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REVISITING MIDDLE STONE AGE HUNTING AT ≠GI, BOTSWANA: A TIP CROSS-SECTIONAL AREA STUDY

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ABSTRACT
≠Gi was excavated almost half-a-century ago. Despite no formally published analyses of its lithic and faunal assemblages, the site has been important to discussions about technological development during the Middle Stone Age (MSA). Dating to ~77 ka, ≠Gi has been argued to represent one of the earliest contexts in southern Africa where the spearthrower-and-dart may have been used as a mechanically projected weapon system. Here we provide a brief history of lithic-point research pertaining to the site, and report on a tip cross-sectional area (TCSA) analysis conducted on 359 MSA points excavated from ≠Gi. Based on the TCSA approach, we hypothesise that the use of stabbing spears in ambush hunting, perhaps in tandem with lightweight javelin hunting, was the most likely scenario for the MSA hunters who used the site.

Keywords: Middle Stone Age hunting, spearthrower-and-dart, bow-and-arrow, lightweight javelin, thrusting/stabbing spears

1. Introduction

≠Gi Pan (we use '≠Gi' for the archaeological excavation, and '≠Gi Pan' to refer to the broader, but immediately related, pan-scape) with its associated archaeological site is in the Dobe Valley of the northern Kalahari Basin, Botswana, one kilometre east of the Namibian border (Fig. 1). The climate here is semi-arid, with sporadic summer rains between October and March and moderate to cool winters with little to no rain (Thomas & Shaw 2010). Southern African pan-scapes are wide, shallow depressions that create localised drainage basins where run-off water accumulates after good rains. The pans often dry out by the end of the winter or during cyclic periods of drought. A /Xam hunter-gatherer from South Africa described pan-scapes as places where there is water which is "level with the ground" (Digital Bleek and Lloyd n.d.: L.II.12: 629). When other open water and grazing become scarce, large animal herds congregate in these spaces, not only to drink when the pans still hold some water, but also to benefit from the minerals and vegetation.

To the Ju/'hoansi hunter-gatherers of the Kalahari Dobe region these areas represent land-use hubs (Lee 2013), wherein the pan-scapes form part of their 'resource territories' that are handed down from one generation to the next (Hitchcock et al. 2019). Similar, inheritable landscape custodianship around water sources is known from the Northern Cape in South Africa that used to be inhabited by /Xam hunter-gatherers (Deacon 1986). Many of the pans, including the one at ≠Gi, are known hotspots for ambush hunting where hunters would build small stone blinds within ~100 m of the water's edge (Hitchcock et al. 2019), or large hunting-funnel systems on higher ground up to 1 km away (Lombard et al. 2021a). In both cases, the structures are strategically constructed along animal trails.

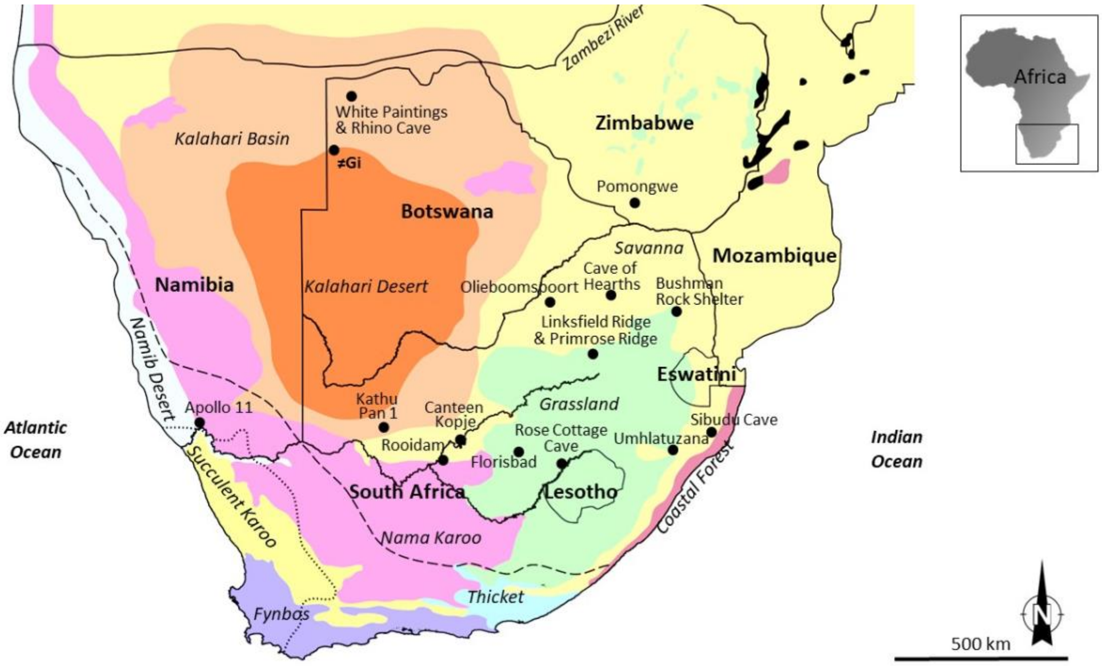

Figure 1. Map of southern Africa with the location of ≠Gi and other sites mentioned in the text. The area left of the stippled line = winter-rainfall zone, the area between stippled and dashed lines = year-round rainfall zone, and the area right of the dashed line = summer-rainfall zone (base map by Matt Caruana, University of Johannesburg, with details and annotations by ML).

Hitchcock et al. (2019) report that in the greater Dobe/Nyae Nyae region hunters preferred to ambush animals such as duiker, eland, gemsbok, hartebeest, impala, kudu, springbok, steenbok, warthog, and wildebeest. Such ambush hunting is often done from the hunting blinds (either shallow-dug hollows or low stone circles) scattered around the pans. Hunting from behind the blinds is mostly done with bows and arrows, probably because they provide stealth. Animals wounded with poisoned arrows or javelins are then pursued and killed elsewhere. Sometimes, ambush hunters also kill prey immediately with their spears and clubs (Hitchcock et al. 2019). These records provide valuable insight into hunting strategies and the different weapon types used simultaneously by the same groups of hunters, indicating that reconstructions of past hunting arsenals focussing on a single weapon type may be out of touch with African hunter-gatherer reality.

