Bone Harpoons Recovered from El-Ga'ab Depression Western Sahara (Sudan): Shape Attributes and Morphometric Analysis

Yahia Fadl Tahir, Huda Abdalla Khalid, Hamad Mohamed Hamdeen and Fatma Idris Mahmoud

Introduction

One aspect of early industries is the use of bone to make tools similar to those made of stone. During the Upper Palaeolithic bone, antler and ivory were extensively worked with a variety of techniques to make projectile points, harpoons, spear-throwers, eyed needles and jewellery.

The bone harpoon is a long spear-like instrument and one of the ancient weapons used in fishing. It has sharp edges to penetrate the body of the target animal and barbs to secure it, allowing the fishermen to use a rope or stick attached to the butt of the projectile to catch the animal.

This paper attempts to shed light on the shape attributes and morphometric dimensions of harpoons which were collected from el-Ga'ab Depression (Western Desert, Sudan).

Bone Harpoon dates and development in Africa

The oldest bone harpoons are reported from Africa. Brooks *et al.* (1995) and Yellen *et al.* (1995) dated bone harpoons to the Middle Stone Age in the Semliki Valley (Zaıre) with thermoluminescence (TL), electron spin resonance (ESR) and Uranium-series, giving a range between 174,000 BP to 82,000 BP. In particular, archaeological sites at Katanda on the Semliki River have provided evidence for a well-developed bone industry in a Middle Stone Age context. Artifacts include both barbed and unbarbed points. Together with abundant fish (primarily catfish) remains, the bone technology indicates that a complex subsistence specialization had developed in Africa by this time (Yellen *et al.* 1995, 553).

Barbed bone points recovered from Katanda (Zambia) and Ishango (Congo), Zaire, and Botswana date back to the Late Pleistocene. One of the bone harpoons from Ishango (Congo) has notches along one edge and dates to (~20 ka), and a bone handle with hafted stone flake from the layer below it (~22 ka) is covered by sets of short incised lines (Clark 1970).

Nelson (1991, 11) excavated site GaJil2 at Koobi Fora, Lake Turkana, Kenya and found uniserial harpoons and points varying in length from 64-166mm in the lowest layers (period 1). In the second period layers he found a fragmentary biserial harpoon in a stratigraphic position just above the position of the period 1 specimens. The third period layers yielded a biserial harpoon with a circular shank in cross-section. Earlier specimens all have flat-bladed shanks. In the fourth period was found a single biserial harpoon with flattened shank the barbs of which appear to be whittled rather than ground.

Robbins (1975, 633) mentioned that it is possible that the deep notches on the bases of some of the larger Lake Rudolf points may have been fashioned for the purpose of securing harpoon lines. Certainly, detachable harpoon heads would have greatly facilitated the catching of Nile perch, which often weigh several hundred pounds. On the other hand, smaller varieties of catfish could easily have been caught with spears or even bows and arrows.

Arkell (1953a, 32) noted that Raymond Mauny had found in Chad a grooved butt, barbed bone harpoon similar to those from Early Khartoum. Heinzelin (1957) found in Ishango, Western Rift (Zaire), a biserial barbed bone harpoon. Monod and Mauny (1957) summarize a series of sites with barbed bone points which lie today within the south-western Sahara and extend in a broad arc across Chad, Mali, and Niger. Camps (1974, 74) mentioned that in Later Stone Age industries, such as that at the Haua Fteah cave (Libya- Jebel Akhdar), fragments of what may be barbed harpoon heads have been found. In central Niger, at the Adrar Bous sites, there was a harpoon industry associated with 'Dotted Wavy Line' pottery predating 7,300 years ago (Smith 1980), in a lake-shore environment. By about 7,500 years ago the lake had largely dried up and the artefactual remains consist primarily of hunting equipment. Catfish Cave (DI-21B) between Abu Simbel and Aswan yielded harpoons (Wendt 1966, 8). The Neolithic inhabitants of the Fayum (7,000 to 6,600 years ago) in Egypt cultivated crops and kept animals; in addition, fishing played an important role using bone harpoons and fish-hooks (Krzyżaniak 1996, 963). Sutton (1974, 1977) defined an 'Aquatic Civilization' of Africa with a postulated origin at *c.* 9,000 years ago and characterized by the utilization of fish and other aquatic resources, barbed bone harpoons and sometimes the presence of wavy line pottery. Robbins (1974) found in Lothagam, Lake Turkana Rift (Kenya), uniserial barbed bone harpoons. The northern Kalahari has also yielded one series of barbed bone points (Robbins *et al.* 1994).

