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RESEARCH REPORT

A Case for Springbok Hunting with Kite-Like Structures in the Northwest Nama Karoo Bioregion of South Africa

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Abstract In the Levant and some arid zones of Central Asia, desert kites are well-known hunting structures often thought to have been used for the large-scale harvesting of gazelles during the Holocene. Until recently, such structures were unknown from the southern hemisphere. However, three kite sites have now been identified in Keimoes in the arid hinterland north of the Gariep River where the northwest Nama Karoo (the geographic area and ecology otherwise known as Bushmanland [Mucina and Rutherford 2006]) and Kalahari Duneveld bioregions meet. Here we use aspects of gazelle behavior, and local ethnographical and ethno-historical records, to explore the possibility that the stone-built kites or funnel chains of South Africa may have been used to hunt springbok (*Antidorcas marsupialis*), southern Africa's only gazelle. We argue that seasonal herds of gazelles, colloquially known as *trekbokken* (large springbok herds on the march), were a possible target of precolonial hunters who used their intimate understanding of the animals and their landscape to design the kites.

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Résumé Dans le Levant et certaines zones arides d'Asie centrale, les cerfs-volants du désert sont des structures de chasse bien connues, souvent utilisées pour la récolte à grande échelle de gazelles pendant l'Holocène. Jusqu'à récemment, de telles structures étaient inconnues de l'hémisphère sud, mais trois sites de cerf-volant ont maintenant été signalés à Keimoes, dans l'arrière-pays aride au nord de la rivière Gariep, à la croisée des biorégions du Nord Ouest Nama Karoo' et du Kalahari Duneveld. Ici, nous utilisons des aspects du comportement des gazelles et des archives ethnographiques et ethno-historiques locales pour explorer la possibilité que les cerfs-volants ou les chaînes en entonnoir construits en pierre d'Afrique du Sud aient été utilisés pour exploiter le springbok (*Antidorcas marsupialis*), seule gazelle d'Afrique australe. Nous soutenons que les troupeaux saisonniers de ce qui était communément connu sous le nom de trekbokken (grands troupeaux de springbok en marche) étaient une cible possible pour les chasseurs précoloniaux de cerfs-volants et d'entonnoirs dotés d'une compréhension intime des animaux et de leur paysage.

Keywords Springbok · *Antidorcas marsupialis* · Desert kite · Northern Cape · Later Stone Age

Introduction

Until recently, archaeological records for the use of what are broadly known as desert kites, with their funnel-shaped stone-built arms, have been restricted to the

northern hemisphere. In the Levant, Middle East, and Central Asia, they are mostly located in arid regions and often associated with gazelle hunting during the Holocene. Yet, it is also possible that these features were used for the management of domesticates (see Crassard et al. 2015 for synthesis). Similar structures are known from Scandinavia where they are connected to reindeer hunting and/or herding (Bang-Andersen 2009; Helskog 2011; Jordhøy 2007), as well as from North America, especially Canada, the Great Basin, eastern California, and the Great Plains, associated with the harvesting of pronghorn antelope and in some cases mountain sheep (e.g., Bettinger 1975; Friesen 2013; Frison 1978; Gordon 2001; LaBelle and Pelton 2013; Lubinski 1999; Reher 1974).

The discovery of three kite-like complexes (Keimoes 1, 2, and 3), north of the central Gariep (central Orange River region), in the arid northwest Nama Karoo of South Africa opens up the opportunity for new considerations regarding the use, distribution, and age of such sites (see Van der Walt and Lombard 2018 for site descriptions; Fig. 1, top). The South African sites, however, as with most desert kites of the Middle East (e.g., Crassard et al. 2015; Holzer et al. 2010; Nadel et al. 2010), lack datable material or directly associated artifacts and faunal remains. An analysis of precolonial stone-built structures in the region revealed that their building method does not share traits with the Iron Age agriculturist walling in the higher rainfall zones toward the east of the subcontinent (Lombard et al. in press). Instead, they are most consistent with the Later Stone Age structures of the arid western areas that are much smaller than the sprawling Iron Age sites, sometimes consisting only of a single circular feature measuring 2–4 m in diameter.