≠Gi is situated on an ancient pan-scape (for geo-archaeological discussion see Helgren & Brooks 1983), and as such was also used by humans during the Stone Age. As an archaeological site, it was first observed by Alison Brooks and John Yellen in the 1960s, and excavated by them during the 1970s (Brooks & Yellen 1979). Some of the hunting blinds or pits at ≠Gi are from Later Stone Age contexts, which date from ~24 ka to the last two hundred years or so (Helgren & Brooks 1983). It is therefore reasonable to suggest that the site was used for ambush hunting during the Holocene, and perhaps the final Pleistocene (Brooks 1978; Kuman 1989).

Beneath the Later Stone Age levels at ≠Gi, sealed by a non-pedogenic lacustrine limestone layer, is a Middle Stone Age (MSA) deposit dated to 77±11 ka (Brooks et al. 1990). Brooks et al. (2006) have suggested that stone points from this context were likely used to tip spearthrower darts, which would be the first and only indication of such weapon use in southern Africa to date. The purpose of this contribution is to make available the morphometric data for 359 MSA points excavated from ≠Gi, report on a tip cross-sectional area (TCSA) analysis based on these data, and discuss what the results may reveal in terms of current research and theorising about MSA weapon use and hunting strategies in southern Africa.

2. Background to the MSA point assemblage from ≠Gi

Despite the 244 m² excavated to an average depth of two metres (Brooks & Yellen 1977), and the recovery of approximately 1500 retouched lithic pieces (Brooks et al. 2006), the only formal stone tool analysis for ≠Gi, of which we are aware, is Kathleen Kuman's (1989) unpublished PhD thesis. She reported that the MSA assemblage is most similar to the Bambatan industries of Zimbabwe (previously known as the Rhodesian Still Bay [e.g., Bond & Clark 1945]), sharing traits such as a common richness and variety of retouched tool types, a variety of unifacial and bifacial points, an emphasis on the radial working of cores and the rarity of blades.

Retouched points and scrapers are dominant in the ≠Gi MSA formal-tool assemblage – here we focus on the points (Fig. 2). Kuman (1989) recorded 597 points, and a further 78 broken point tips. Her point categories included unifacial points (n=218), unifacial points with basal ventral retouch (n=93), points with inverse-obverse/dorsal-ventral retouch (n=17), partly bifacial points (n=124), bifacial points (n=131), and an incomplete/uncertain sub-type (n=14). The summarised descriptive statistics for the four most frequent point categories studied by Kuman are presented in Table 1. The number of points for each category measured by Kuman differs from the number of points reported for each category in the text (Kuman 1989: 189), probably reflecting broken points for which maximum dimensions could not be measured.

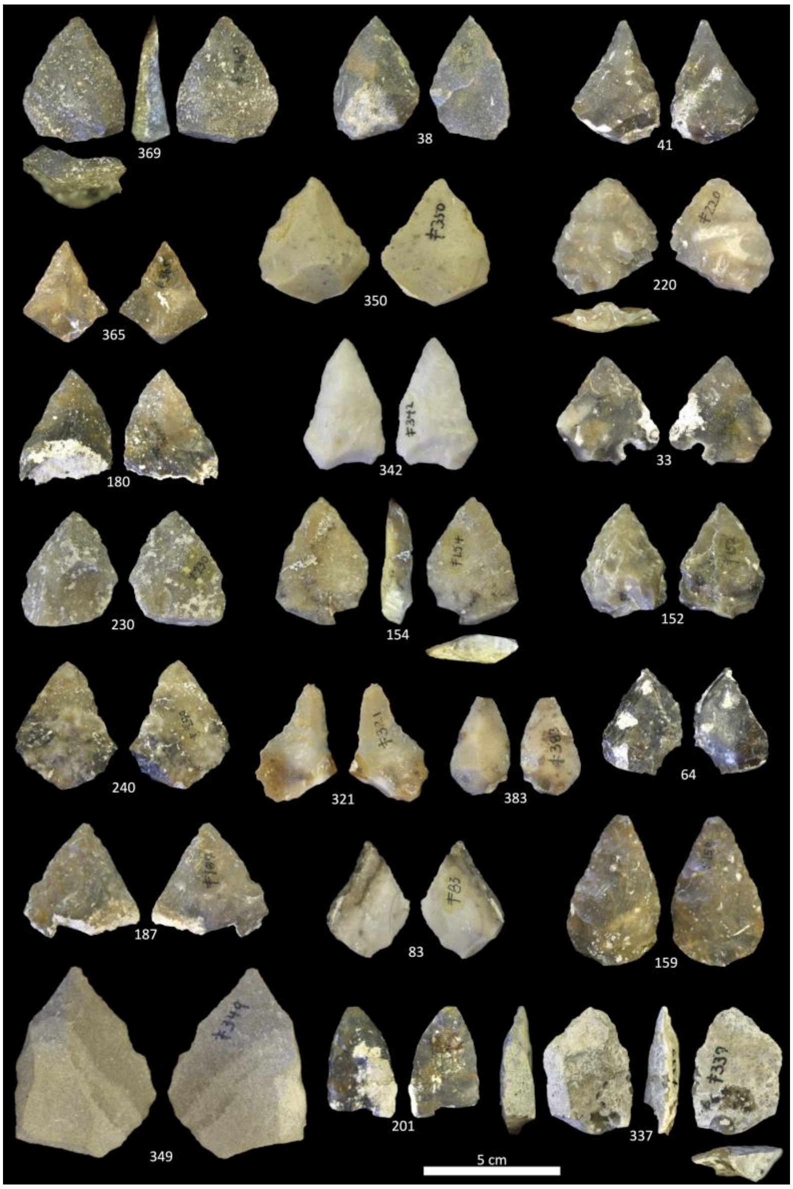

Figure 2. Selected examples of what were interpreted as MSA points from ≠Gi (photographs and individual numbers by Julie Daniel, plate preparation by Matt Lotter).

Table 1. Mean dimensions and standard deviations for points from ≠Gi from Kuman (1989: 242), Brooks et al. (2006), and dimensions of stone arrow and dart tips published by Thomas (1978).