Bone harpoons in Sudan

In Sudan, Arkell (1949, 75) found a bone harpoon with un-perforated base in the early Khartoum Mesolithic site while he found examples with perforated bases at the esh-Shaheinab Neolithic site; he believed that this reflected the development of the tool.

Many workers have found bone harpoons in Sudan (Figure 1); in the Early Khartoum Mesolithic site (8000-6000 BP) Arkell (1949, 75) reported 70 substantial fragments and about 200 other fragments, with either butts or barbs, of bone harpoons during his excavations. No complete specimen was found. Two fragments indicate that harpoons existed with at least four barbs. Normally the barbs were only on one side of the shaft. According to Arkell (1953b, 56) it is probable that the true harpoon was in use by the end of the Khartoum Mesolithic, but its developed form seems to be characteristic of the Khartoum Neolithic.

In Nubia, by around 7,800 years ago fishing was undertaken by means of harpoons with barbed bone heads akin to those of the Khartoum Mesolithic (Wendt 1966). Eight bone harpoons were collected from central Sudan at Saggai (Zarattini 1983) and one complete specimen is recorded from the site of Sarurab (Hakem and Khabir 1989). At Shabona on the White Nile three fragments were collected by Clark (1989). In Abu Darbein three complete harpoons were found; these are small implements, the largest being 85mm and the smallest 58mm in length. One complete harpoon and one fragment were recovered from ed-Damer, the length of the complete specimen, a well-burnished and polished tool, is 95mm. At the site of Aneibis only two fragments of harpoons were found (Haaland and Magid 1995, 130). In el-Geili only two bone harpoons were recovered; one is fragmentary, only the point with two barbs being preserved. The other one is almost complete; it is an atypical specimen, with only one barb and a deep notch on the same side (Caneva 1988, 138-139). At el-Barga in northern Sudan one fragment of a broken bone harpoon was reported by Honegger (2004). Two harpoons were reported from Kadero, with lengths of 146mm and 136mm (Bobrowski 2011). Recently, many harpoons were collected by Tahir (2013, 126) from the el-Ga'ab Depression.

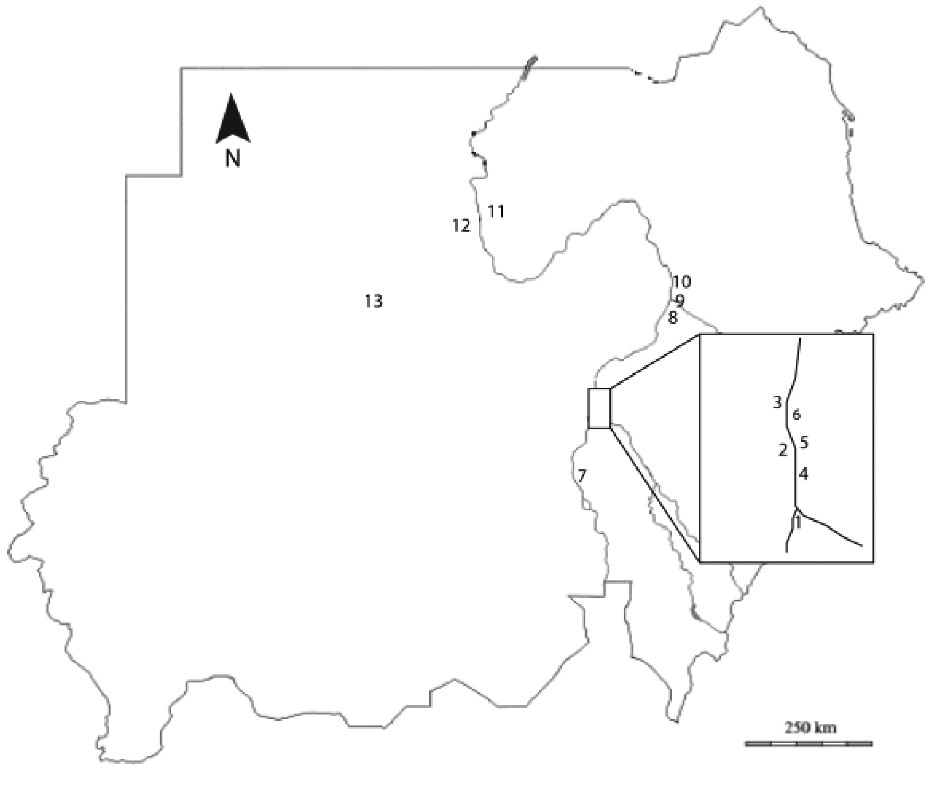


Figure 1. Bone Harpoon Sites in Sudan. 1 – Early Khartoum, 2 – Sarurab; 3 – esh-Shaheinab; 4 – Kadero; 5 – Saggai; 6 – el-Geili; 7 – Shabona; 8 – ed-Damer; 9 – Abu Darbein; 10 – Aneibis; 11 – el-Barga; 12 – el-Ga'ab; 13 – Wadi Howar.