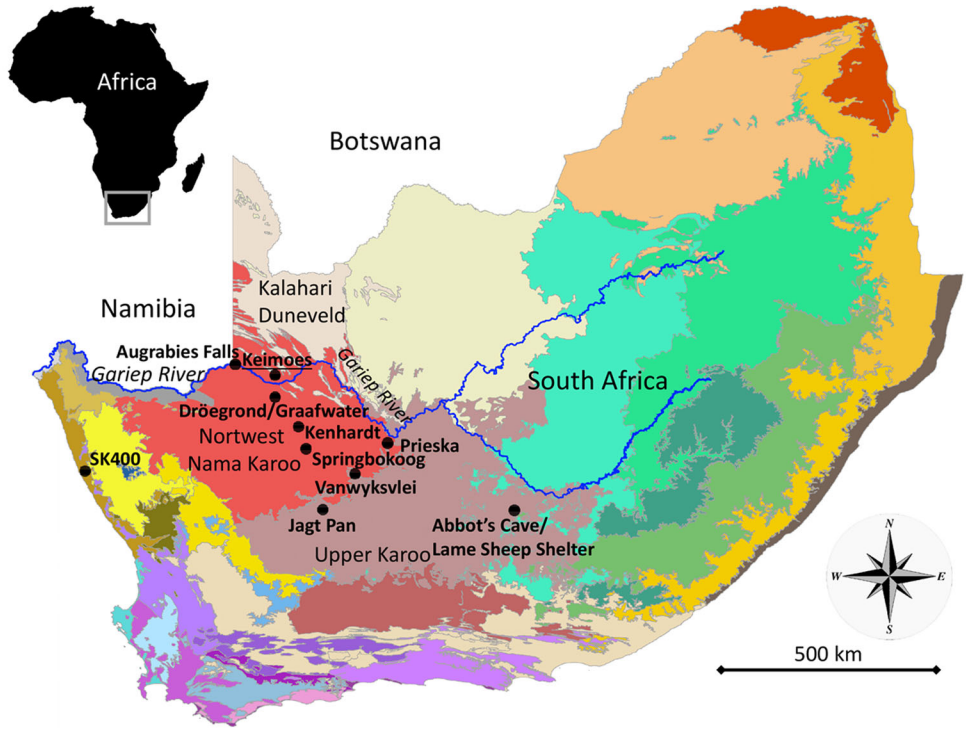
Archaeologically, such Stone Age structures have been associated with both herding and hunter-gatherer groups (e.g., Parsons 2008; Sampson 2010), and Kinahan (1991) suggested that after adopting livestock, some hunter-gatherers abandoned rockshelters in favor of stone circle settlements (also see Veldman et al. 2017). Thus far, no livestock remains have been found in direct association with excavated Stone Age stone circle sites (Badenhorst et al. 2016). However, these structures are often associated with herders' pottery and sometimes with metal objects (Table 1). Orton and Parson's (2018) reassessment of artifacts from open-air archaeological sites in the northwestern Nama Karoo suggests that it is not easy to distinguish between these two lifeways in this area during the last two millennia (also see Parsons 2006, 2007).

Fig. 1 Top: part map of South Africa with relevant bioregions (Mucina and Rutherford 2006), towns, and archaeological sites mentioned in the text. Middle left: orthographic (aerial) photograph of the Keimoes 3 kite site. Middle: plan views with the layout of the funnel structures highlighted in black. Bottom: hillshade model of the Keimoes 3 landscape viewed from funnel series 1

The stone circles at Bloubos 7, dating to 1450–1670 calAD at 95.4% probability, are the closest to Keimoes 3 and resemble the building methods used for the kites. Further afield are the oval or circular structures at Jagt Pan 7 dating to 380–600 calAD, and Springbokoog 1 that has an outlier age estimate of 3520–3090 calBC. The oldest continuous stone walling designed to control the movement of livestock are found at Simon se Klip along the west coast, dating to between 540 and 770 calAD. In the eastern Nama Karoo, Later Stone Age circular stone-walled livestock enclosures are known, dating to 890–1150 calAD (Table 1).

Thus, based on an analysis of precolonial stone-built structures in southern Africa, the presence of both pottery and metal associated with several of them, and their associated radiocarbon dates, Lombard et al. (in press) argue that the South African kites were probably used during the last 2000 years. The earliest ethnohistorical records do not mention them so that they were perhaps no longer in use by the 1770s when European travellers started to write about the region. Apart from the Keimoes sites, only one other funnel-shaped stone structure has been reported at Graafwater, located about 90 km to the southwest of Keimoes (Beaumont et al. 1995; Fig. 1, top).