Point category	Length mm mean±SD	Width mm mean±SD	Thickness mm mean±SD	Mass g mean±SD
≠Gi Pan Kuman dimensions				
Bifacial	43.4±7.9 (n=47)	35.5±18.8 (n=57)	11±3.3 (n=55)	-
Partly bifacial	41.6±8.7 (n=69)	34.4±15.3 (n=70)	10±2.7 (n=69)	-
Unifacial	49.7±9.5 (n=138)	32.8±14.3 (n=149)	10±3 (n=148)	-
Unifacial basal/ventral ret.	40.7±7.1 (n=43)	30.1±4.7 (n=48)	10± 2.4 (n=48)	-
Kuman sample total	**~43.9 (n=297)**	**~33.2 (n=324)**	**~10.3 (n=320)**	**-**
Dimensions provided by Brooks et al. (2006)				
≠Gi Table 2	74±24.9 (n=16)	46.8±14.7 (n=16)	14.1±10.8 (n=16)	50.1±43.9 (n=16)
≠Gi Figures (same as Aduma 5 in Table 2)	40.2±8.2 (n=299)	30.1±6.1 (n=299)	10.2±2.7 (n=299)	11.8±7.2 (n=299)
Thomas' (1978) ethnographic standards				
Stone arrow tips	31.1±2.8 (n=132)	14.7±1.3 (n=132)	4.0±0.4 (n=132)	2.1±0.3 (n=132)
Stone dart tips	46.2±10.5 (n=10)	22.9±4.77 (n=10)	4.9±1.37 (n=10)	4.4±2.1 (n=10)

Based on point variability and informal wear observations (hand lens 5-10x magnification), Kuman's (1989: 240) working hypothesis was that the points were a dependable tool form, "perhaps akin to a pocket-knife, that was used in more than one manner", but mostly for cutting. She also suggested that some of the points may have been handheld, but that many were probably curated (re-sharpened), some perhaps in their shafts or hafts. Kuman (1989) interpreted the site as 'purposely specialised', but was cautious to ascribe a hunting function for the MSA because, at the time, there were no published records of MSA points in direct association with carcasses or hunting contexts, and no points have been associated with shafts to demonstrate their function as hunting weapons. There is, however, a reasonable faunal assemblage from the MSA context at ≠Gi. The preliminary list provided by Kuman (1989) includes: zebra (*Equus burchelli*), warthog (*Phacochoerus aethiopicus*), white rhinoceros (*Ceratotherium simum*), blue wildebeest (*Connochaetes taurinus*), giraffe (*Giraffa camelopardalis*), and Antelopini sp. (a tribe of medium-sized gazelles that may be springbok), as well as three extinct taxa in the form of giant zebra (*Equus capensis*), giant buffalo (*Pelorovis antiquus*), and a giant alcelaphine (?*Megalotragus priscus*).

Based on the 'abundant mammalian fauna' accompanying the lithic assemblage, apparently including >1000 teeth, Helgren and Brooks (1983) considered the use of ≠Gi Pan during the MSA as a hunting location for specialised techniques such as game drives or ambush hunting. According to them the dominant fauna are zebra and warthog (extinct and extant). Because these animals are difficult to hunt without dogs and/or from horseback today, the authors hypothesise hunting them during the MSA may have been best achieved through an ambush strategy – and that ≠Gi Pan provided such an ambush landscape.

In a review of trends in point assemblages, Brooks et al. (2006: 233) argued that the comparatively small size of many African MSA points – as opposed to Middle Palaeolithic (MP) points from Europe – denotes the use of "a complex projectile technology" rather than simple spears. They provide a discussion of the ≠Gi points listing the following traits:

- Predominantly small, triangular, and bifacial.
- Bases are heavily thinned and modified, presumably for hafting.
- Although some points are entirely unifacial, most have some degree of bifacial working, either just at the base, over part of the edge, or over the entire ventral surface.
- Maximum width, usually at the base, was tightly controlled, despite the range of raw materials including chert, jasper, chalcedony and quartzite (mostly locally available).
- Made on discoidal cores, with flake bulbs and striking platforms frequently on the corner rather than in the centre of the base.
- Markedly smaller than typical MP points from outside Africa.
- Multiple examples of projectile impact damage, including hinge fractures, broken tips, and burination spalls, micro-striations possibly due to hafting wear (but no formal use-trace method or results are presented).

Although she has not been cited, these traits are in general agreement with Kuman's (1989) analysis, so that it is uncertain whether Brooks et al. (2006) drew from her work or conducted their own analysis. The mean dimensions for 16 points from ≠Gi are, however, given as 74±24.9 x 46.8±14.7 x 14.1±10.8 mm (Brooks et al. 2006: table 2; our Table 1), which is different from the data for ≠Gi points in the subsequent figures (n=299). It seems that the row that says '≠Gi' contains the data for Aduma 1 and the 'Aduma 5' row that of ≠Gi, the row for 'Aduma 1' contains data for Aduma 8, the 'Aduma 8' row the data for Aduma 4, and the 'Aduma 4' row that of Aduma 5 (Benjamin Schoville pers. comm. March 2022). The authors nonetheless suggest that the size of the points from ≠Gi "places them at the lower limits of ethnographically known spear armatures and within the range of ethnographically known spear thrower darts and larger arrowheads" (Brooks et al. 2006: 240). They do not provide a baseline for spear tips, but conclude that the relatively small dimensions and mass of MSA points from Africa indicate the development of a projectile system – spearthrowers-and-darts more likely than bows-and-arrows (Brooks et al. 2006). Their inferences are based on Thomas' (1978) examination of 142 stone-tipped projectiles (10 darts and 132 arrows) from ethnographic contexts housed at the American Museum of Natural History. At the bottom of Table 1 we show how the Brooks et al. (2006) data for points from ≠Gi compare to that of Thomas (1978) for stone-tipped arrows and spearthrower darts, and return to this topic in our concluding discussion.

One of us (Lombard 2021) used the TCSA method (Table 2), with new ranges for poisoned arrow tips (Lombard 2020a, b) and lightweight javelins as used in sub-Saharan Africa to hypothetically assess variation in hunting weaponry during the MSA of southern Africa. Raw data for the points from ≠Gi were not available for that study (John Yellen pers. comm. January 2021). However, mean data from Kuman (1989) were used to calculate their approximate average TCSA value, following Villa and Lenoir (2006) for the use of processed data in TCSA studies. Compared to the standardised TCSA ranges for five Stone Age weapon-delivery systems (Table 2), the derived TCSA value of ~168 for the points from ≠Gi indicates that they would have been most effective for use as thrusting/stabbing-spear tips, and that their cumulative TCSA value is considerably greater than the ranges for American dart tips or arrowheads.