Bone Harpoons in el-Ga'ab Depression

Study Area

The study area is a depression situated south of the Third Cataract of the Nile on the western bank, parallel to the Dongola Reach. It extends for 123km in a north east-south west direction. El-Ga'ab depression is considered to be a palaeolake connected to the Nile during the early and mid-Holocene (Tahir 2012, 99).

The archaeological survey revealed the presence of Palaeolithic (150,000-9000 BC), Mesolithic (8,000-5,000 BC) and Neolithic (5,000-3,000 BC) sites. Extensive Mesolithic and Neolithic settlement occurred on the edges of the Holocene palaeochannels and lakes where many fish remains were scattered on the surface of the sites (Tahir 2012, 106). Most of the sites are associated with scattered archaeological material. Among them many bone harpoons were recovered (Tahir 2013, 126).

Archaeological Sites

Sites GL-29-2, GL-31-2, KO-2-24 and KO-2-15 are situated at the edge of the palaeolake west of Ga'ab el-Lagia village. The first three sites are located at the eastern bank of the palaeolake over a distance of approximately 3km. Site KO-2-15 is situated on the western bank of the palaeolake about 3.6km west of site KO-2-24. They are very extensive prehistoric settlements aligned along the shore, with surfaces very rich in Mesolithic and Neolithic pottery sherds, lithic tools and grinding stone artifacts. Very large numbers of fish bone fragments were distributed on the surface. In addition, ostrich eggshell beads and some unidentified stone structures were reported. Many complete and fragmented bone harpoons were collected from all sites.

Low-lying land extends westwards to sites GL-29-2, GL-31-2, KO-2-24 and parallel to the shore, on which a very high concentrations of aquatic animal remains, mostly fish remains as well as crocodile and tortoise carapace fragments were noticed.

Materials and Methods

The material discussed in this paper was collected from el-Ga'ab Depression: 25 bone harpoons from sites GL-29-2, 21 from GL-31-2, two from KO-2-24 and one from KO-2-15 (Plates 1-4). Nine complete or almost complete and 40 distal and proximal fragments of bone harpoon were collected from the surface during the first, second, fifth and sixth archaeological seasons in the area.

The typological analysis of important attributes of the harpoons was carried

Plate 1. Bone harpoon (HB-62) in situ *with fish bone fragments with hook–shaped barb – from GL-2-29.*

Plate 2. Bone harpoon (HB-2) with strip groove back and convex edge – from KO-2-24.

Plate 3. Bone harpoon (HB-64) with three saw-tooth barbs – from GL-2-31.

Plate 4. Bone harpoon (HB-8) with unmodified base – from GL-1-31.

out according to Yellen (1998, 182). The attributes chosen were:

(1) number of barb rows (uniserial, biserial, triserial);
(2) number and shape of barbs (straight, curved, hooked, saw-tooth, Roman nose);
(3) shape of the back, or side opposite barbs on uniserial pieces (straight, convex);
(4) butt shape (pointed, rounded, bulbous);
(5) butt treatment (unmodified, notched, grooved, perforated).

This study also added the edge shape as an important attribute (convex-chisel, chisel, convex, V-edge, compound, drop point, spear point and el-Ga'ab style) (Table 1).

Digital calipers and a digital balance were used in measuring harpoon dimensions and weights respectively.

A computer program for statistical analysis (SPSS 16.0 for Windows) was used in this study.

Bone Harpoons – typological analysis of important attributes

The results of the typological analysis are shown in Table 2. From this, it can be seen that the most common edge shape is convex-chisel (42.1%), the most common barb shape is saw-tooth (47.4%), while the most common shape of the back is curved (85%), the most common base shape is rounded (89.5%) and the base treatment is most commonly notched (47.6%).

Statistical analysis

Complete and almost complete harpoon typological shapes, dimensions and weights were used in this part of the study (Table 3).

Hierarchical cluster analysis

Hierarchical cluster analysis was carried out on the nine complete bone harpoons, to ascertain the degree of relationship between the studied bone harpoons utilizing typological shape data. It is illustrated in the dendrogram (Figure 2).

