothesis –that the orientations of the funerary structures of Xiis could be related to the movements of nomads – requires a wider and more comprehensive study of funerary structures throughout Somaliland. At this time, the only other site where this type of information has been gathered is Guguh (also called Gugux; Figure 13), a cairnfield in an inland mountainous region in central Somaliland. This cairnfield is located on the top of a low hill in the middle of a valley which acted as a corridor for nomads in their displacements, connecting the important medieval towns of Berbera and Fardowsa with the Hawd. In 2020, 61 tumuli were documented here by the Spanish Archaeological project in Somaliland. They are organised along a north–south axis, mostly on the top of the hill with several of them on the slopes.

The chronology of the Guguh cairnfield is unknown, but there is some evidence that it could be pre-Islamic: two small fragments of glass and pottery were found during the survey, none of the cairns had stelae on top (as often happens with Islamic tumuli) and two small nomadic mosques had been built, removing part of the flat disc of one of the main cairns in the site and indicating that the burials had lost their meaning during the arrival of Islam. In addition, the cairnfield is very close to the burial place of Sheikh Loobogey, a pilgrimage place which has grown around a well and the tomb of the sheikh, and which includes a mosque and a large Muslim cemetery. This nearby (*c.* 800 m distant) but differentiated cemetery indicates that although the Guguh area had a strong symbolism for the communities living in the region, in the Islamic period the focal place of cult had moved from the cairnfield to Sheikh Loobogey. Although none of this evidence is conclusive, put together it reinforces the idea of Guguh as a pre-Islamic or non-Islamic graveyard, with an unknown chronology which should not go beyond the fourteenth century AD.

Most of the structures were circular cairns or stone ring structures, and therefore no relevant orientations could be taken, but three rectangular structures and one cairn with three stelae provided orientations that could be measured (Figure 14). We have performed the same kind of analysis as described for the site of Xiis, and again we focused on the eastern side here for the sake of comparison. The stelae seem to be placed

FIGURE 13. Orthophoto of Guguh showing (1) rectangular structure, (2) circular cairn with perpendicular stelae and (3) late mosques.

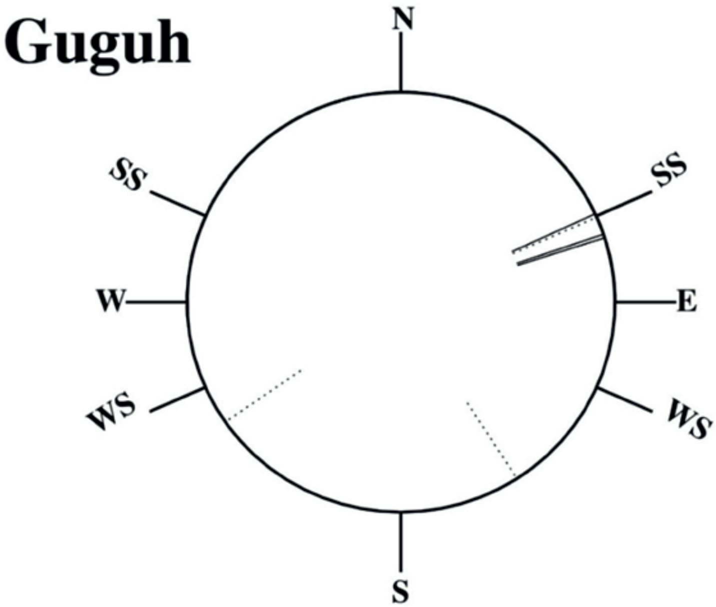

FIGURE 14. Orientation chart for the orientations of the sample chosen for the Guguh site. The solid lines indicate the eastern side of the three square tumuli, the dotted lines the directions indicated by the three stelae in one round tumulus. Note that these lines are nearly perpendicular, and the one towards the eastern part coincides with the orientation of the square tumuli.

nearly perpendicular alongside each other. Further, they seem to appear close to the perpendicular directions of the square tumuli. The most frequent orientation is towards *c.* 72°. This orientation would correspond to sunrise in mid-May or the beginning of August. Such dates would correspond to one month difference with the zenith passage described in Xiis. However, a number of tumuli instead have orientations close to declination 18°. This does not appear to be related to any specific solar or lunar event (although it could be marginally consistent with the minor lunar standstill), but it would correspond to the rising of Regulus (α Leonis) and the Pleiades. The heliacal rising for these asterisms for the pre-Islamic era (assumed here from the first century AD to 1400 AD) would be from early to late August (Regulus) and from early to late May (Pleiades), which would coincide with those mentioned earlier. The Pleiades – *Lixo* to the Somali, who only recognise six stars in the constellation – are important in the astronomical lore of the Somali, especially with respect to the Moon stations (Galaal 2016, 36–37).

Although extensive research is still needed, the data gathered at Xiis and to a lesser extent at Guguh seems to point to a relationship between astronomical knowledge, movements and funerary practices prior to the arrival of Islam. Although the latter have nowadays disappeared due to the adoption of Islamic funerary ritual, the existence of a specialist with pre-Islamic roots specialising in weather lore and astronomy (the waadad) supports the idea that this knowledge was used as a basis for the decisions taken by the nomads in their movements – something of which the data collected at Xiis would be a fossilised expression.

Final remarks

The data gathered at the archaeological site of Xiis constitutes the first archaeoastronomical research conducted in Somalia/Somaliland, and one of the few eastern African case studies since Namoratunga, whose interpretation is still under discussion (Lynch and Robbins 1978; Soper 1982; Doyle and Frank 1997). Although the sample studied is small, and the research must be considered preliminary, it is nevertheless consistent, showing a set of significant orientations which seem intentional. The interpretation of these orientations is challenging, but the available data seem to establish a relationship between them and the moments when the nomads occupied Xiis, roughly between October and April. The equinoxes especially seem to fit well with two key moments in the displacements of the nomads at Xiis: the departure to the interior in search of grazing areas after the main rains, and the arrival at the coast to spend the winter and to conduct trade once the changes in the monsoon winds allowed ships safe journeying in and out of the Red Sea.

Of course, other hypotheses for the orientations of the Xiis funerary structures cannot be ruled out, including religious ones. It should also be noted that these are not mutually exclusive. However, the importance given in Somali astronomical lore to weather predictions in relation to herd management and pastoral movement (Galaal 2016, 29–30, 45–46, 50, 66) seems to support our hypothesis, with the orientations of the cairns and burials being a reflection of key moments in the annual cycle of the nomads. Moreover, most of this astronomical lore seems to have pre-Islamic roots, inserted into a wider corpus of so-called Cushitic beliefs (Zitelmann 2005) at whose apex was the sky god Waaq, many of whose manifestations are related to atmospheric events (Aguilar 2005, 57–59) and which has also rendered other sophisticated calendars (Ruggles 1987). Therefore, a relationship between a pre-Islamic astronomical lore focused on weather prediction and cattle management, the well-established seasonal movements of the nomads and the orientations documented in Xiis and Guguh seems plausible and will be tested in future years as more cairns are included either from Xiis or other sites in Somaliland. Although more work is undoubtedly needed, the information gathered at Xiis opens a path to understanding – beyond the material remains – the cultural background of one of the least-known groups in the Red Sea during antiquity.

Acknowledgements

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