Table 2. Standardised TCSA ranges for five Stone Age weapon-delivery systems.

Weapon type	N of artefacts	Mean TCSA	TCSA range
Poisoned arrow tips (Lombard 2020a, 2021)	434	11±7	4-18
Arrowheads (Shea 2006)	118	33±20	13-53
Dart tips (Shea 2006)	40	58±18	40-76
Javelin tips (Rios-Garaizar 2016; Lombard 2021)	137	71±27	44-98
Thrusting/stabbing spear tips (Shea 2006; Lombard 2021)	75	159±71	88-230

To re-assess the inferences about MSA weapon use at ≠Gi Pan we report here on the TCSA analysis of 318 points curated at the National Museum of Natural History in Gaborone (Botswana), and 41 points currently held at the Smithsonian Institution in Washington (USA) (Fig. 2). Morphometric data for the artefacts identified as points were generated by Julie Daniel in 2005 as part of an unpublished student project supervised by SC, and we share some of these data in the Supplementary Online Material [SOM File 1]).

3. Tip cross-sectional analysis of MSA points from ≠Gi

TCSA analysis is based on a simple formula (0.5 x maximum width x maximum thickness) that provides directly comparable data for the part of a weapon tip that cuts the hole through the hide for the shaft to enter the prey animal (Hughes 1998; Shea 2006). Sitton et al. (2020) also demonstrated that TCSA geometry can be used to predict the penetration depth of stone-tipped weapons. The approach has been published often, and ML has recently provided methodological improvements (Lombard 2020a, b, 2021). We therefore do not rehash such discussion here. Instead, we start by presenting the TCSA values for each individual point from ≠Gi (Fig. 3), and interpret what these results may indicate about the use of weapon tips against the background of the standardised TCSA ranges in Table 2.

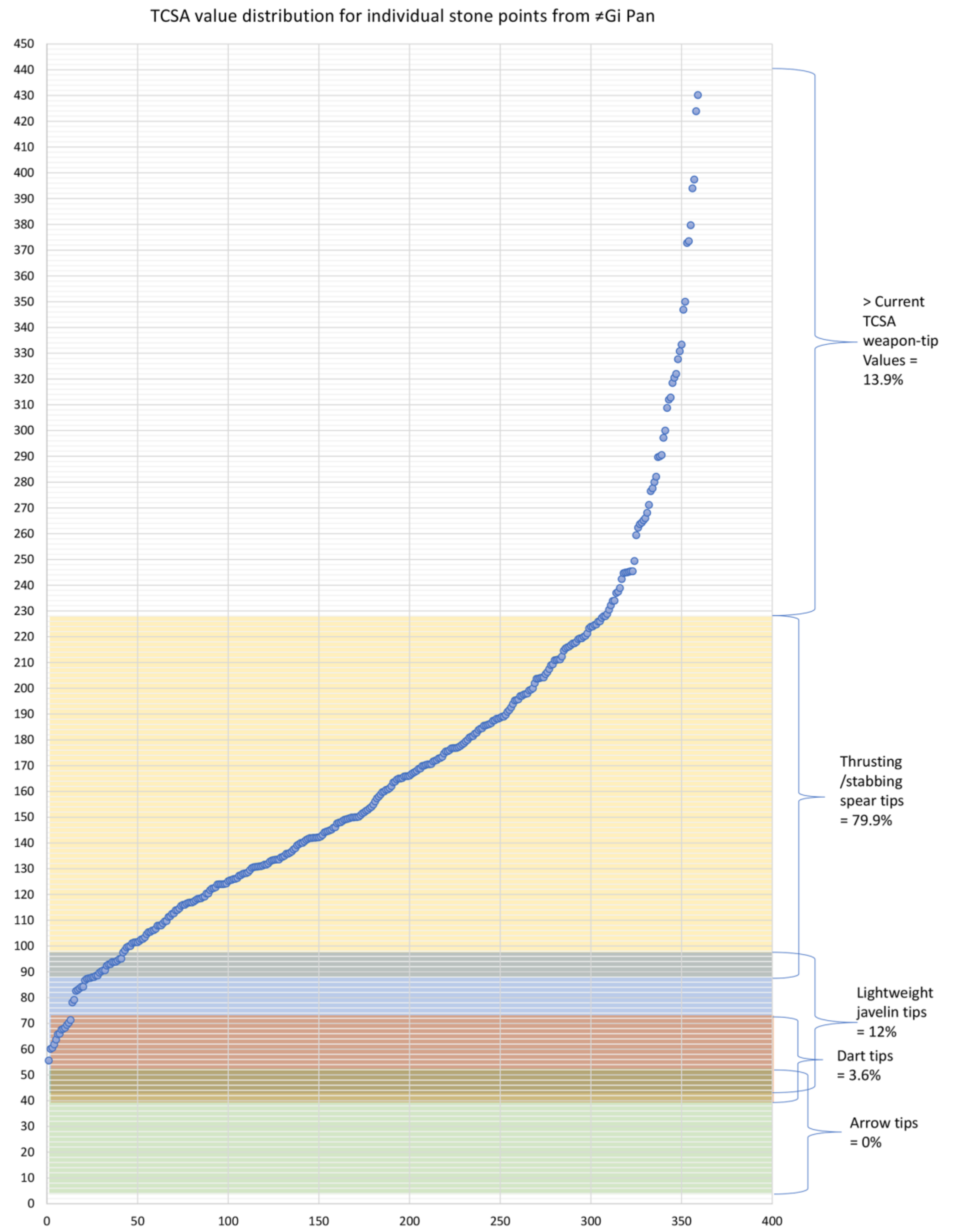

Figure 3. TCSA values for each of the MSA points from ≠Gi Pan plotted against the standardised TCSA ranges of the different weapon-delivery systems.

Our analysis shows that, hypothetically, 287 (79.9%) of the points from ≠Gi would have been most effective when used to tip thrusting or stabbing spears. By contrast, only 43 (12%) would be most suited for tipping lightweight javelins, and 13 (3.6%) conform to northern American spearthrower-dart tips. None of the ≠Gi points fall in the TCSA category for arrow tips, either poisoned or un-poisoned (in Fig. 3 we combined the range for both arrow-tip types).