Results

The analysis shows different clusters:

Harpoons number 5, 9 and 7 are the most closely clustered, exhibiting the shortest clade distance.

Harpoons number 4 and 6 are closely clustered with each other and relatively closely clustered with the above.

Harpoons number 2, and 3 are closely clustered to each other, and relatively closely to the above 2 clusters.

Harpoon number 1 is isolated and appears only distantly related to all the other harpoons.

Radar Chart

The dimensions and weights were subjected to statistical analysis using radar charts for all variables (length, width,

Table 1. Bone harpoons and their dimensions, weights and shapes. (a. Complete = almost complete).

Serial no.	Code	L. mm	Th. mm	W. mm	Wt gm	Faces	No. of barbs	Barbs shape	Backs	Base	Edge	Notes
1	HB-1	190	16	34	75.1	2	5 – 5	Saw-tooth	--	Barbed base	El-Ga'ab edge	Complete
2	HB-2	180	12	23	5.7	1	4	Roman nose	Curve	Strip groove	Convex	Complete
3	HB-3	55+	06	09	4.6+	1	1+	Saw-tooth	Curve	Broken	Convex-chisel	Broken
4	HB-4	43+	04	12	3.4+	1	1+	Broken	Broken	----------	----------	----------
5	HB-5	32+	02	09	0.6+	1	1+	Roman nose	Curve	-----------	Chisel	----------
6	HB-6	47+	52	01	2.2+	1	2+	Roman nose	Broken	-----------	Broken	----------
7	HB-7	60+	05	13	3.7+	1	2+	Roman nose	Curve	-----------	Broken	----------
8	HB-8	79	07	16	7.5	1	2	Roman nose	Curve	Unmodified	Compound	Complete
9	HB-9	57+	05	11	2.5	1	3+	Curve	Strait	Broken	Convex-chisel	----------
10	HB-10	55+	08	19	7.3+	1	2+	Roman nose	Curve	----------	V-edge	----------
11	HB-11	71+	08	-	5.5+	1	1+	-	-	----------	Broken	----------
12	HB-12	54+	06	14	3.7+	1	3+	Hooks	Curve	-----------	----------	----------
13	HB-13	42+	05	14	2.4+	1	1+	Saw-tooth	Broken	Notched	----------	----------
14	HB-14	35+	06	-	3.6+	1	1+	Broken	Broken	Notched	----------	----------
15	HB-15	72+	07	14	3.4+	1	1+	Hooks	Strait	Broken	----------	----------
16	HB-16	59+	06	63	5.9+	1	3+	Roman nose	Curve	Notched	----------	----------
17	HB-17	42+	07	17	6.1+	1	1+	Broken	Broken	Notched	----------	----------
18	HB-18	36+	05	13	2.8+	1	1+	Saw-tooth	Curve	Broken	----------	----------
19	HB-19	28+	06	01	1.6+	1	1+	Saw-tooth	Curve	Notched	----------	----------
20	HB-20	32+	03	01	1.4+	1	2+	Saw-tooth	Broken	Broken	----------	----------
21	HB-21	45+	-	-	-	-	-	Broken	----------	Notched	----------	----------
22	HB-35	39+	04	01	1.8+	1	1+	Broken	----------	Broken	----------	----------
23	HB-36	40+	04	94	1.6+	1	1+	Saw-tooth	Broken	unmodified	----------	----------
24	HB-37	37+	04	11	1.8+	1	3+	Saw-tooth	Broken	Broken	----------	----------
25	HB-38	29+	03	11	1.6+	1	2+	Saw-tooth	Curve	-----------	----------	----------
26	HB-39	24	05	01	2.2	1	2	Roman nose	Curve	unmodified	Convex-chisel	Complete
27	HB-40	44+	03	01	1.4+	1	2+	Broken	Broken	Broken	----------	Broken
28	HB-41	69+	05	-	5.0+	1	2+	Saw-tooth	Broken	unmodified	----------	----------
29	HB-42	60	05	14	4.0	1	2	Hooks	Curve	unmodified	Convex-chisel	Complete
30	HB-43	78+	06	-	5.0+	1	2+	Roman nose	Curve	Broken	------------	Broken
31	HB-44	51+	08	-	4.4+	1	-	Broken	Broken	Notched	----------	----------
32	HB-45	33+	06	11	2.6+	1	1+	Roman nose	----------	Broken	Convex-chisel	----------
33	HB-59	45+	05	12	3.8+	1	2+	Broken	Broken	----------	Chisel	----------
34	HB-60	62+	04	12	4.1+	1	3+	Saw-tooth	Curve	Notched	Broken	----------
35	HB-61	50+	05	12	2.6+	1	1+	Saw-tooth	----------	----------	Broken	----------
36	HB-62	51	04	13	2.6	1	2	Hooks	----------	----------	Convex-chisel	a. Complete
37	HB-63	35+	04	01	1.5+	1	2+	Saw-tooth	----------	Broken	Convex-chisel	----------
38	HB-64	73	04	14	5.4	1	3	Saw-tooth	----------	Notched	Convex-chisel	a. Complete
39	HB-65	45+	07	14	4.7+	1	2+	Saw-tooth	----------	----------	Broken	----------
40	HB-66	35+	05	11	2.3+	1	1	Saw-tooth	Broken	unmodified	Broken	----------
41	HB-67	41	04	11	2.5	1	2	Broken	----------	Notched	Broken	a. Complete
42	HB-68	37+	02	07	0.9+	1	1+	Broken	----------	Broken	Broken	----------
43	HB-70	34+	08	02	3.5+	1	1+	Roman nose	----------	----------	Broken	
44	HB-71	34+	06	14	1.7+	1	1+	Hooks	----------	unmodified	V-edge	----------
45	HB-72	33+	06	12	1.6+	1	1+	Hooks	Curve	Broken	Drop point	----------
46	HB-73	43+	06	13	2.6+	1	2+	Saw-tooth	Broken	unmodified	Broken	----------
47	HB-74	63+	06	14	4.1+	1	3+	Hooks	----------	Broken	Chisel	----------
48	HB-75	56+	02	15	2.2+	1	2	Saw-tooth	----------	----------	Spear point	----------
49	HB-76	46	05	12	2.8	1	1	Hooks	Curve	unmodified	Chisel	Complete

