



Ramparts and walls: Building techniques of kites in the Negev Highland

Dani Nadel^{a,*}, Guy Bar-Oz^a, Uzi Avner^b, Dan Malkinson^c, Elisabetta Boaretto^d

^a Zinman Institute of Archaeology, University of Haifa, Mount Carmel, Haifa 31905, Israel

^b The Arava Institute and the Dead Sea-Arava Research Centre, Eilat 88133, Israel

^c Department of Geography and Environmental Studies, University of Haifa, Mount Carmel, Haifa 31905, Israel

^d Radiocarbon Dating and Cosmogenic Isotopes Laboratory, Weizmann Institute of Science, Israel

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ABSTRACT

Remarkably, the largest archaeological game traps ever recorded in the Near East are found in arid landscapes, both on plains and in hilly terrains. This paper describes the construction methods used on steep slopes in the Negev Highland. Apparently, in some cases a massive rampart (rather than a free-standing wall) was built around the trap's head. The details reflect careful planning and heavy-duty work, including leveling and then using more than 100 t of stone for the rampart construction. New ¹⁴C data date the Sayarim site to the Early Bronze Age (minimum age), and the Pitam site to pre-Late Bronze Age.

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1. Introduction

Remarkably, the largest archaeological game traps ever recorded in the Near East are found in arid landscapes. They were first termed 'Desert Kites' by pilots almost 100 years ago (Maitland, 1927; Rees, 1929), though the term has nothing to do with their past function (for research history see Holzer et al., 2010; references therein; Bar-Oz and Nadel, 2013).

The large game traps (henceforth kites) discussed here are generally triangular structures (V-shaped), each built of two long converging stone walls (arms) with a small round structure (head) at the apex. The heads vary in shape and their diameter can range from a few m to over 200 m. The walls extend for tens of m and more commonly for hundreds of m; they were constructed of local stones and vary in width and height. These extensive stone structures are common in many desert environments in the Middle East, either as isolated phenomena or as sets of long chains (Betts, 1982).

The Negev and Sinai kites are usually isolated constructions, with no chains (Kobusiewicz, 1999; Meshel, 2000; Holzer et al., 2010). In addition, they are usually much smaller than those found in the deserts of East Jordan and Syria (Maitland, 1927; Rees, 1929, p. 398; Helms and Betts, 1987; Betts, 1998; Van Berg et al., 2004; Kennedy and Bewley, 2009; Kempe and Al-Malabeh, 2010; Kennedy, 2011, 2012). In all areas, kites were constructed of locally

available stones; in the Negev Highland kites discussed here, limestone was the only rock used.

To date, very few of the Negev and Sinai kites (and their associated features) were thoroughly excavated or studied, and function-specific finds such as animal bones are extremely rare (Avner, 1972; Meshel, 1974, 2000; Kobusiewicz, 1999; Holzer et al., 2010; Nadel et al., 2010; Bar-Oz et al., 2011a). The same is also true for the large east Jordanian and Syrian chain kites (Helms and Betts, 1987; Echallier and Braemer, 1995; Betts, 1998; Betts and Yagodin, 2000; Van Berg et al., 2004). The differences in types, topography and distribution patterns suggest that the kites were used in various ways. Thus, a variety of functional reconstructions were suggested, not always separating the utilization of the large chains from those of the smaller isolated features (see Holzer et al., 2010; Bar-Oz and Nadel, 2013; Nachmias et al., in press).

While it is argued that the chain kites were used to trap the large migratory herds of Persian (goitered) gazelle (*Gazella subgutturosa*) (e.g. Legge and Rowley-Conwy 1987; Kempe and Al-Malabeh, 2010; Bar-Oz et al., 2011b), the Negev and Sinai kites were probably built to trap small numbers of non-migratory ungulate prey i.e., gazelle (Dorcas gazelle, *Gazella dorcas* or mountain gazelle, *Gazella gazella*), onager (*Equus hemionus*) and probably Arabian oryx (*Oryx leucoryx*), which locally grazed in small herds year round (c.f. Holzer et al., 2010; Nadel et al., 2010). It appears that species behavioral ecology, herd size, and body-size of the target game were among the factors that determined the characteristics of each kite (c.f. Perevolotsky and Baharav, 1991; Rosen and Perevolotsky, 1998).

Currently, 12 kites are known in the Negev; five in flat settings and seven on hilly terrain (Fig. 1). All were thoroughly surveyed and mapped by the authors, including the use of aerial photos and

* Corresponding author.

E-mail addresses: dnadel@research.haifa.ac.il (D. Nadel), guybar@research.haifa.ac.il (G. Bar-Oz), uzia@012.net.il (U. Avner), dmalk@geo.haifa.ac.il (D. Malkinson), Elisabetta.boaretto@Weizmann.ac.il (E. Boaretto).