Whereas TCSA results provide objective comparable data, without the support of contextualised use-related evidence the outcomes remain hypothetical, and is most suitable for building heuristic frameworks that can be assessed and fine-tuned with ongoing research. In the southern African context, we have reached a critical mass in multi-stranded work on the interpretation of Stone Age weapon use (see references listed in table 1 of Lombard & Shea 2021; also see Donahue et al. 2004; Lombard 2004; Lombard et al. 2004; Lombard 2005a, b; Wilkins et al. 2012; Wilkins et al. 2014; Schoville et al. 2016, 2017; Rots et al. 2017; Hitchcock et al. 2019). The interpretations of TCSA results for the region are thus anchored in a diverse range of ethno-historical, experimental, use-trace and archaeological records.

This allows us to hypothesise that, if some of the MSA points from ≠Gi were hafted and used as hunting weapons, they were most likely made to tip thrusting or stabbing spears, while a small percentage could also have served well as tips for lightweight javelins. Based on their TCSA values, the likelihood that these artefacts were made to tip darts (akin to those used in northern America) or arrows is unlikely in the sub-Saharan context. Also, their potential to serve as weapon tips do not distract from the probability that pointed tool forms were used as hafted knives (e.g., Clark JD 1988, Kuman 1989). Only detailed use-trace and residue analyses can demonstrate which tools were last used as either a weapon tip or a knife blade (e.g., Lombard 2004, 2005a).

The lightweight javelin category is, however, strict (Lombard 2021), and there is a reasonable expectation that many of the points with lower TCSA values in the thrusting/stabbing spear category could have been thrown effectively over shorter distances, compared to lightweight javelins that can be thrown forcefully and accurately for up to 30 m (Lombard submitted). Either thrown, stabbed or thrusted, it seems that the specialisation at ≠Gi Pan during the MSA was hunting with hand-held weapons. To further assess the points from ≠Gi in terms of variability in MSA hunting behaviour, we compare our results with those of other inland sites (Nama Karoo, Grassland Biome, Savanna Biome and the Kalahari Desert/Basin) dating roughly between MIS 4 and MIS 12 (Table 3; Figs 1 & 4).

Table 3. TCSA results and distribution across the potential weapon-delivery systems. Data for assemblages may vary from Lombard (2021), because we now include pieces with TCSA values >230. Also included are the Howiesons Poort backed microliths and corrected data for the Umhlatuzana Howiesons Poort where the tools now measured n=232. We also collated some assemblages from the same sites such as the Apollo 11 MSA 1.1 and 1.2 assemblages of MIS 5.

Assemblage	**TCSA**			**% Potential weapon-delivery system**					
Total number of artefacts n=2101	Mean	SD	Median	Spear	Javelin	Dart	Arrow	P-arrow	>230
~MIS 4 assemblages (n=712)									
Umhlatuzana HP ~56.5-63.5 ka (n=232)	24	21	17	3	7.3	7.3	62.9	45.3	0
Apollo 11 HP ~63.2 ka (n=57)	56	44	41	19.3	33.3	29.8	61.4	7	0
Pomongwe Magoisian MIS 4 (n=65)	87	55	77	26.9	59.7	38.8	23.9	0	3
Rose Cottage HP ~62-69 ka (n=84)	39	32	47	7.1	35.7	32.1	56	20.2	0
Sibudu HP ~60-67 ka (n=219)	51	44	36	14.6	32.4	28.3	58	18.3	0.5
Rhino Cave MSA ≥66 ka? (n=26)	89	43	72	42.4	61.5	50	23.1	0	0
White Paintings MSA ≥66 ka (n=29)	94	31	88	58.6	58.6	34.5	10.3	0	0
~MIS 5 Assemblages (n=840)									
Apollo 11 SB ~68-73 ka (n=15)	107	42	104	73.3	40	27.7	6.7	0	0
Sibudu SB ~68.5-72.5 ka (n=38)	116	51	102	71.1	34.2	26.3	7.9	0	0
Umhlatuzana SB ≥70 ka (n=39)	89	31	92	58	53.8	25.6	15.4	0	0
Sibudu pre-SB >77 ka (n=46)	100	54	84	45.7	54.30	43.8	15.2	0	2.2
≠Gi Pan, Botswana, ~77 ka (n=359)	168	76	155	79.9	12	3.6	0	0	13.9
Apollo 11 MSA MIS 5 (n=45)	176	108	152	55.6	17.8	11.1	6.7	0	24.4
Bushman Rock MIS 5 (n=165)	146	81	130	56	25.9	13.9	9.6	0	16.9
Cave of Hearths MIS 5 (n=63)	126	51	116	69.8	33.3	11.1	4.8	0	4.8
Florisbad expedient MSA 121±60 ka (n=70)	208	85	198	60	8.6	5.7	2.9	0	34.3
~MIS 6-8 assemblages (n=398)									
Olieboomspoort ~134-164 ka (n=79)	158	75	139	75.9	16.5	7.6	0	0	13.9
Florisbad early MSA ~175 ka (n=76)	190	71	187	68.4	5.3	1.3	0	0	28.9
Rooidam 2 MSA/Fauresmith >174 ka (n=130)	170	101	150	53.1	29.2	15.4	5.4	0	23.8
Linksfield Ridge Sangoan MIS 6-8? (n=46)	200	73	194	65.2	0	0	2.2	0	32.6
Primrose Ridge Sangoan MIS 6-8? (n=54)	210	64	195	68.5	0	0	0	0	31.5
Canteen Kopje Fauresmith >300 ka (n=13)	189	94	190	76.9	7.7	0	0	0	15.4
~MIS 11-12 assemblage (n=151)									
Kathu Pan Fauresmith >464 ka (n=151)	223	85	215	56.3	6	2	0	0	40.4