Table 2. Barb, back, base and edge shapes and their percentages for 49 harpoons.

Edge			Barb			Back			Base					
Shape	**No.**	**%**	**Shape**	**No.**	**%**	**Shape**	**No.**	**%**	**Treatment**	**No.**	**%**	**Shape**	**No.**	**%**
Convex-chisel	8	42.1	Saw-tooth	18	47.4	Curve	17	85	Rounded	17	89.5	Notched	10	47.6
Chisel	4	21.1	Roman nose	11	28.9	Strait	2	10	Pointed	2	10.5	Unmodified	9	42.8
Convex	2	10.5	Hook	8	21.1	None	1	5	Bulbous	-	-	Strip groove	1	4.8
V-edge	1	5.3	Curve	1	2.6	Total	20	100	Total	19	100	Barbed	1	4.8
Compound	1	5.3	Total	38	100							Total	21	100
Drop point	1	5.3												
Spear point	1	5.3												
El-Ga 'ab style	1	5.3												
Total	19	100												

Table 3. Complete harpoons and their dimensions, weights and shapes.

Case no.	Length mm	Width mm	Thickness mm	Weight gm	Edge shape	Barb		Base		Back shape
						Shape	**No.**	**Shape**	**Treatment**	
1- Hb-01	190	34	16	75.1	El-Ga'ab style	Saw-tooth	6	Pointed	Barbed	No back
2 -Hb-02	180	23	12	50.7	Convex	Roman nose	4	Pointed	Strip groove	Curve
3 -Hb-08	79	16	07	7.5	Compound	Roman nose	2	Rounded	Unmodified	Curve
4 -Hb-64	73	14	04	5.4	Convex-chisel	Saw-tooth	3	Rounded	Notched	Curve
5 -Hb-42	60	14	05	4.0	Convex-chisel	Hook	2	Rounded	Unmodified	Curve
6 -Hb-62	51	13	04	4.1	Convex-chisel	Saw-tooth	2	Rounded	Notched	Curve
7 -Hb-76	46	12	05	2.8	Chisel	Hook	2	Rounded	Unmodified	Curve
8 -Hb-67	41	11	04	2.5	………	Saw-tooth	1	Rounded	Notched	Curve
9 -Hb-39	24	10	05	2.2	Convex-chisel	Roman nose	2	Rounded	Unmodified	Curve