From a global perspective, the Keimoes 1 and 2 kite sites share characteristics with examples known from the Negev (Israel) and Sinai (Egypt) deserts (Van der Walt and Lombard 2018). These similarities include general layout, the existence of single/isolated funnel-shaped structures, and their smaller size, compared to the massive funnel complexes characteristic of some other Middle Eastern and Central Asian kites (e.g., Echallier and Braemer 1995; Helms and Betts 1987). The megakites are generally thought to have been used to trap large migratory herds of Persian (goitered) gazelle (*Gazella subgutturosa*) (e.g., Bar-Oz et al. 2011; Legge and Rowley-Conwy 1987). Riemer (2009) also described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Nortwest
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SK400
Nama Karoo
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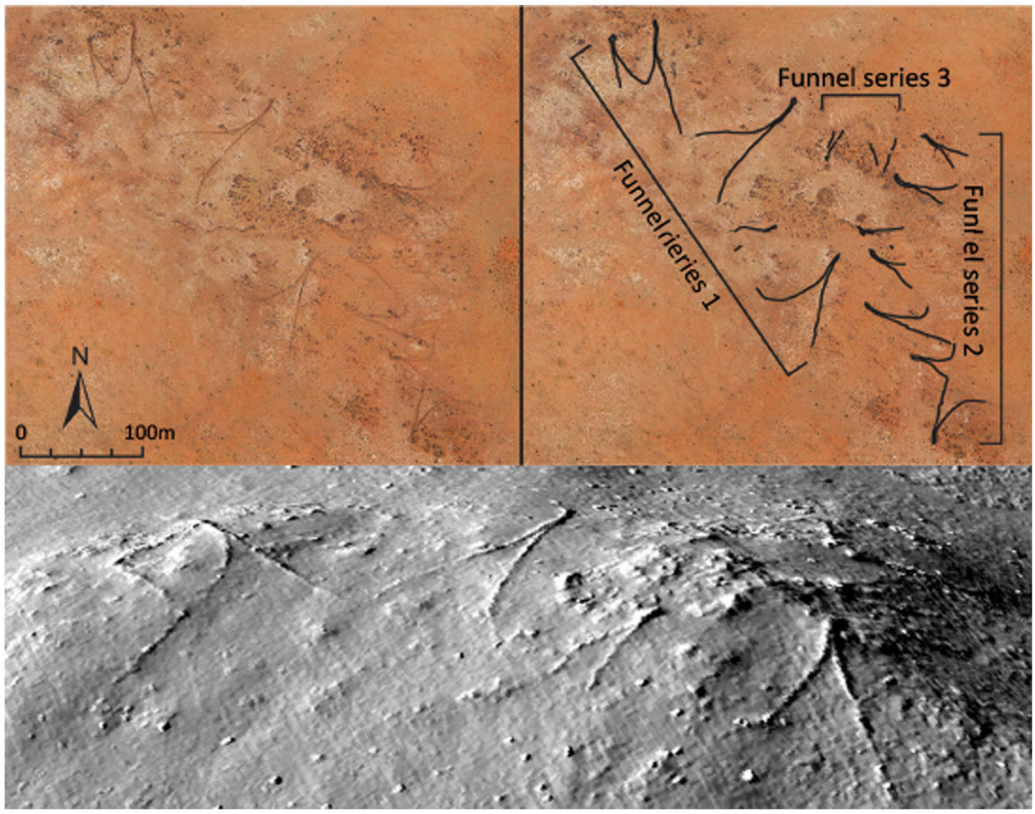
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Table 1 Newly calibrated age ranges for all the C14-dated Stone Age stone structures from Namibia and South Africa with some associated artifact classes indicated (adapted from Lombard et al. in press; calibrations based on Hogg et al. 2013; Loftus et al. in press)

Site	C14 date	Calibrated range at 95.4%	Pottery	Metal	Source/s
Brandberg (date 1)	150 ± 50 bp (Pta-3891)	AD 1670 and younger	Yes	Not stated	Kinahan 1991
Skeleton Coast N2003/3	165 ± 50 bp (KIA-21033)	AD 1660 and younger	Yes	None	Eichhorn and Vogelsang 2011
Kuidas Spring	216 ± 24 bp (OxA-27897)	AD 1650–1880	Yes	Present	Veldman et al. 2017
Bloubos 7 (Spit 2)	340 ± 50 bp (Pta-7730)	AD 1450–1670	Yes	None	Parsons 2004
Zerrissene Mountains	345 ± 40 bp (Pta-1577)	AD 1470–1660	Yes	Present	Carr et al. 1978
Skeleton Coast N2002/5	400 ± 50 bp (KN-5565)	AD 1440–1640	No	None	Eichhorn and Vogelsang 2011
Sylvia Hill (date 1)	510 ± 45 bp (Pta-3294)	AD 1390–1610	Yes	Not stated	Shackley 1983
Brandberg (date 2)	570 ± 50 bp (Pta-3873)	AD 1310–1460	Yes	Not stated	Kinahan 1991
Sylvia Hill (date 2)	1070 ± 60 bp (Pta-3295)	AD 890–1160	Yes	Not stated	Shackley 1983
Seacow River Valley	1080 ± 40 bp (Beta-230584)	AD 890–1150	Yes	Not stated	Sampson 2010
Skeleton Coast N2002/7	1175 ± 25 bp (KIA-18993)	AD 880–990	Yes	None	Eichhorn and Vogelsang 2011
Simon se Klip	1440 ± 60 bp (GX-32343)	AD 540–770	Yes	None	Jerardino and Maggs 2007
Jagt Pan 7	1610 ± 50 bp (Pta-4300)	AD 380–600	Yes	None	Parsons 2008
Hartmann's Valley	1690 ± 110 bp (UtC-9880)	AD 130–640	Yes	Present	Eichhorn and Vogelsang 2011
Springbokoog 1	4630 ± 60 bp (Pta-4091)	3520–3090 BC	No	No	Morris 1988; Beaumont and Vogel 1989; Beaumont et al. 1995

huge prehistoric stone-built structures in the eastern Sahara Desert, into which large herds of gazelle were probably driven during cooperative hunting activities. On the other hand, "the smaller and isolated Negev and Sinai kites were probably built to trap small numbers of local herbivore prey […] which locally grazed in small herds year round," such as dorcas gazelle (*Gazella dorcas*), onager (*Equus hemionus*), and Arabian oryx (*Oryx leucoryx*) (Bar-Oz et al. 2011, p. 208).