Fig. 1. Location of large game traps ('desert kites') in the southern Levantine Negev and adjacent regions. The hilly kites are marked with bold V. The map is based on Holzer et al. (2010) and Nadel et al. (2010). Sites discussed in the paper: 1, 2 – Horshua north and south; 3 – Achshuv; 4, 5 – 'Ein Qadis; 6 – Pitam; 7 – Harut; 9 – Eshel; 10 – Sayarim; 11–13 – Samar. An isolated wall west of the Samar kites may be an unfinished kite, not marked here but see Holzer et al. (2010) and Nadel et al. (2010).

a LiDAR scanner. Following the survey we excavated the heads of four kites, two of each type. This paper focuses on the construction details of the heads built on steep slopes. It also provides new ^{14}C dates on charred plant remains from two of these excavated kites. Combining the new results presented here with those from previous research on the plain kites (i.e., the Samar kites, Nadel et al., 2010) allows characterization of each group within its particular settings, obtaining further insights into the function of the Negev kites, their dates and their importance for local desert societies.

2. The Negev Highland and its cultural history

The Negev Desert is an extension of the north-eastern fringe of the Sinai desert, located between 29.5° and 31.3°N and bordered by the Rift Valley in the east. The desert rises from below sea level at the Rift Valley to an elevation of over 1000 m in the central highlands. A precipitation gradient exists from the rift valley north-westwards, where hyper-arid conditions prevail with mean annual precipitation <30 mm in the Rift Valley, and ~ 200 mm of mean annual precipitation at the northern highlands. Mean temperatures also vary along this gradient, where in the lower elevations mean maximal temperatures are 30.4°C and mean minimal temperatures are 21.8°C . In the higher elevations the respective values are 22.6°C and 12.6°C (IMS, 2012).

The spatial distribution of the precipitation is highly variable in these regions, and consequently the germination of herbaceous vegetation is unpredictable and varies across the landscape (Noy-Meir, 1973). The interaction between the topography, lithology and climate results in a landscape characterized by low-density vegetation communities. In the Negev Highlands, vegetation grows in wadi beds and on northern slopes, while in the southern Negev vegetation is restricted to the wadi beds.

The riverbeds are dominated by shrubs and scattered trees (primarily *Acacia* spp. in the lower elevations and *Pistacia atlantica*

in the higher ones). In the past, the Negev vegetation sustained a fairly rich fauna (Paz, 2002), including several species of herbivores, which played an important role in human subsistence, whether game or domesticated.

Herding and farming began in the Negev desert around 6000 Cal BC. In most of the area, herding was the primary economical branch while in some places farming was the leading. These developments brought a steady growth of population, reaching a climax in the 3rd millennium BC (Avner, 1998, 2002 (Ch. 2), 2006; Avner et al., 2003; Rosen et al., 2005; Babenko and Khassanov, 2007; Rosen, 2011; Kolska-Horwitz et al., in press).

Some of the currently available ^{14}C dates of the Negev kites fall in the beginning of the Early Bronze Age, ca. 3500 Cal BC, while other dates indicate their continued use during the Early Bronze II (some later dates are probably the result of random human presence in the abandoned kites) (e.g., Holzer et al., 2010; Nadel et al., 2010; references therein).

3. The Sayarim kite

The Sayarim kite is located above and to the west of Sayarim Valley, with the arms opening to a plateau on the west. The slope is steeper towards the wadi and moderate at the top. The head was built in a narrow wadi, below a series of vertical rock steps (Fig. 2). The wadi has cut through the constructed head, and the perimeter wall was only preserved on the sides, where we excavated two trenches.

The first trench (Locus 1, 2.5×2.0 m) was dug in the head, below the rock step (small cliff) separating the arms from the head (Fig. 3). It was filled by collapsed construction stones and wadi gravel. The remains of a hearth were found at a depth of 0.4 m, including burnt stones and ash. The hearth was on bedrock, and could be contemporaneous with the kite, or later. Charred material from it was radiometrically dated to 3350–3010 Cal BC (Early Bronze Age I), one of the earliest radiometric dates for any kite in the southern Levant (Fig. 4).

The trench of Locus 2 (1.0×1.0 m) was excavated on the other side of the wadi, where the head wall was well preserved in several sections (Fig. 3). Both sides of the wall were built with boulders and stones, in some places five courses high (>1 m). We excavated about 1 m^3 at this site, sieved it all, and found no faunal or lithic remains.

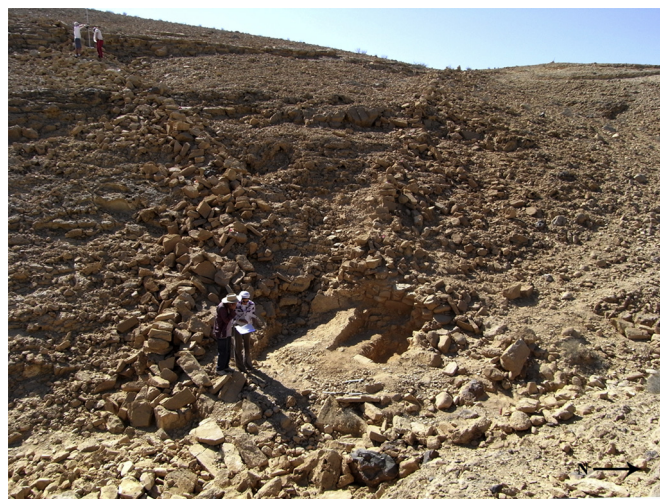


Fig. 2. A general view of Sayarim kite, looking west. Note the setting of the head, inside a narrow wadi that damaged its central part. Two people are standing in the head and two half way up the right arm.