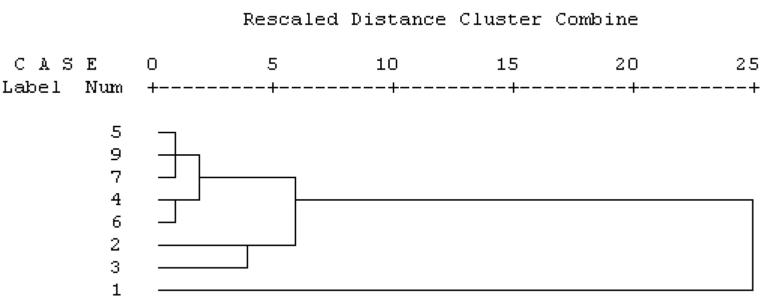


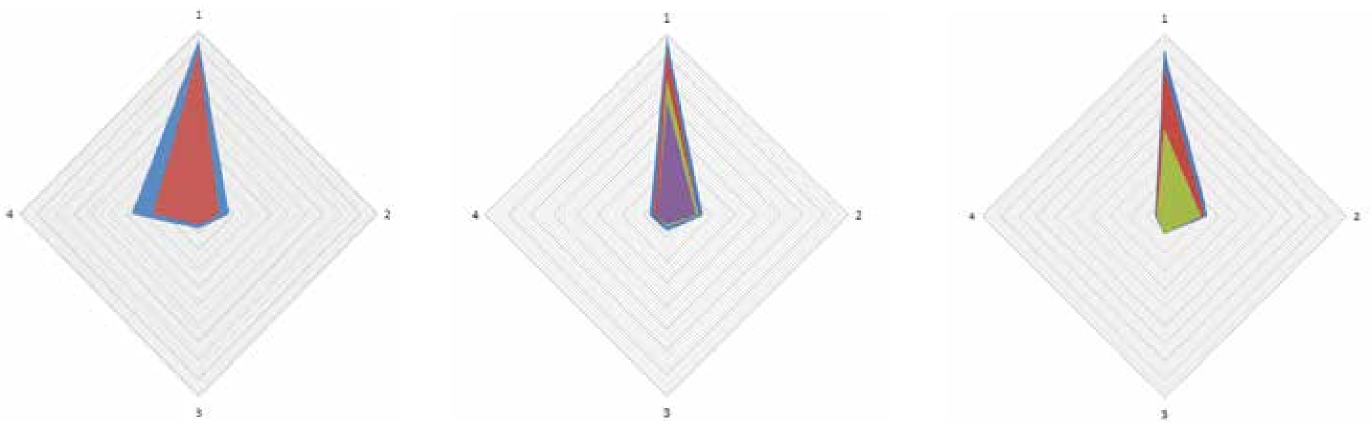
Figure 2. Dendrogram using Average Linkage (between harpoons).

thickness and weight) to elucidate the relationship between them (Figure 3).

The nine harpoons were arranged in three groups according to their size. Harpoons nos 1 and 2 fall into Group 1, 3 to 6 fall into Group 2, and 7 to 9 fall into Group 3.

Result

The three radar charts resemble each other (Figure 3). Each group shows a very close similarity to both of the others.



Group 1: Harpoon 1-2 Group 2: Harpoon 3-6 Group 3: Harpoon 7-9

Figure 3. Radar Charts of the three groups of harpoons.

This reflects that the three groups of harpoons have the same geometric shape with very close similarities within each group.

Correlation analysis

The correlation between the variables (length, width, thickness and weight) is calculated to extract the degree of correlation between variables.

Result

Pearson correlation is significant at the 0.01 level (2-tailed) for all variables (Table 4). The analysis reveals that there is strong correlation between variables, length, width, thickness and weight. This again confirms the previous result obtained by the radar chart: that ancient man was capable of designing tools by determining the proper dimensions for a particular raw material used in carrying out a certain function.

Table 4. Correlation between length, width, thickness and weight.

		Length	Width	Th.	Weight
Length	Pearson Correlation		.944**	.943**	.959**
Sig. (2-tailed)		.000	.000	.000	
N		9	9	9	
Width	Pearson Correlation	.944**		.967**	.974**
Sig. (2-tailed)	.000		.000	.000	
N	9		9	9	
Thickness	Pearson Correlation	.943**	.967**		.982**
Sig. (2-tailed)	.000	.000		.000	
N	9	9		9	
Weight	Pearson Correlation	.959**	.974**	.982**	
Sig. (2-tailed)	.000	.000	.000		
N	9	9	9		