Although associated artifacts—lithic tools and animal bones, and other organic materials—are seldom found directly associated with kite sites (Bar-Oz et al. 2011), various lines of evidence link the Middle Eastern and Central Asian kites with hunting activities. First, their location and topography in relation to the migratory routes of game, pastures, and water sources demonstrate the use of local ecological and ethological understanding to facilitate game trapping. Secondly, if not constructed on natural drops in the landscape, pits or ramparts were often built at funnel apices so that the prey could fall and be injured, thereby making the killing easier for the hunters (Bar-Oz et al. 2011). In addition, there are rock art depictions and ethnohistoric descriptions of hunting scenes and encounters, as well as faunal remains from sites in the vicinity of some kites (Crassard et al. 2015). For example, a large and unusual concentration of Persian gazelle (*Gazella subgutarosa*) bones found near kites at Tell Kuran (north-eastern Syria, dated to the fourth millennium BCE) is likely the result of kite-assisted mass hunting (Bar-Oz et al. 2011). Where present, in situ and excavated artifacts such as lithic projectile points, arrowheads, flakes, and blades further indicate that hunting, killing, and slaughtering activities were performed at some kite sites (Hadas 2011; Helms and Betts 1987).

Keimoes 3, the largest of the known South African kite sites, with its three funnel chains/series stretching over a small hill of ~ 130,340 m^2, is in between the "larger and smaller" Middle Eastern kites (Fig. 1, middle and bottom). The kite could have been used for mass hunting as well as for trapping and slaughtering few or single animals. The kite sites at Keimoes were not built on natural drops, neither do they have pits at the end of their funnels, as do most of those in the Negev and Sinai deserts. However, the line of sight, profile, and

viewshed analyses conducted at Keimoes 3 (Lombard et al. in press) demonstrate that the South African funnel builders used the microtopography of the immediate landscape to plan and position their structures with care, purposefully ensuring that most of the cul-de-sac heads were obscured from the view of oncoming herds (Fig. 1, bottom). Such tactics would have given hunters substantial advantages, allowing them to observe and control herd movement, and to drive animals into the funnel arms and ultimately into a single file through the funnel necks. All of these enabled easy harvesting of the herd while the hunters were protected by the (now collapsed) stacked walling of the funnel necks and heads. Thus, similar to the Negev and other kite hunters (e.g., Bar-Oz et al. 2011), the Keimoes funnel hunters displayed a deep understanding of their environment and prey behavior by choosing strategic locations that had the maximum potential for game hunting and modifying them with permanent stone-built structures.

Archaeological evidence of mass hunting in southern Africa is sparse. In northwest Nama Karoo, at the Later Stone Age site of Droëgrond (Fig. 1, top), there is evidence of the exploitation of large herds of small-medium bovids at about 1296–1710 calAD (Smith 1995). This site is located just a few kilometers west of the Graafwater funnel site (Andrew Smith pers. comm. January 2019), and Beaumont et al. (1995, p. 259) suggested that "a rather specialised hunting association probably evolved in the thirstland areas in southern Africa as they did with the Barbary sheep, *Ammotragus lervia* and gazelles in North Africa, and gazelles in the Levant." About 500 km to the southeast of the Keimoes sites, in the less arid Seacow River Valley of the Upper Karoo Bioregion, the Holocene sites of Abbot's Cave and Lame Sheep Shelter (two openings of the same cave system occupied between 700 and 300 years ago; Fig. 1, top) yielded copious springbok (*Antidorcas marsupialis*) remains (Plug 1993, 1994). On the Namaqualand coast, an open-air shell midden (SK400), dated to between 1528 and 1627 calAD and 1641 calAD, also produced a large sample (MNI = 123) of springbok remains. The site has been interpreted as a mass kill site (Dewar et al. 2006). Thus, wherever Stone Age mass killing of animals may be inferred in South Africa, it seems that springbok or springbok-sized animals were targeted. Here we explore whether the harvesting of springbok herds may have been one of the objectives for the construction of the kite sites at Keimoes.

Springbok (*Antidorcas marsupialis*) of the Northwest Nama Karoo

Apart from the Gariep River itself, surface water is scarce in this bioregion. As a result, the diversity of ungulates is relatively low (Rutherford and Westfall 1986). In the recent past, a number of ungulates occurred in the area, notably black and white rhinoceros (*Diceros bicornis* and *Ceratotherium simum*), plains zebra (*Equus quagga*), warthog (*Phacochoerus africanus*), giraffe (*Giraffa camelopardalis*), grey duiker (*Sylvicpra grimmia*), steenbok (*Raphicerus campestris*), klipspringer (*Oreotragus oreotragus*), grey rhebok (*Pelea capreolus*), springbok (*Antidorcas marsupialis*), gemsbok (*Oryx gazella*), red hartebeest (*Alcelaphus buselaphus*), black and blue wildebeest (*Connochaetes gnou* and *taurinus*), kudu (*Tragelaphus strepsiceros*), eland (*Taurotagus oryx*), and buffalo (*Syncerus caffer*) (Du Plessis 1969). Many of these animals are solitary or live in relatively small herds (e.g., Rautenbach 1982).

Springbok (Fig. 2), the only gazelle found in southern Africa, are endemic to the arid zones and dry savannas of Namibia, Botswana, and northwest South Africa (Cain et al. 2004), where they are also the most abundant plains antelopes (Estes 1991). Although thousands of kilometers separate them from the gazelle populations of arid northeastern Africa (Rautenbach 1971; Roberts 1937; Stevenson-Hamilton 1947), Bigalke (1972) found that springbok attitudes and mating behaviors resemble that of other gazelles. In recorded times, vast herds of springbok roamed the southern African arid interior (e.g., Humphreys and Thackeray

Fig. 2 Springbok (*Antidorcas marsupialis*) or "leaping antelope" depicted by Samuel Daniell (from Daniell and Daniell 1804 with permission of Smithsonian Institution Libraries)

1983; Rutherford and Westfall 1986; Skinner and Louw 1996). For example, in 1872, herds of 2,000 to 6,000 animals were noted to dot the landscape for a hundred miles between Kenhardt and Van Wyksvlei (Smith and Metelerkamp 1995), about 100 km south of Keimoes (Fig. 1, top). Their numbers declined significantly after the 1870s when European demand for skins increased, and rifle hunting became commonplace (Cronwright-Schreiner 1925; Skinner and Louw 1996).