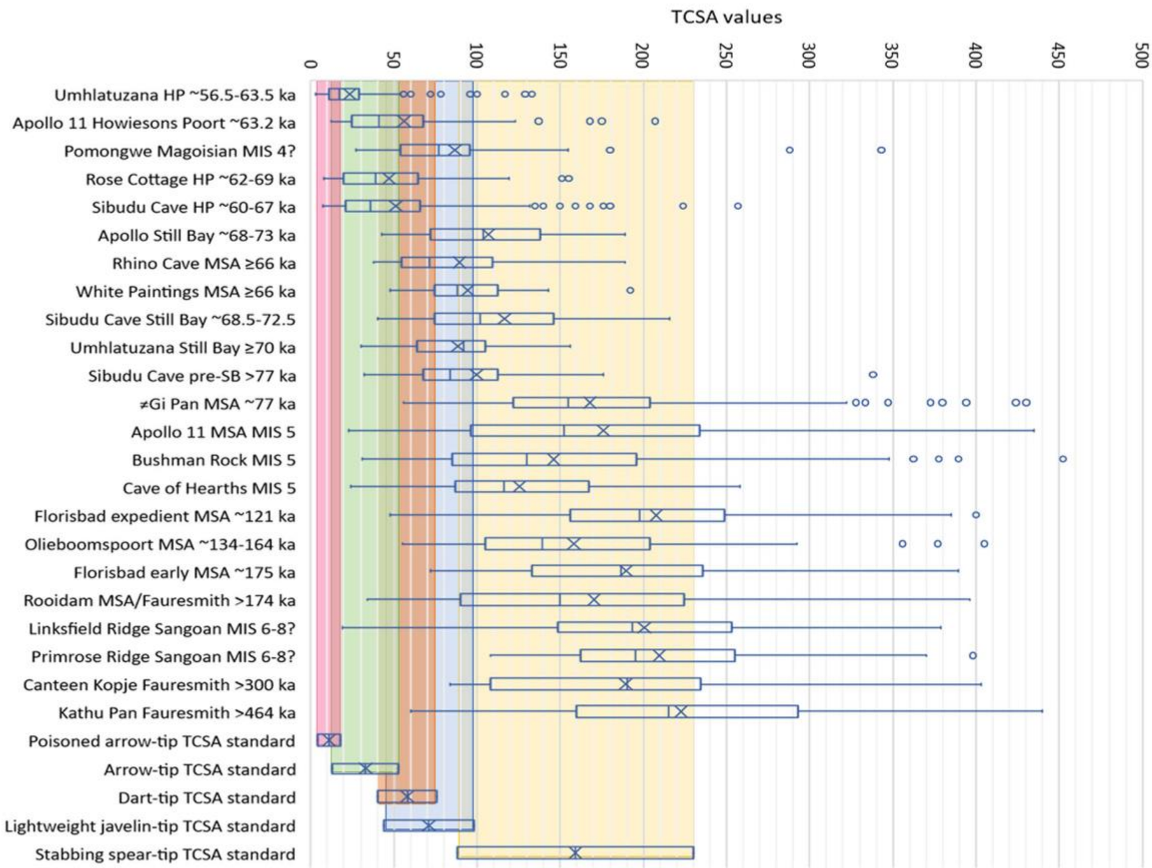

Figure 4. Bar and whisker plots of the TCSA values for points from inland (Nama Karoo, Grassland Biome, Savanna Biome and the Kalahari Desert/Basin) sites in southern Africa, with assemblages dating from roughly 60 ka to almost 500 ka.

The median TCSA value (indicating the main weapon-tip trend) for the points from ≠Gi groups with other MIS 5 point assemblages falling in the thrusting/stabbing spear-tip range such as those from Apollo 11, Bushman Rock Shelter and Cave of Hearths (Table 3, Fig. 4). These assemblages are different from the Still Bay/pre-Still Bay group of MIS 5 assemblages wherein two (Umhlatuzana Rock Shelter [Still Bay] and Sibudu Cave [pre-Still Bay]) have medians in the lightweight javelin-tip range and the other all have relatively large proportions (34.2-54.3%) of their points suitable for tipping lightweight javelins. The possible use of spearthrower-dart tips is also highest in the Still Bay/pre-Still Bay assemblages (25.6-43.8%), but never reach levels to indicate that it was the preferred weapon-tip type. The ≠Gi point assemblage has the lowest proportion (3.6%) of possible dart-tip use (according to the northern American standard) amongst all the MIS 5 assemblages.

In contrast to the MIS 5 assemblages, none of the younger MIS 4 assemblages have median TCSA values that are consistent with the preferred use of thrusting/stabbing spears, instead, there is a clear trend towards hunting with stone-tipped arrows, especially in the Howiesons Poort assemblages (56-62.9%) that also indicate the use of poisoned arrow tips at Umhlatuzana Rock Shelter (45.3%), Rose Cottage Cave (20.2%) and Sibudu Cave (18.3%). Lightweight javelin-tips dominate the Rhino Cave (61.5%) and Pomongwe Rock Shelter (59.7%) assemblages. At White Paintings Shelter the production of points falling into either the lightweight javelin or thrusting/stabbing spear categories were equally practiced (58.6% for both). The possibility of hunting with spearthrowers-and-darts during MIS 4 ranges from 7.3% at Umhlatuzana Rock Shelter to 50% at Rhino Cave, but is never the dominant category (Table 3, Fig. 4). Collectively, the MIS 4 assemblages demonstrate a clear shift away from hunting with thrusting/stabbing spears to using long-range weapons.

The ≠Gi points also group well with the older assemblages where thrusting/stabbing spear tips were the preferred category (Fig. 4). Three of the seven older assemblages (Florisbad, Rooidam 2 and Kathu Pan) were excavated from open pan-scape sites. It is reasonable to suggest that these localities were similarly attractive to deep-time Stone Age hunters as land-use hubs and for ambush hunting as ≠Gi Pan is still today – what we do not know is whether deep-time hunters ambushed from hunting blinds as they did during the Later Stone Age. Although the MIS 5 sites of Apollo 11, Bushman Rock Shelter and Cave of Hearths, as well as the ≥MIS 6 sites of Olieboomspoort, Linksfield Ridge, Primrose Ridge, and Canteen Kopje are not pan-scape sites, they are all positioned in locations conducive of ambush hunting (Lombard et al. 2021b), with some or all of the following traits:

- Topographic barriers such as river gorges and fault scarps with safe, high-lying lookout points for surveying animal herd movements.
- Predictable drinking points with water-logged soils that limit herd response time and mobility.
- The presence of suitable knapping material for artefact production.
- Diverse mountainous biotopes with rugged topography juxtaposed between extensive grazing plateaus that facilitate the congregation of large animal herds.