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

The bone harpoon finds along the western side of Lake Rudolf were of major interest to archaeologists because they suggested relationships to either the Nile Valley site of Early Khartoum, or the site of Ishango in eastern Congo, where similar bone harpoon points had been found (Arkell 1949; Heinzelin 1957). The harpoons collected from el-Ga'ab resemble those of Early Khartoum's uniserial harpoons and their shape attributes, but we cannot compare them in terms of size because there were no complete examples collected from the Early Khartoum site. Only one biserial harpoon was collected in the current study and it seems to be a Saharan tradition as well as being found in central Africa; however, el-Ga'ab Depression, due to its situation in the desert yet not far from the Nile, may have been influenced by and/or provided a connection between the Nile Valley and the desert. Cluster Analysis showed that the biserial harpoon is stylistically distinct from other harpoons. This may result from the type being older as stated by Nelson (1991, 11), who found examples in the lowest layers at Koobi Fora, Lake Turkana. The edge of the biserial harpoon from el-Ga'ab Depression is different and does not fall into any known harpoon edge shape hitherto noted in the literature, hence the adoption of the term 'el-Ga'ab style' here to describe it.

El-Ga'ab harpoons were collected from the surface of Mesolithic and Neolithic settlements on the edges of the Holocene palaeolake (Tahir 2012; 2013). The large number of the bone harpoons from these sites is attributed to their being fishing sites with a long duration of occupation over both periods. Net sinkers were also found in these sites indicating fishing activities in the area. Most of the harpoons were collected from the lake basin near to the shore and sometimes the harpoon was associated with fish remains *in situ*. These findings agree exactly with those of Robbins (1975, 632) in the Lake Rudolf Basin. He mentioned that harpoons were located on the surface, most of them on sandy or sandy-clay sediments of lacustrine or littoral origin. There is the strong likelihood that many of these artefacts were lost while people were fishing. Bone points have also been recovered from within habitation layers at Lothagam, where they are directly associated with Mesolithic stone tools and food refuse consisting mostly of catfish and Nile perch.

In el-Ga'ab harpoons reach a length of 190mm, the longest harpoon found to date on any Sudanese archaeological site; also in el-Ga'ab Depression very short harpoons of 24mm are reported. Wendt (1966, 11) mentioned that the lengths of bone points vary from 45mm to 120mm in Catfish Cave (DI-21B). Small and median size harpoons are typical for the traditions of the area, resembling other parts of the Sudan, such as Abu Darbein with harpoons of 58-85mm in length (Haaland and Magid 1995, 130). However, at Kadero harpoon lengths range from 136-146mm (Bobrowski 2011). The same measurements are given by Yellen (1998, 194) for Katanda where harpoons reach 147mm in length; this range of length is absent from the el-Ga'ab collection so far.

From the statistical analysis it is clear that the most common types of the harpoon elements are: convex-chisel edge, saw-tooth barb, curved back and notched base. There are no comparative data available from other regions to indicate cultural affiliation.

Hierarchical cluster analysis shows three different clusters according to different parts of the harpoon. Again here the reason may be function, different chronologies, ethnic differences and influences from different neighboring areas and this needs further study and comparisons. The three radar charts reflect the similarities of geometric shapes of all the harpoons despite their difference in size, suggesting that the same tradition or technique was used in making these harpoons. Similarities in the geometric shapes of the harpoons suggest that the harpoon designers were aware of the dimensions of the harpoon whether small or large. The dimensions used by the ancient designers were not arbitrary. The minor difference between the geometric shapes of the groups may be attributed to function (i.e. the size and type of animal hunted). In el-Ga'ab Depression, in spite of its situation in the desert, being near Wadi Howar and not far from the Nile, the influences from both areas appear in, for example, the Middle Palaeolithic Aterian stone tools and Neolithic pottery which were collected during the fieldwork.

More advanced studies on methods of production, microscopic examination, dating etc. will give a more detailed understanding of these objects.

Acknowledgement

Sincere thanks to the Nubian Archaeological Development Organization (Qatar-Sudan) for the financing of the el-Ga'ab Archaeological Project. Thanks are due to NCAM for granting a concession for archaeological work in the el-Ga'ab Depression. Special thanks to all the mission members, workers and drivers.

Bibliography

Arkell, A. J. 1949. *Early Khartoum*. Oxford.

Arkell, A. J. 1953a. 'A Bone Harpoon from Chad', *Man* 53, 32.

Arkell, A. J. 1953b. *Shaheinab*. Oxford.

Bobrowski, P. 2011. 'Bone implements', in M. Chlodnicki and M. Kobousiewicz (eds), *Kadero. Lech Krzyżaniak excavations in the Sudan*. Studies in African Archaeology 10. Poznań, 147-153.