Springbok are herd animals that feed night and day (Von Wielligh 1921; Stapelberg 2007), preferring open tablelands with pans—shallow, often nonpermanent water catchment surfaces on flat landscapes (Liversidge and Berry 1986; Moffat 1858; Stevenson-Hamilton 1947). They generally avoid mountains, rocky hills, and woodlands where vegetation restricts their vision and movement (Bigalke 1972; Cain et al. 2004; Estes 1991; Williamson 1985). Springbok herd size is determined by the availability of grazing (Siegfried 1980). Larger herds usually form during the summer rainy season in areas with green vegetation, but these disperse into smaller groups during the winter when grazing becomes less abundant (Cain et al. 2004; Skinner and Louw 1996). After dry spells, their numbers can increase rapidly with the first rains (Bothma 1972) and under good grazing conditions, herds of > 2,000 animals can gather within a relatively small area (Bigalke 1972). Thus, a flush of green vegetation brought about by localized thunder showers may cause large numbers of springbok to concentrate in a single locality, quickly disbanding when grazing area contracts (Estes 1991).

When a lack of food or water forces them to move from their usual habitat, herds join together to form a trek or group march (Cronwright-Schreiner 1925); and during extreme conditions, megatreks would develop consisting of several thousand individuals (Stevenson-Hamilton 1947). Such mass springbok treks, referred to as "trekbokken," were well-known events throughout the northwest Nama Karoo and the Kalahari, and were often described by European travellers of the eighteenth century (e.g., Le Vaillant 1790; Masson 1994; Paterson in Forbes and Rourke 1980; Sparrman 1977; Thunberg 1986). Not far from Keimoes, between the Augrabies Falls on the Gariep and Kenhardt to the south (Fig. 1, top), Thompson (1827) observed how thunder showers would rapidly turn parched grass into short-lived green pastures during the rainy season. This quick turnaround in water sources (in the form of shallow pans) and plant biomass resulted in "myriads of wild animals," including destructive flocks of *trekbokken*, migrating across the landscape. Between 1887 and 1896, four exceptionally large treks were recorded in the Prieska district (Cronwright-Schreiner 1925), about 200 km southeast of Keimoes.

When trekking is embarked upon, the animals become fearless and oblivious to their surroundings, relentlessly pushing on (Skinner 1993). For example, Cain et al. (2004, p. 752) write:

> The speed of treks varies from a steady walk to a run … During these migrations, springbok lose much of their customary weariness and often pass through towns where they are shot or clubbed to death … thousands drown when a trek reaches a river or the ocean … After the passage of a trek, the migration path is severely overgrazed and is often left devoid of plants.

Wakefield (1988) described how a herd of 2,000 to 3,000 *trekbokken* in Namibia were unable to change course, rushing headlong into a train. Skinner (1993) mapped historical accounts of springbok treks. In northwest Nama Karoo, they often trekked in large numbers in a southwesterly direction from the Kalahari toward the Gariep (also see Shortridge 1934). Food quality and abundance in the bioregion is seasonal, reaching its lowest level in winter. This usually induced treks toward the winter rainfall region southwest of the central Gariep. However, northerly treks from the Upper Karoo were also recorded during the winter months, and we suggest that reaching the green Gariep riparian line may have been the purpose of such treks. Skinner (1993) wrote about information passed on by Sir Laurens van der Post, who gained an intimate knowledge of the northwest Nama Karoo during the 1940s–1950s.

> … there was hardly a year [1940s-50s] when he did not encounter springbok 'on the march' … Some herds were very large, some smaller, but never smaller than some thousands … I did notice that the migratory movement was in some mysterious way connected with the weather and the prospect of the rains … I never encountered springbok on the march without the first flickers of lightning having appeared below the northwest horizons of the Kalahari. And the greatest springbok march of all I encountered was after three years of terrible drought towards October/

> November I think, when, for the first time the lightning began to flicker at night and the very next day I ran into what could easily have been 100,000 springbok, lean and not walking and grazing so much as drifting towards the area of the lightning. [Skinner 1993, p. 301]

Thus, because springbok are generally less vigilant when they are part of larger herds and are further away from dense vegetation such as bushy outcrops, kite hunting would have been an efficient harvesting strategy (Burger et al. 2000). Moreover, forage utilization by springbok was found to be greater in and around pans than on adjacent plains and dunes (Milton et al. 1992). Most noteworthy is that although springbok are known for their jumps and leaps, Bigalke (1972, p. 336) observed how "they do not however usually leap over even quite low vertical barriers." The observation that gazelle rarely jumps over low barriers is corroborated by reports from Israel (Holzer et al. 2010). For example, in 1970/1971, the Israel Nature Reserves Authority attempted to capture mountain gazelle (*Gazella gazella*) using a 2.5-m-high metal fence. This proved unsuccessful—probably because the gazelle became skittish when they saw the massive vertical barriers in front of them. However, when the team laid white plastic tubing of about 10 cm in diameter on the ground to form "kite arms," it proved sufficient to guide the animals into a barely visible fishnet enclosure. Summing up their observations, Holzer et al. (2010, p. 815) concluded that "gazelles tend to run parallel to obstacles such as low walls/fences rather than traversing them."