And it may be noteworthy that all their point assemblages have TCSA ranges consistent with a preference for hunting with thrusting/stabbing spears.

4. Discussion

Harvesting ambush-trapped animals probably represents the oldest context in which hominins started to actively kill their prey with weapons (Bunn & Gurtov 2014). Direct evidence for lake-edge horse ambush hunting with wooden spears was excavated at Schöningen, Germany, dated to ~300 ka (Thieme 1997). In southern Africa, ambush hunting or harvesting during the Acheulean is suggested for the spring wetland at Elandsfontein (Bunn 2019), and the natural ambush funnel at Wonderboompoort (Lombard et al. 2021b). These sites may date to ~0.5-1 Ma, and neither has yet been associated with hunting weapons, so that it is uncertain whether people actively hunted or simply harvested animals from the ambush scenarios (Lombard et al. 2021b). The large lithic assemblage from Kathu Pan possibly dating to ≥464 ka, however, contains pointed artefacts with impact fractures that are consistent with some of them having been hafted and used for hunting (Wilkins et al. 2012). Similar evidence was observed on point assemblages from Blombos Cave dating to 73-99 ka (Lombard 2007), Sibudu Cave dating to ~52-72 ka (Lombard 2005a, 2006), and White Paintings Shelter dating to ≥66 ka (Donahue et al. 2004), so that it is now widely accepted that pointed stone tools and/or convergent flakes were used for hunting in southern Africa – amongst other things.

At the time that Kuman (1989) conducted her study, there was no such evidence and researchers such as Klein (e.g., 1979) still thought that 'active hunting' only occurred after a sudden genetic mutation by ~40 ka. When Shea (1988, 1990) identified impact wear on points from the Levantine Mousterian dating back to ~60 ka, it was seen as controversial because similar evidence was thought to be lacking in European assemblages (e.g., see discussion in Shea et al. 2002). Some Euro-centric researchers remain sceptical (e.g., Rots & Plisson 2014), despite the now prodigious evidence for stone-tipped weapon use during the MSA in southern Africa, and despite themselves using similar approaches to argue for the use of stone-tipped hunting weapons during the European Upper Palaeolithic (e.g., Tomasso & Rots 2021). As things stand, the onus is on those who still doubt that MSA hunters used stone-tipped weapons to explain the hunting strategies responsible for the often-sizeable faunal assemblages associated with these artefacts (e.g., Steele & Klein 2013; Reynard & Henshilwood 2017; Hutson 2018; Clark JL 2019).

Whilst Kuman attempted a rudimentary approach to use-wear, she did not follow a protocol designed to recognise hunting use specifically, and several of the approaches for doing so were only refined after her study of the ≠Gi assemblage. Her working hypothesis that the retouched points were dependable multi-purpose tools may be accurate. For example, Lombard (2006) found that Still Bay points from South Africa dating to a similar timeframe may have been hafted and used as both knives and spear tips. Use-trace evidence for variable functionality does not distract from discussing MSA weapon-assisted hunting strategies.

Almost 20 years after Kuman's analysis, the Brooks et al. (2006) study had much more research to draw from in terms of MSA hunting. Yet, different from other groups working on an assortment of hunting-weapon questions at the time (e,g., Hutchings & Bruchert 1997; Shea et al. 2001, 2002; Schmitt et al. 2003; Lombard 2004, 2005a, b; Shea 2006; Whittaker & Kamp 2006), they never conducted experiments or systematic use-trace work. Instead, although their inference about spearthrower-and-dart hunting at ≠Gi was based on Thomas's (1978) ethnographic data for northern American stone-tipped arrows and spearthrower darts, they did not present his data in direct relation to their results.

At the bottom of Table 1 we present a summary of these data, demonstrating how the Brooks et al. (2006) data for the points from ≠Gi compare to that of Thomas (1978). This direct comparison reveals that both data sets presented by Brooks et al. (2006) for the points from ≠Gi (Table 1) is markedly different from Thomas' arrows or darts in terms of width, thickness and mass, so that the basis for their interpretation is unclear. For example, although they claim that weight may be the most important attribute in the development of a projectile technology, the mean mass they report for the ≠Gi points is either 50.1±43.9 g or 11.8±7.2 g, whereas Thomas' (1978) are 2.1±0.3 g for arrows and 4.4±2.1 g for darts. Thus, even if the smaller weight range for ≠Gi is the correct one (our weight for 359 points = 12.1±7.4 g [SOM File 1]), they are still considerably heavier than the ethnographic dart tips from northern America. Thomas (1978) also warned about low confidence levels for his spearthrower-dart standard because the data come from only 10 artefacts.

The perception that the points from ≠Gi are relatively small compared to Middle Palaeolithic points from Europe (Brooks et al. 2006), may come from the fact that they are fairly short. For example, Still Bay points from four sites (Apollo 11, Hollow Rock Shelter, Sibudu Cave and Umhlatuzana Rock Shelter) in southern Africa have mean lengths of ~47-65 mm whereas the mean length of our sample from ≠Gi is ~41 mm. The ≠Gi points are, however, relatively wide (~31 mm) and thick (~11 mm) compared to the four Still Bay assemblages ranging from 20-29 mm in width and 8-11 mm in thickness. This could reflect Kuman's (1989) observation that many of the ≠Gi points may have been re-sharpened in their shafts or hafts, so that their original length and mass is perhaps obscured.

Returning to their possible use as dart tips, Lombard (2021) highlighted some issues regarding the current TCSA standard for dart tips, and the TCSA value of 132 hafted Leilira points analysed by Newman and Moore (2013) from the South Australian Museum is ~290, so that they fall outside the conventional TCSA values for the different weapon-delivery systems (Table 2). According to Newman and Moore (2013), it demonstrates that indigenous Australians did not optimise the ballistically-relevant attributes of their darts (also see Clarkson 2016). It is therefore likely that the TCSA method (in its current format) is ineffective for distinguishing darts tips from other weapon-delivery systems, whilst being robust for hypothesising about arrows, lightweight javelins, and stabbing/thrusting spears in the sub-Saharan African context. In our results section (Table 3) we included a >230 TCSA category. In the Australian context, this may relate to dart tips for specific prey types such as emus and kangaroos (e.g., Trigger 1987). Leilira points were, however, mostly used as resin-hafted ceremonial knives or fighting picks (Akerman 2007), so that expectations of them conforming to a ballistically relevant TCSA standard in a generalised sense may be skewed.