Brooks, A. B., D. M. Helgren, J. S. Cramer, A. Franklin, W. Hornyak, J. M. Keating, R. G. Klein, W. J. Rink, H. Schwarcz, J. N. Leith Smith, K. Stewart, N. E. Todd, J. Verniers and J. Yellen 1995. 'Dating and context of three Middle Stone Age sites with bone points in the Upper Semliki Valley, Zaire', *Science* 268, 548-553.

Camps, G. 1974. *Les Civilizations préhistoriques de l'Afrique du Nord et du Sahara.* Paris.

Caneva, I. 1988. *El Geili: The History of a Middle Nile Environment 7000B.C.- 1500 A.D.* BAR Int. Ser. 424. Oxford.

Clark, J. D. 1989. 'Shabona: An early Khartoum settlement on the White Nile', in L. Krzyżaniak and M. Kobusiewicz (eds), *Late prehistory of the Nile Basin and the Sahara*. Poznań, 387-411.

Clark, J. D. 1970. *The Prehistory of Africa.* London.

Haaland, R. and A. Magid (eds) 1995. *Aqualithic sites along the rivers Nile and Atbara, Sudan*. Alma Mater Forlag AS, Norway.

Hakem, M. and A. M. Khabir 1989. 'Sarourab 2: A new contribution to the early Khartoum tradition from Bauda site', in L. Krzyżaniak and M. Kobusiewicz (eds), *Late Prehistory of the Nile Basin and the Sahara.* Poznań, 381-287.

Heinzelin, J. de 1957. *Les fouilles d'Ishango'*, *Exploration du Parc National Albert 2, 1950.* Brussels.

Honegger, M. 2004. 'Settlement and cemeteries of the Mesolithic and Early Neolithic at el- Barga (Kerma region)', *Sudan & Nubia* 8, 27-32.

Krzyżaniak, L. 1996. 'Late Prehistory of Egypt', in S. J. de Laet, A. H. Dani, J. I. Lorenzo and R. B. Nunoo (eds), *History of Humanity Vol. 1: Prehistory and the beginnings of civilization*. New York.

Monod, T. and R. Mauny 1957. 'Dicouverte de nouveaux instruments en os dans l'Ouest Africain', in J. D. Clark and S. Cole (eds), *Third Pan-African Congress on Prehistory. Livingstone.* London, 242-247.

Nelson, C. M. 1991. 'Harpoon Evolution on the Spit (GaJil2) at Koobi Fora, Lake Turkana, Kenya', *Nyame Akuma* 36, 10-14.

Robbins, L. H. 1974. *The Lothagam Site: A Late Stone Age Fishing Settlement in the Lake Rudolf Basin*, *Kenya.* East Lansing.

Robbins, L. H. 1975. 'Bone Artefacts from the Lake Rudolf Basin, East Africa', *Current Anthropology* 16, 4, 632-633.

Robbins, L. H., M. L. Murphy, K. M. Stewart, A. C. Campbell and G. A. Brook 1994. 'Barbed bone points, paleoenvironment, and the antiquity of fish exploitation in the Kalahari Desert Botswana', *Journal of Field Archaeology* 21, 257-264.

Smith, A. B. 1980. 'The Neolithic tradition in the Sahara', in M. A. J. Williams and H. Faure (eds), *The Sahara and the Nile.* Rotterdam, 451-465.

Sutton, J. E. G. 1974. 'The aquatic civilization of middle Africa' *Journal of African History* 15, 527-546.

Sutton, J. E. G. 1977. 'The African aqualithic', *Antiquity* 51, 25-34.

Tahir, Y. F. 2012. 'A Holocene Palaeolake in El Ga'ab depression western desert, Northern Sudan', *Sahara* 23, 99-112.

Tahir, Y. F. 2013. 'The Archaeological, Ethnographical and Ecological Project of El-Ga'ab Basin in western Dongola Reach: A Report on the second season 2010', *Sudan & Nubia* 17, 124-130.

Wendt, W. E. 1966. 'Two Prehistoric Archaeological Sites in Egyptian Nubia', *Postilla,* 102, 1-46.

Yellen, J. E. 1998. 'Barbed Bone Points: Tradition and Continuity in Saharan and Sub-Saharan Africa', *The African Archaeological Review* 15, 3, 173-198.

Yellen, J. E., A. S. Brooks, E. Cornelissen, M. J. Mehlman and K. Stewart 1995. 'A middle stone age worked bone industry from Katanda, Upper Semliki Valley, Zaire', *Science* 268 (5210), 553-556.

Zarratini, A. 1983. 'Bone tools and their culture-economic implications', in I. Caneva (ed.), *Pottery using Gathers and hunters at Sagga (Sudan): Preconditions for food production.* Rome, 243-251.