Indigenous Use and Knowledge Systems of Springbok in the Northwest Nama Karoo

/Xam San hunter-gatherers used to live in the northwest Nama Karoo south of the Gariep around Kenhardt and Prieska, about 100 km south of the Keimoes kite sites (Fig. 1, top). During the 1860s and 1870s, /Xam informants provided—in the context of a degree of coercion (e.g., Wessels 2015)—a rich ethnographic record transcribed by Wilhelm Bleek and Lucy Lloyd, often referring to hunting and knowledge systems about springbok (Bleek 1931; Bleek and Lloyd 1911; Hollmann 2004). From these sources, it is clear that springbok were a major resource to these arid land inhabitants. The game provided an abundant meat source (e.g., Dornan 1975; Dunn 1931) and was an integral part of /Xam San subsistence. Hence, they keenly observed the animal's behaviors. Among other things, /Xam informants talked about the seasonal (summer) hunting of springbok, the disappearance of the herds at times of drought, scouting for springbok at outcrops, and understanding that springbok herds follow the leader, as well as methods of ambush hunting of springbok from behind dugouts or screens (Bleek and Lloyd 1911, pp. 53–54, 283, 309–311, 337).

The San further understood the difficulty of hunting game on the open, arid landscape where animals could easily spot hunters and avoid any unusual signs such as uprooted bushes or wooden posts with ostrich feathers tied to them (Von Wielligh 1921). Thus, when a herd of springbok was identified from a distance, the hunters could take advantage by disguising themselves for the stalk and preparing ambush situations (see Fig. 3). According to /Xam San informants, when springbok herds were observed from afar, ostrich feathers were tied to sticks planted in a curl, at the end of which hunters would lie in ambush, concealed in hollows. In Fig. 3, position 1 is the direction from where the herd comes. Position 2 shows them approaching the row of feathered stakes. From position 3, a woman throws some dust into the air. This would have the effect of coaxing the springbok to move into the ambush. Position 4 represents the lead hunter and owner of the feathered sticks. From position 5, a driver would force the springbok to run toward the concealed hunters after having planted small feathered sticks at positions 6 and 7. Positions 8 and 9 represent specific hunting positions in the group (see Bleek and Lloyd 1911, pp. 285–289). Von Wielligh (1921, p. 24) also described how two wide rows of signs or posts were erected with sufficient space between the rows for animals to graze. Between the posts, the hunters would make hollows or blinds for hiding (also see Hitchcock et al. 2019 for ethnoarchaeological work on hunting blinds in the Kalahari). The rest of the group, including women, would then slowly coax the animals to move between the rows, careful not to frighten them away. This process requires much practice and attention, but once the animals were grazing unsuspectingly between the post rows, the concealed hunters would then fire their deadly arrows.

Roche (2005) collated further /Xam San impressions about springbok migrations; for example, how they spoke of the *trekbokken* as sending up the dust, their numbers being so large that they resemble the stars in

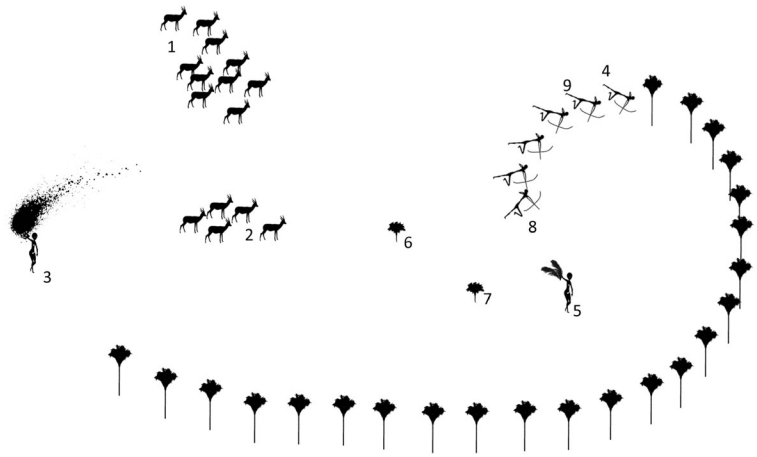

Fig. 3 Illustration of /Xam "tactics in springbok hunting" where a row of feather-topped sticks/wooden stakes were planted in a curl to "turn the game." At the top of the curl, the bow hunters lie in wait, concealed in hollows. Position 1 is the direction from where the herd comes. Position 2 shows them approaching the row of feathered stakes. From position 3, a woman throws dust into the air, coaxing the springbok to move into the ambush. Position 4 represents the head hunter and owner of the feathered sticks. At position 5 is the driver who coaxes the springbok to run toward the concealed hunters after having planted small feathered sticks at positions 6 and 7. Positions 8 and 9 represent specific hunting positions in the group (reproduced by Marlize Lombard after Bleek and Lloyd 1911, p. 289)