As indicated above, morphometric studies do not have the power to determine use 'blindly', instead, interpretations must be anchored contextually to be robust (Lombard & Shea 2021). This also applies to morphometric studies that suggest the use of spearthrowers in sub-Saharan Africa during the MSA (e.g., Brooks et al. 2006; Sisk & Shea 2011; Sahle & Brooks 2019). Thus far, there is no ethno-historical, experimental, or convincing use-trace backup for the use of spearthrower-propelled darts – neither in their small northern American form, nor in their large Australian shape. It is our stance that much more experimental and use-trace work is needed to resolve the dart-tip TCSA category.

The use of javelins and spears is, however, habitual amongst hunter-gatherers from sub-Saharan Africa – and their TCSA categories for the African context relatively robust (Lombard 2021). It is therefore necessary to have controls for these weapon types when hypothesising about Stone Age weapon-assisted hunting strategies. Our TCSA results suggest that, similar to other Middle and Earlier Stone Age ambush sites, the MSA hunters at ≠Gi preferred to kill their prey animals with relatively sturdy thrusting/stabbing spears, which could perhaps be thrown over short distances – not much different from what hunters still sometimes do at the site. Some (12%) of the points would have been most suitable for tipping lightweight javelins. The proportions of artefacts that can be ballistically associated with long-range, mechanically projected weaponry such as northern American spearthrowers with darts or bows with arrows (3.6% and 0% respectively) are too small to indicate their habitual use at the site during the MSA. At other sites with point assemblages that are roughly contemporaneous with the MSA occupation at ≠Gi, hunters seem to have used lightweight javelins together with thrusting/stabbing spears. Such a variable strategy would have brought adaptive advantages such as a broader range of prey animals, killing prey with less risk of injury, and increased potential for opportunistic hunting on a more diverse hunting landscape.

The trend at ≠Gi, however, seems to have been a general preference for using the tried-and-trusted thrusting/stabbing spears (sometimes perhaps flung from a short distance), appropriate for hunting herd animals congregated at the water's edge, as demonstrated by the horses hunted at Schöningen. The zebras and blue wildebeest in the faunal assemblage of ≠Gi would support such a hypothesis, as does the presence of warthog, giraffe and extinct giant buffalo remains. Based on the TCSA results we presented in this study, those looking for the possible use of spearthrower darts (similar to their northern American counterparts) during the southern African MSA may fare better by looking at Still Bay and Howiesons Poort assemblages. Yet, also in those assemblages, points conforming to the current TCSA range associated with either small northern American or large Australian dart tips never dominate. Until experimental, use-trace and faunal evidence can corroborate the use of spearthrowers for the southern African context it remains an unsubstantiated hypothesis (Lombard & Shea 2021).

5. In conclusion

To further assess MSA hunting hypotheses for the ≠Gi pan-scape, we need to return to the assemblage. First, we need to identify all the points and point fragments in the assemblage of both retouched and Levallois-type points that may not be included in this study. For example, Daniel measured 359 points, and Kuman 324, yet Kuman (1989) indicated that 597 points and a further 78 broken point tips were present in the assemblage, and she did not consider the presence of unretouched Levallois points (Kuman pers. comm. March 2021). Secondly, a formal macro-fracture analysis should be able to confirm whether some of the points from ≠Gi were indeed used for hunting. However, if the excavators did not use fine-meshed sieves to curate all the small tips of broken points, such an analysis cannot be thorough or directly comparable with the results of other studies that included all the fragments and tips in an assemblage (e.g., Lombard 2005b, 2007). Robust hunting interpretations – or the lack of hunting – cannot be based on casual fracture observations made on assemblages of unbroken points (as done by Douze et al. [2020], self-citing a paper [Douze et al. 2015] that does not include any reference to a formal micro-fracture study). The depositional and curational history of the MSA artefacts from ≠Gi may also prevent micro-wear and micro-residue studies from being fruitful, for example, several of the points have depositional concretions (Fig. 2), but possibilities for such studies will be evaluated when/if access to the assemblage is granted.

To explore possible variability in hunting strategies practiced at ≠Gi Pan during the MSA, we also need to better understand the proportion of points with TCSA values >230. In the current ≠Gi assemblage this constitutes almost 14% of all the points represented in this study and 40.4% of the Kathu Pan points. If these large points were used to tip hunting weapons, they are currently not covered by TCSA weapon-tip ranges – apart from perhaps representing large Australian Leilira-tipped darts. Although not impossible, we are not about to suggest that southern African *Homo erectus* hunters used spearthrowers at Kathu Pan by ~500 ka. On the other hand, the thick wooden spears from Schöningen seem to have been most comfortable and effective to use in bimanual thrusting (underarm and overarm) as opposed to one-handed stabbing (Milks 2018). Bimanual thrusting-spear use was suggested by Schmitt et al. (2003) as consistent with anatomical features observed in the Neandertal anatomy – as opposed to the 'throwing' arms and shoulders of later *Homo sapiens* (e.g., Roach et al. 2013). It could, however, also indicate different weapons used for different purposes, or during different phases in an ambush hunt.

Future experimental research needs to explore variation in dart-tip categories, and the parameters of bimanual thrusting *vs* single-handed stabbing spears in more detail. The current TCSA standard for thrusting/stabbing spears was derived from experiments using a calibrated crossbow (Shea 2006) and one-handed stabbing spears as used by some African warriors (Lombard 2021). Continued experimentation and locating ethno-historical weapons that were used mainly for bimanual thrusting may, however, provide a new TCSA baseline to distinguish between tips suited better for one-handed stabbing spears *vs* those best suited for bimanual thrusting. Similarly, continued work on dart-tip variation may confirm two distinct categories as was proposed by Cattelain (1997), namely large terrestrial spearthrowers most effective for Bov II (sheep size) and larger animals, and small Arctic spearthrowers to hunt marine mammals and birds. Whether either of these were ever used in a southern African context such as on the ≠Gi pan-scape remains to be established.

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Supplementary online material

Lombard & Churchill Supplementary Online Material File 1

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