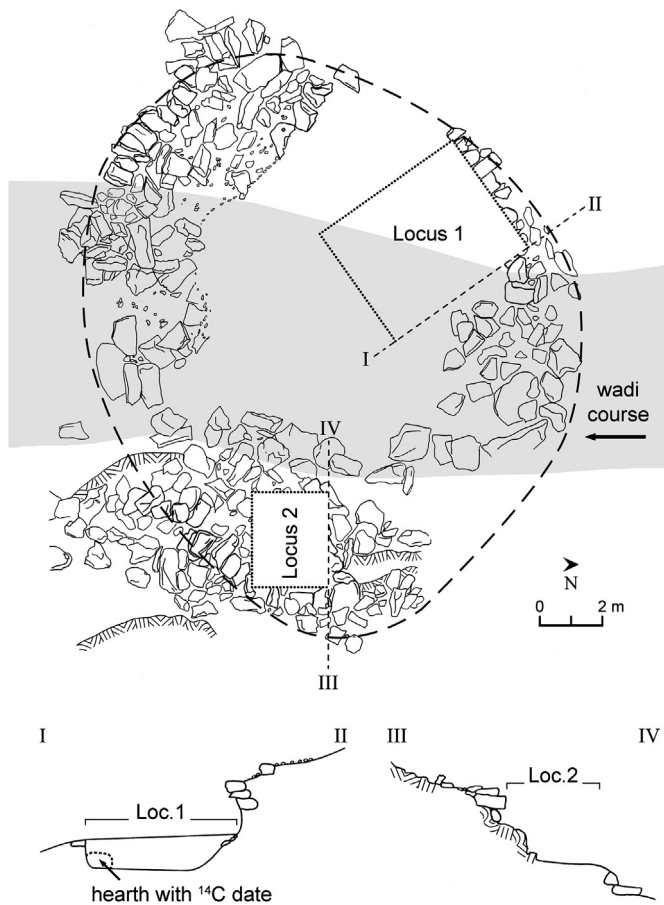


Fig. 3. General plan of the Sayarim kite head, with two sections along the excavated loci and surrounding cliff.

4. The Pitam kite

The Pitam kite (Rosen, 1994, pp. 86–87) is one of only two constructed in the Ramon Crater, a 40 km-long geological feature. It was built on a steep slope dropping eastward (Figs. 1 and 5). The

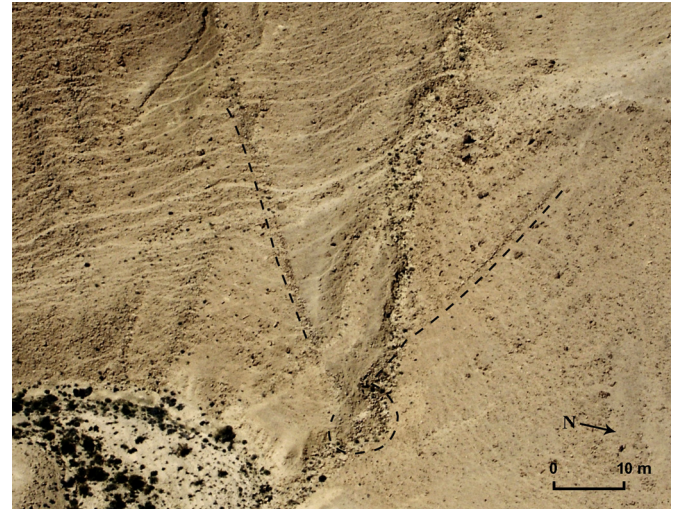


Fig. 5. An aerial view of Pitam kite, looking west. Note the left arm crossing a channel before turning in a right angle. Many animal trails cross the trap.

right arm (as viewed going down-slope into the kite) crosses one small channel and rises topographically before descending into the head. The left arm crosses a larger channel, before turning in a right angle into the head.

Noteworthy, the kite could have been built to incorporate the steep cliff of the large wadi below as part of the trap, in a manner somewhat similar to the Nahal Horsha kites (see below). However, it was built leading into a much smaller and shallow wadi, with a right angle turn toward the head instead of a straight entrance.

A cluster of animal trails crosses the right arm (Fig. 5), through narrow gaps in the wall. Since there are no collapsed stones in these gaps, it seems that the gaps were left intentionally, to allow animal passage when hunt was not desired.

There are not enough collapsed stones in the vicinity of the gaps to suggest that originally there were no gaps in the walls. The same phenomenon was observed for most of the Negev kites, including those on the plain (Nadel et al., 2010).