the sky or the water of the ocean. There were so many animals that the hunters feared they might run out of arrows to hunt them. When the springbok were driven out of their region by extreme spells of drought, the /Xam thought of themselves as becoming lean as a consequence, having to rely on ostrich eggs and honey until the rains and the springbok returned. The usual late-summer rains of the bioregion and the predictable response of the vegetation and springbok were eagerly anticipated by the /Xam who noticed the appearance of the *//khwai* stars (Aquila constellation) in the early-morning sky each February and March (see Bleek and Lloyd 1911; Roche 2005). The constellation of Orion's Belt, visible in the early mornings of June and July, was called *whai ta Tkuatti*, or "the springbok stars," and it served as a predictable/seasonal link between springbok scarcity and abundance. The appearance of the springbok stars possibly triggered shamanic rainmaking ceremonies to "let out the rain's blood, that the rain-blood may run upon the earth, that the springbok may … drink the rain's blood …" (Roche 2005, p. 19). Also, strong winds from the north were seen as harbingers of rain and springbok, so that rainmakers would encourage such winds to blow during their ceremonies. Indeed, the rainfall in the northwest Nama Karoo is caused by the northerly flow of tropical air, initiated by a high-pressure system that develops in March, resulting in late summer and autumn rainfall.

Given the arid nature of the northwest Nama Karoo, the reliance and complete use of a desert-adapted antelope such as the springbok for protein and raw materials is unsurprising. Apart from being a staple protein, springbok by-products were central to the general economy of the /Xam. Among other things, their skins were used as roof layers for shelters, water containers, clothing, carrying bags, *karosses* (softly tanned hide blankets), drum skins, and even food during times of famine. Bones were whittled into needles and spoons; horns were used as tinder boxes and handles; sinews as bowstrings; and dried springbok ears as dancing rattles. These accounts demonstrate the dependence of southern African arid-land hunter-gatherers on the springbok and their seasonal treks for subsistence and household goods, and their acute awareness of the seasonal weather cycles "that determined springbok movements" (Roche 2005, p. 13).

Hunting Springbok with Desert Kites

It is usually thought that the hunter-gatherers of southern Africa did not habitually anchor themselves with possessions or constructions on the landscape, and even Khoekhoe herding communities were mostly seen as transhumant (Maxwell and Harris 1706–1707; Smith 1995). Substantial Stone Age structures such as the

funnel series at Keimoes are rare and unexpected, but they form an exception to the rule about the relationship of the San and Khoekhoe with their landscape (for other examples, see Jerardino and Maggs 2007; Kinahan 1996; Sadr 2012; Sampson 2010). Their construction, using thousands of stones of different sizes, would have required considerable labor, with some of the boulders requiring several people to move them (Figs. 1, middle, and 4). What is more, with the exception of a single site, Springbokoog (Fig. 1, top), all the kite-like stone structures (mostly small stone circles) in South Africa and Namibia postdate the arrival of herders on the landscape, and most (15 out of 17) of these dated stone structures are associated with herder pottery (Table 1). Some of them probably served as hut bases of pastoralist camps (e.g., Parsons 2004; Veldman et al. 2017), and it has been reported that by the late 1770s, some of the islands in the Gariep around Keimoes housed up to about 100 Einiqua Khoekhoe pastoralists in villages of 20–30 residences each (Penn 1995; Fig. 5, top).

Small stone circles or curved structures were, however, also used as hunting blinds from which to ambush game. Such blinds are still in use further north in the Kalahari (Hitchcock et al. 2019) and have been found in Namibia along game trails (Badenhorst et al. 2016; Shackley 1985). A stone circle at Jagt Pan 7, a few hundred kilometers south of Keimoes, could have served as a hunting blind (Badenhorst et al. 2015). Early travellers also noticed some of these blinds (e.g., Alexander 1838), and in the Keimoes region, Moffat (1858, pp. 168–169) reported that: "On the summit[,] I observed the little circular hiding places of stone, from which the

Fig. 4 The expanse of Keimoes 3. Top: view to the southeast. Middle: view to the north. Bottom: view to the south west where the pan is located behind the steep-sided hill (photographs: Marlize Lombard)

Fig. 5 Top: Watercolor by Samuel Daniell of pastoralists in their settlement on the banks of the Gariep by the end of the eighteenth century (from Daniell and Daniell 1804 with permission of Smithsonian Institution Libraries). Bottom: the rich Gariep riparian vegetation photographed on the same day in April 2019 as the images of Keimoes 3 in Fig. 4 only about 2 km to the north (photo: Marlize Lombard)

ancient Bushmen were wont to shoot the Zebra and Quagga."

From both the archaeological and ethnohistorical records, it is clear that the northwest Nama Karoo was a complex socioeconomic landscape, especially in the past 2000 years (Gordon 1779–1780; Mossop 1935 [Coetsé 1760; Wikar 1779; Van Reenen 1791]; Orton and Parsons 2018; Parsons 2004, 2008; Penn 1995; Smith 1995). Several societies with a wide range of subsistence economies lived there. By the late 1700s, travellers reported at least ten San families and seven Einiqua Khoekhoe groups (Penn 1995). These people had both lasting and constantly shifting, sociopolitical relationships with each other and, with other groups and individuals such as Korana Khoekhoe pastoralists and the *Trekboere*– farmers of European descent moving into the interior to avoid European autocracy reigning in the Cape (Penn 1995). Most of the observed subsistence economies of the central Gariep indigenous groups were flexible, shifting between various grades of hunting, fishing, and animal husbandry (e.g., Mossop 1935 [Coetsé 1760; Van Reenen 1791; Wikar 1779]).