The head of the trap was constructed at the bottom of a north-facing steep slope, inside a small channel running east (Figs. 5 and 6). A large mass of stones surrounded its lower sides, over

RTT #	TYPE	Age	Calibrated age $\pm 1\sigma$ year BC	Calibrated age $\pm 2\sigma$ year BC	Collection Site	prep%	C%	$\delta^{13}\text{C}$ ‰ PDB
RTT 5868	charcoal	3200 \pm 45	1510BC (68.2%) 1425BC	1610BC (4.7%) 1570BC 1560BC (90.7%) 1390BC	Kites, Pitam depth 50–80 cm. Center of section	56.8	62	-23.1
RTT 5869	charcoal	4465 \pm 45	3330BC (39.0%) 3210BC 3180BC (7.2%) 3150BC 3130BC (13.0%) 3020BC	3350BC (94.2%) 3010BC 2980BC (1.2%) 2960BC	Kites, Sayarim, depth 2.95–3.13.	62.2	72	-24.2

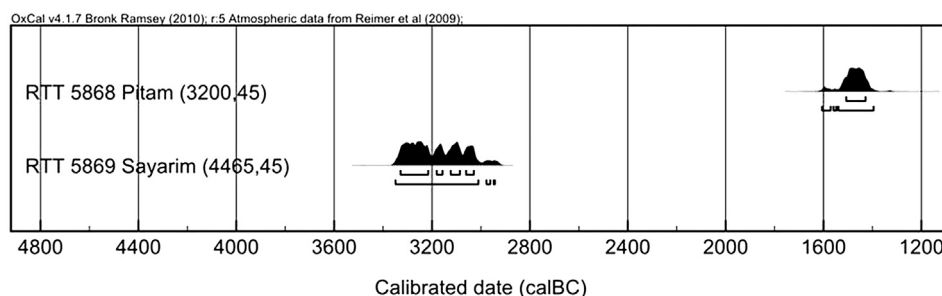


Fig. 4. Radiocarbon dates on charred plant remains from two recently excavated kites in the Negev. Top: the calibrated ranges represent the $\pm 1\sigma$ and $\pm 2\sigma$ standard deviations. Bottom: probability distribution of the calibrated ages. The samples were pre-treated, characterized and measured using the procedure described in Yizhaq et al. (2005). The calibrated ages were determined using the 2010 calibration program OxCal v4.1.7 (see Bronk Ramsey, 1995, 2001); atmospheric data from Reimer et al. (2009).

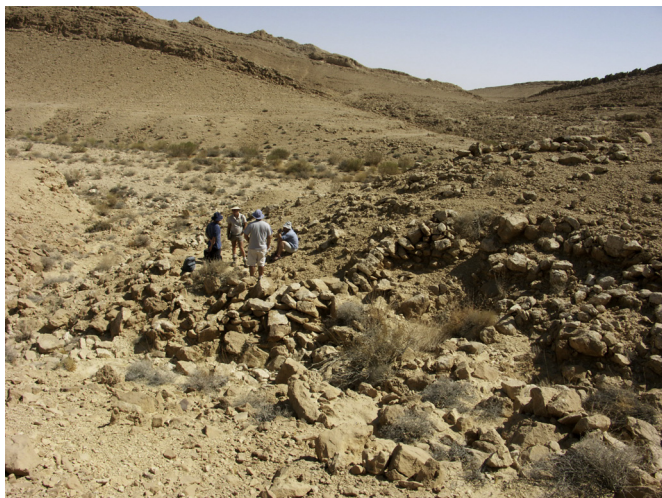


Fig. 6. General view of the Pitam head, looking southeast. Four people are in the middle of the head, and the remains of the rampart are visible below them.

3 m wide at the bottom and up to ca. 1.2 m high. The head is oval in shape, 5.5×6.0 m, and a thick deposit of fine material (mostly aeolian) accumulated inside.

We excavated a 1.5 m wide trench across it (Fig. 7). On the inner steep side of the head (south), below the in-coming arms, we found the remains of a vertical wall (Fig. 8). It was built of undressed slabs,



Fig. 8. Close-up view of the retaining wall during excavation (Pitam head, looking south).

the two lowest stones more than 0.5 m long. These remains indicate that the first stage of head construction was to cut vertically into the slope and create a human-made wide step, and then a retaining wall was built against the slope. Towards the lower side (north), no vertical wall was encountered in the trench. Rather, a wide semi-circular rampart was built in the channel bed, to protect the head from flash floods. Massive boulders were used for construction, some more than 1 m long.

To the best of our knowledge, this is the first excavation in which such a building method of the head is revealed. It was also observed in the Nahal Horsha kites (see below and Fig. 14c). The channel course was diverted northwards by 3.0–5.0 m.

We excavated about 3 m³, sieved it all, and found no faunal or lithic remains. We did find, near the bottom of the trench (but above bedrock), several charred fragments. The only dated sample was retrieved from a depth of 0.5–0.8 m (in the head's center), with an age of 1510–1425 Cal BC (Fig. 4). This Late Bronze Age reading post-dates the construction event, as the charred material was not found in situ.

5. The Nahal Horsha kites

The two Nahal Horsha kites (Haiman, 1986, pp. 24, 137) were built ca. 800 m apart (Fig. 1). In most cases the Negev and Sinai kites are several tens of kilometers apart. The Nahal Horsha setting with two relatively close kites is less common. Another pair was documented near the 'Ein Qadis spring (Fig. 1; Haiman, 1986, pp. 223–224, 2007, pp. 346).

The two studied Nahal Horsha kites have their arms open to the plateau, converging in the same general direction, using a south or south-east facing vertical cliff (Fig. 9). Both are located above and to the west of the large Nahal Horsha wadi course. Neither of the kites was excavated, though a meticulous survey and documentation was accomplished.

6. The Nahal Horsha south kite

The kite has two distinct components, the arms on the plateau and the head below a vertical cliff, ca. 2.5 m high (Figs. 9 and 10). The arms run almost horizontally on the plateau, the right much shorter than the left. Only towards the head do they descend, before converging on the cliff where they create a narrow 'bottle neck'. The arms were constructed of local field stone, up to three courses high and 2–4 stones wide; only a few were found fallen. Thus, originally the arms were only 0.5–0.8 m high.

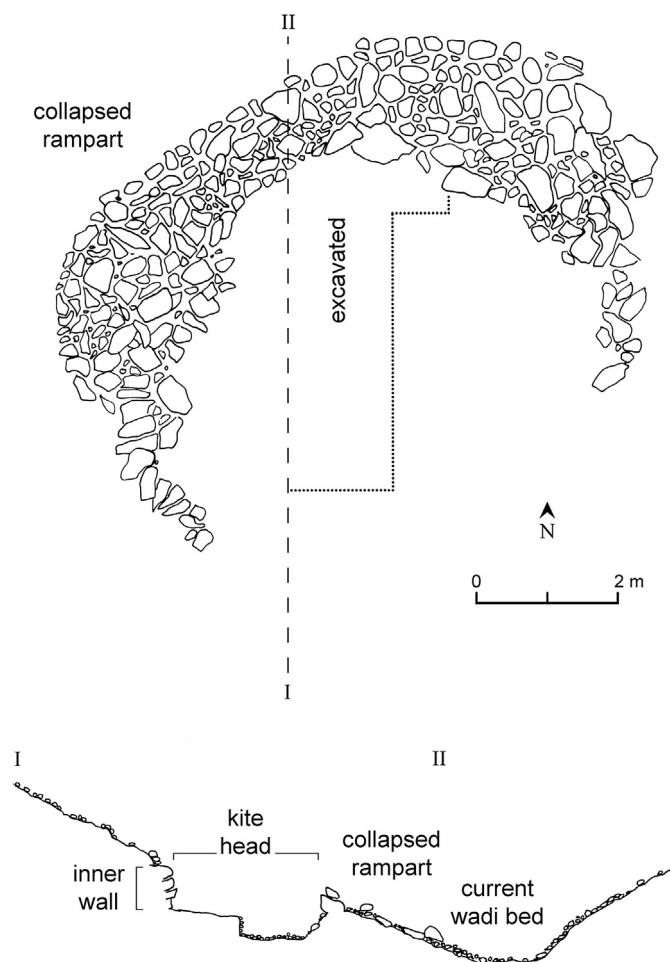


Fig. 7. Plan and section of the head, Pitam kite.

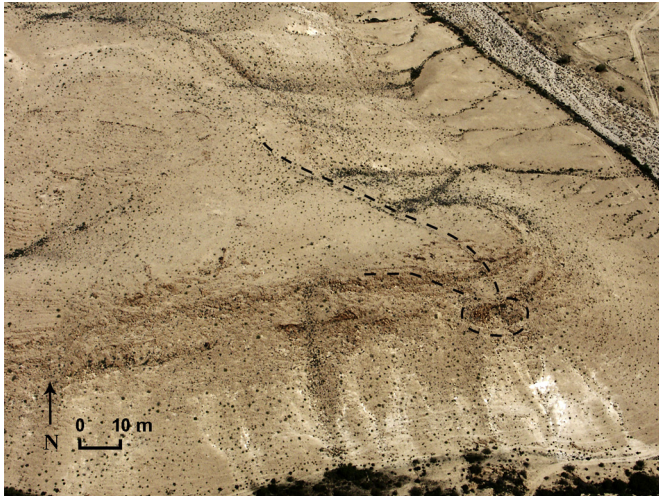


Fig. 9. An aerial view of the Nahal Horsha south kite, looking north. Note the converging arms to a south facing cliff, with the left arm much longer. The wide Nahal Horsha is at the top right, and a tributary at the bottom.

The head below the cliff has two components, a massive semi-circular structure and a small stone alignment within it. As the latter appears to be a surface feature built after the head was in-filled by post-depositional processes, it post-dates the kite and is not dealt with here. The inner diameter is ca. 5.0 m, while the width of the ring of collapsed stones ranges between 3.0 and 5.0 m (Fig. 11). Many more stones are scattered on the slope below the structure.

It appears that the builders first created a wide flat space (or a shallow depression) on the slope, before construction (Fig. 14a). The massive structure appears to be a rampart, built to function on a steep slope. It was constructed of boulders and stones, with no visible pattern. The area of the rampart is ca. 70 m², and according to surface observations the average thickness is at least 0.5 m, suggesting that the volume of stone used for construction was at least 35 m³ or 100 t. This represents a formidable effort for the construction of a 5.0 m wide (inner diameter) trap head.