The /Xam San accounts demonstrate that the people of this bioregion had (a) a deep understanding of springbok behavior; (b) often used ambush hunting for springbok; and (c) prepared themselves for the recurring arrival of springbok herds at predictable times of the year. The effort involved in constructing and maintaining the kites was worthwhile considering the potential of bountiful springbok harvests. The ancestral Khoekhoe pastoralist communities originating from East Africa and arriving in southern Africa from about 2000 years ago (e.g., Breton et al. 2014; Lombard and Parsons 2015; Parsons and Lombard

2017; Schlebusch et al. 2017; Schlebusch and Jakobsson 2018) would have brought with them experience in handling and corralling animal herds, and possibly the habit of shaping structures on the landscape for their management. On the other hand, the local hunter-gatherers had age-old knowledge systems about the rhythms of the landscape, and of when and where resources such as springbok herds would become plentiful and how to best hunt them.

Until about 1780, hunters and herders maintained a mostly permeable and symbiotic existence around the islands and in the hinterland of the central Gariep in the greater Keimoes area. The Einiqua controlled the islands with their rich riparian grazing, and the hunter-gatherers roamed the arid hinterlands north and south of the river (Figs. 4 and 5). The river, the only permanent open water source in the region, brought together people and animals in a vibrant socioeconomic environment where cooperation, intermarriage, the exchange of resources, and familial/group skirmishes were all part of everyday life (Penn 1995; Smith 1995). We suggest that the amalgamation of all these circumstances and knowledge sets, together with gazelle behaviors (such as reduced vigilance in larger herds and the fact that they can be easily guided by low lines on the landscape), probably led to the construction of the Keimoes kites. These features would have been used for the mass harvesting of *trekbokken*. Dunn (1931, p. 30) linked the first of two great San festivals in the area with the time "when the travelling springbok passed by" and "thus fell an easy prey to the Bushman's arrow." This would indicate that the mass killing of springbok was carried out by several groups on the landscape, in the summer, during which they also feasted, and "visited each other."

The size and positioning of the Keimoes kites, as well as the existence of single funnel features, however, point to the probability that these features were also used year-round to trap and kill smaller numbers of animals, or even a single prey other than springbok, as suggested for the kites in the Negev and Sinai deserts (Bar-Oz et al. 2011). As permanent features on the landscape, maintained and handed from generation to generation, it is difficult to think that in such a harsh, competitive landscape, hunters would not have made optimal use of the structures.

Discussion and Conclusion

The Keimoes 3 site with its 14 funnels were arranged in three series or chains around a small hill from where scouts could look out for oncoming herds in all directions (Fig. 1, middle and bottom). These funnels open toward the surrounding plains and occasional water sources where springbok, among other animals, would have gathered for grazing and drinking (Fig. 4). The vegetation on the plains directly surrounding Keimoes 3 is a mixture of Kalahari Karroid Shrubland, Gordonia Duneveld, and northwest Nama Karoo Arid Grassland. Several species of grazing grasses grow there, some of which are high in protein such as blue buffalo grass (*Cenchrus ciliaris*), and others such as perennial love grass (*Eragrostis nindensis*) and twabushman grass (*Stipagrostis brevifolia*) are drought resistant (Fish et al. 2015). A large pan is located about 1 km southwest of the site, and here much water accumulates after intense thunder showers (Ampie Vlok, pers. comm. January 2019). Environments at such pans are known to be the choice aggregation areas for large herds of springbok (Cain et al. 2004).

The use of low walling at the funnel mouths, opening toward the plains, would not have alarmed the springbok herds. The topographic features used to conceal higher apex walling and hunters from the animals, and the possible use of drivers (as described in the ethnohistorical records) would have helped to guide herds toward the hill and ultimately force the animals (following their leader) into a single file. Once the animals arrived in the narrow funnel necks, they could be easily picked off by hunters hiding behind the stacked wall. These structures would have provided the infrastructure to maximize springbok harvesting as the herds started moving south from the Kalahari toward the river when grazing there was depleted, or north returning from the Gariep when the hinterland was replenished. Being in large herds and on the open veld (grass-/shrubland) would have lowered the animals' wariness levels. The use of the microtopographic features as the location for building the kites, and the fact that springbok, like other gazelles, do not tend to jump low barriers, would have made them the ideal targets for funnel/kite hunting—similar to the gazelles from the Middle East. What is more, the kite sites with their potential for mass killing could also have served as a buffer to protect the "thin green line" of riparian vegetation around the Einiqua herding settlements, close to the river, from the

destructive feeding of the *trekbokken*. The carcasses of the animals provided the various populations of the area with many resources, from ample meat supplies to hide, sinew, horn, and other materials which were used for a wide range of activities. Although we do not rule out a varied use for the Keimoes kites, our emphasis here is that these high-cost, permanent landscape alterations were used to trap and hunt *trekbokken*. Their potential for concurrently managing domesticated herds will be explored in the future.

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