7. The Nahal Horsha north kite

This kite has longer arms than the previous, though the setting is similar (Fig. 12). Here, the right arm is much longer than the left.



Fig. 10. Nahal Horsha south: A side view of the vertical cliff and the rampart remains on the slope (right). The trapped animals were driven from the left to the natural cliff (person standing on edge). Remains of the collapsed head in center.

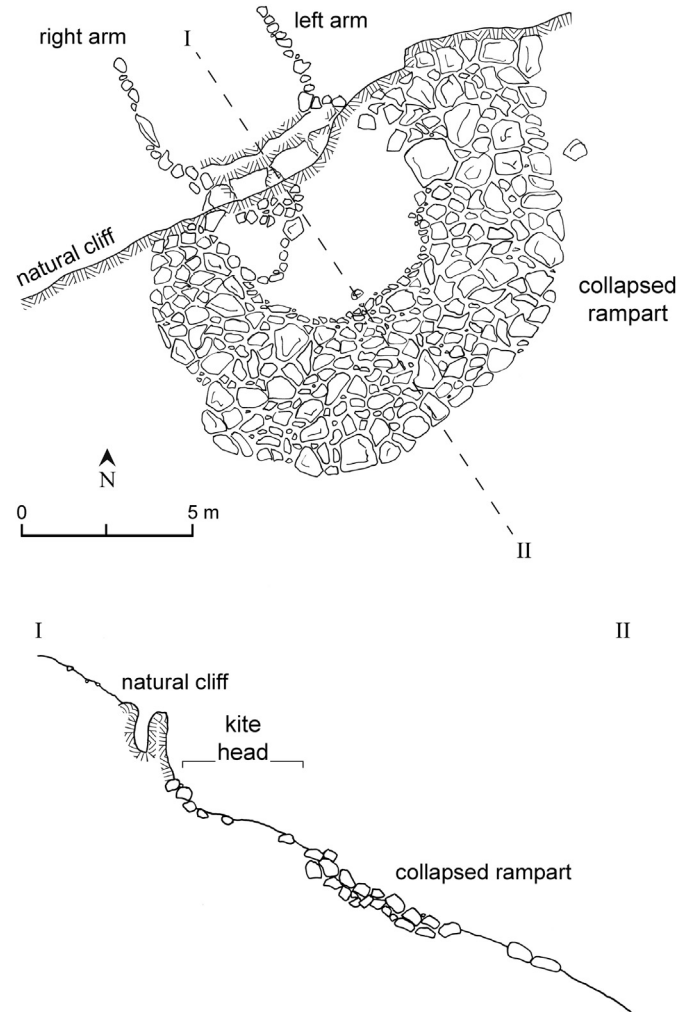


Fig. 11. Nahal Horsha south kite: plan and section of the head and cliff above it.

It crosses a channel and makes an almost right turn still far from the head. The cliff edge above the head is not visible from the far ends of both arms.

The head, 3.0 m below the cliff edge, is semi-circular with an inner diameter of ca. 5.0 m, surrounded by a massive rampart, 2.0–5.0 m wide and many more stones are scattered below it (Figs. 12 and 13). A small stone feature built within the head post-dates the kite and will not be dealt here.

The area of the rampart is ca. 50 m² and it is at least 0.5 m thick, suggesting that the volume of stone used for construction was no less than 25 m³ (70 t). This demonstrates the efforts required for the construction of a 5.0 m wide (inner diameter) kite head. It appears that the constructors of both kites first leveled a wide area on the slope before building the surrounding rampart (Fig. 14b).

8. Discussion

The Bronze Age inhabitants of the Negev and Sinai constructed game traps in a variety of topographic and ecological niches. The three Samar kites compose the largest concentration, located on a flat terrain in the Southern 'Araba Valley (Nadel et al., 2010). In the Negev Highlands, kites were built on steep slopes (e.g., the Pitam, Sayarim, Eshel and Achshuv kites), or on plateaus, incorporating cliffs at their edges (e.g. the Harut and both Nahal Horsha kites).

Kites in the hilly terrain comprise two types of heads at their apex. One is surrounded by a vertical wall, as was documented by



Fig. 12. A general view of the Nahal Horsha north head, with the arms converging towards the cliff. Note the large collapsed head on the slope.

excavation at the Sayarim kite and by a survey at the Eshel kite. In the other type the head is surrounded by a massive rampart, 3.0–5.0 m wide and probably originally 1.0–2.0 m high, as was documented by excavations at the Pitam kite and surveys at the Nahal Horsha kites. The Achshuv case is yet to be clearly established.

Evidently, the construction of the head was not limited to a surrounding wall/rampart. Both on the plain and up in the hills,

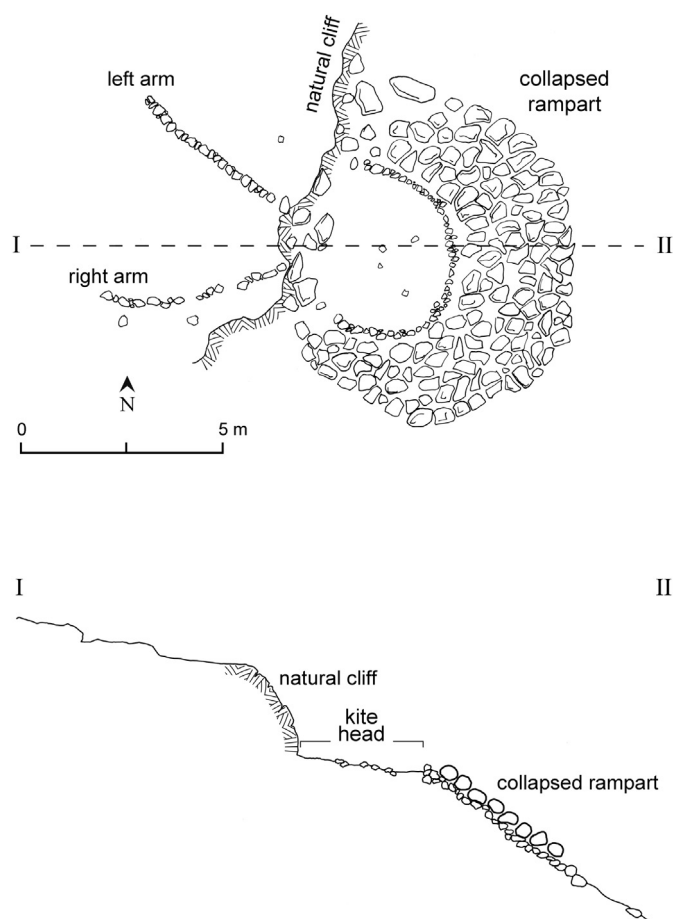


Fig. 13. Nahal Horsha north kite: plan and section of the head and cliff above it.

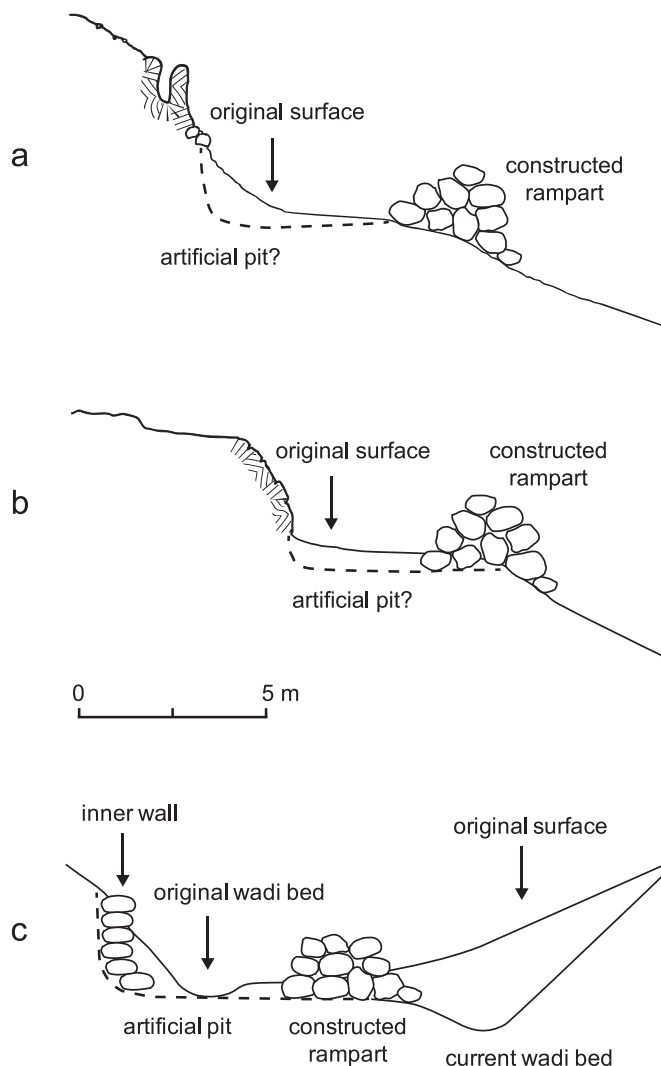


Fig. 14. Schematic sections of the heads of three studied hilly kites, presenting the leveling and construction phases. The kites' arms are not shown here. Top: the Nahal Horsha south kite. Middle: the Nahal Horsha north kite. Bottom: the Pitam kite: the digging of a wide pit; the construction of the retaining wall on the steep side; the construction of the rampart around the lower side. Note the change in wadi bed location after construction.

digging or leveling preceded the stone construction. Accommodating for specific topographic conditions, the courses of the arms were carefully chosen, sometimes crossing natural channels in order to follow the general planned direction. This direction may have been chosen following parameters such as wind direction (preventing the animals from smelling the hunters) or sun direction (sun in the eyes of the target herd). Furthermore, the specific head location was likely selected to maximize the available topographic opportunities.

On the plains, small channels were used for head location, and if the vertical difference between the plain and the bottom of the head was insufficient, it was enhanced by digging in the channel and by building a ramp on the plain's edge (Nadel et al., 2010). In the hilly terrain, the head was set either in a channel (e.g., Pitam, Sayarim) or directly below a vertical cliff (e.g., Nahal Horsha south and north, Harut). Construction included the use of available large boulders and stones. On steep slopes it was usually a rampart, while in channels it was either a wall or a rampart.

The head construction effort in some of the hilly kites was of a magnitude not documented during the studied Samar kites. The

construction of one kite included leveling the slope and moving ca. 100 t of rocks for building the head and construction of the arms; it was indeed a remarkable effort (see also Kempe and Al-Malabeh, 2010 for kites in Jordan; and Hockett et al., 2013, for experimental results and ensuing calculations).

This is especially outstanding when compared to local contemporaneous dwelling structures, which were small and simple in terms of stone use. In other words, the investment in kite construction reflects their importance on the one hand, and the communal effort on the other (probably many tens of construction man/days per kite). Accordingly, the kites may have also had a special and even symbolic/ritual meaning for local communities, even if originally planned only as large-scale hunting devices.

Whatever the construction method, the long arms and the head had a direct impact on the environment – though only on a limited local scale (Nadel et al., 2010; Bar-Oz et al., 2011a). The landscape was now built with massive stone structures enduring the elements for thousands of years. In all cases the constructed features remain on the landscape, either complete, almost complete, or as piles of collapsed stones. These changed water regimes on the slopes and diverted runoff water, though only in the immediate vicinity of the walls. Soil characteristics and vegetation growth at these locales also changed, with the construction stones themselves inhibiting the germination of almost all species. In the case of the Pitam kite, the channel course itself was diverted by 3.0–5.0 m. All head structures became sediment traps, infilling by natural processes and creating a micro-niche with preferred conditions for plant growth (more soil and humidity).

The only other kind of massive building on the landscape incorporated graves (such as tumuli and Nawamis), but usually not mundane features or dwelling structures. This correlation of kites and burial structures is also known in other parts of southwest Asia, and should be further explored. On another level, numerous contemporaneous dwelling sites also had direct impact on the environment. These, most probably, had profound and different effects on their immediate landscape (using construction materials such as stone and wood, using the already scarce vegetation for fuel and herd fodder, accumulating refuse dumps, etc.).

In terms of targeted game, our results are limited. It is clear that the kites were set either near grazing locales, or on commonly used routes (Fig. 5). The dimensions of the kites reveal that the size of herds was limited to a few herbivores, with no place to capture hundreds or even tens at a time (though see a different scale in other chapters in this volume). We suggest that the plain kites were mostly used for gazelle capture, while the hilly ones were aimed at capturing the larger and heavier species, most probably focusing on the onager (*E. hemionus*) (see also Holzer et al., 2010; Nadel et al., 2010; Bar-Oz et al., 2011a). The massive ramparts may be explained not only in terms of durability on steep slopes, but also in preventing onagers from escaping the trap.

We found that the strategy of “leaving the trails open” between hunting episodes was practiced at all the 12 Negev and 'Araba game traps we studied (regardless of topographic setting or head construction method). In each, animal trails cross the arms of kites at points where narrow gaps were left within the walls (in a width of a trail, ca. 0.5–0.7 m). During communal hunts these passages were probably temporarily manned by hunters or blocked by dry bushes, rocks, etc. This kind of evidence, as well as all the above-described details, reflects profound knowledge of the physical environment and the behavior of the indigenous species roaming through it. Only by setting the kites at the right point (‘bottle neck’ or topographically advantageous location) and using them at the appropriate time (when the target herd was passing), could the ancient hunters succeed in their communal endeavor.

Despite previously published ^{14}C and OSL dates (Holzer et al., 2010; Nadel et al., 2010), the issue of absolute and precise dating of all desert kites is yet to be addressed. Even in excavated cases, cultural-specific finds (e.g. arrow heads, pottery sherds, etc.) are rare at best, and datable organic remains are also very scarce. Though several plain kites were radiometrically dated (see summaries in Holzer et al., 2010; Nadel et al., 2010), the following dates are the first for hilly kites in this region of the Near East. We have one ^{14}C date on charred remains from Pitam (1560–1390 Cal BC), and another ^{14}C date on charred remains from Sayarim (3350–3010 Cal BC). In both cases the dates appear to be later than the kites themselves, and though the two dates are ca. 1500 years different, the traps may be contemporaneous. Whatever the case, such dates were also obtained (by both ^{14}C and OSL) for other kites in the Negev and Sinai (see discussion in Holzer et al., 2010).

At this stage we have no evidence to support a model of a chronological trajectory between the plain and hilly structures, and in both ecological niches kites were used at least from the beginning of the Early Bronze Age, perhaps around 3500 Cal BC. In some cases they may have been used for many generations and even millennia. In others – like the three dated Samar kites – they went out of use already during the Early Bronze Age, as is evident by construction of a habitation camp or a tumulus on top of the kite's head, both radiometrically dated (Holzer et al., 2010; Nadel et al., 2010).

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