www.sciencemag.org/cgi/content/full/312/5781/1785/DC1

Supporting Online Material for

Middle Palaeolithic Shell Beads in Israel and Algeria

Marian Vanhaeren,* Francesco d'Errico, Chris Stringer, Sarah L. James, Jonathan A. Todd, Henk K. Mienis

*To whom correspondence should be addressed. E-mail: m.vanhaeren@ucl.ac.uk

Published 23 June 2006, *Science* **312**, 1785 (2006)
DOI: 10.1126/science.1128139

This PDF file includes:

Supporting Online Material for

Middle Palaeolithic Shell Beads in Israel and Algeria

Marian Vanhaeren,* Francesco d'Errico, Chris Stringer, Sarah L. James,
Jonathan A. Todd, Henk K. Mienis

* To whom correspondence should be addressed. E-mail: m.vanhaeren@ucl.ac.uk

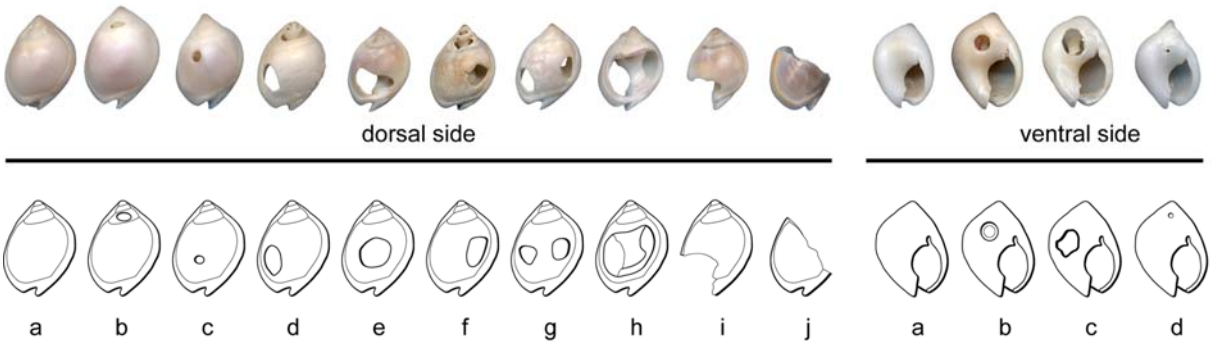
This PDF file includes:

Materials and Methods

Sediment matrix analysis.
Five sediment samples were analysed for mineralogy and chemical composition. Sample L15134 is a fragment of dark breccia from Skhul upper layer A, L15135 a light brown breccia from underlying layer B1, L15136 a grey breccia from lower layer B2, L15137 a breccia adherent to a *Levantina spiriplana caesareana* land snail labelled as coming from the "Mousterian breccia" (layer B) and L15138 corresponds to the sediment matrix adherent to one of the two perforated *N. gibbosulus* (Fig. 1a). Samples were analysed by three methods i) morphology and composition examined using a Scanning Electron Microscope (SEM) coupled with an Energy Dispersive Spectrometer (EDS) detector (Jeol 5900LVProbe), ii) mineralogy determined by X-Ray Diffraction and iii) bulk chemistry determined by Inductively-Coupled Plasma Atomic Emission Spectrometer (ICP-AES) and Inductively-Coupled Plasma Mass Spectrometer (ICP-MS). For chemical analysis the sediment were crushed to a fine powder in an agate swing mill grinder, after first being broken into small pieces with a fly-press. A small piece of sediment from the pierced shell was split off and crushed in an agate pestle mortar. Two dissolution methods were used to produce the sample solutions i) hydrofluoric acid dissolution (HF) and ii) lithium metaborate fusion. Where sample size permitted, repeats were prepared for each of the samples, to give an estimate of sample heterogeneity. For the former dissolution method 100mg of sample was weighed into a platinum crucible and digested on a sand-bath with 4ml HF, 2ml $HClO_4$ and 2ml HNO_3 and taken to dryness. The digested material was then redissolved with 1ml HN03 and then made up to 10ml with deionised water. Along with the samples, a blank and five certified reference materials were prepared. For the latter dissolution method, 40mg of sample was weighed into a platinum/gold crucible and mixed with 120mg of lithium metaborate. The mixture was then fused on a meker burner for 20-30 minutes, then allowed to cool with the resultant glass bead being dissolved in 5% HNO_3 and made up to 100ml. Along with the samples, a blank and the reference materials were prepared. The solutions were analysed by a combination of ICP-AES and ICP-MS. The fusion samples were analysed solely by Varian Vista Pro ICP-AES for the major elements. The HF dissolutions were analysed for trace elements by both ICP-AES and by Varian ICP-MS. ANOVA was undertaken for a number of major and trace elements, and two Null Hypotheses were tested at the 0.05 significance level. The first hypothesis was that layer A and layer B were not significantly different. For every element tested, this hypothesis was rejected because the F ratio (variation between group/variation within group) was higher

than the critical value. The second hypothesis was that the pierced shell sediment was not significantly different from Layer B. This last hypothesis is supported by our results as the F ratio was lower than the critical factor.

Malacological reference collection.
We collected 158 living and 285 dead *N. gibbosulus* in 2005 on the North East shore of Djerba Island, Tunisia. The biocoenosis was collected by twice anchoring a net overnight filled with putrefied fish, at a depth of 1.5 m, and sieving 4m² of surrounding seafloor surface the following mornings. The thanatocoenosis was gathered by systematically prospecting 20 km of beach during 4 days. The collection of *N. gibbosulus* from Tel Aviv University consists of a sample of 312 specimens dredged in the Haifa Bay, Israel, between 1981 and 1983 by H. Hornung (TAU MO 34621, 34624, 34625) and E. Gilat (TAU MO 34629). We recorded shell length and width, age class (juvenile, sub-adult, adult), perforation types, and breakage pattern on the dorsal and ventral side of the shell. The same variables were recorded on the specimens from Skhul and Oued Djebanna. Meat extracted from 100 living shells was dried and weighed in order to estimate *N. gibbosulus* nutritional value (shellfish=4.2kcal/gram (*S1*)).



		dorsal side					N (%)					ventral side				N (%)
N. gibbosulus collection	N	a	b	c	d	e	f	g	h	i	j	a	b	c	d	na
Djerba thanatocoenosis	285	126 (44.2)	34 (11.9)	10 (3.5)	8 (2.8)	10 (3.5)	4 (1.4)	4 (1.4)	13 (4.6)	12 (4.2)	64 (22.5)	153 (53.7)	30 (10.5)	31 (10.9)	12 (4.2)	59 (20.7)
Skhul	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Oued Djebbana	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

Fig. S1. Perforation types (top) recorded on the dorsal and the ventral side of *Nassarius gibbosulus* shells and their frequency (bottom) in a modern and thanatocoenosis and in the archaeological specimens.

Sample	L15134a	L15134b	L15135a	L15135b	L15136a	L15136b	L15137a	L15137b	L15138
Description	Dark Breccia	Dark Breccia	Light Brown Breccia	Light Brown Breccia	Grey Breccia	Grey Breccia	Sediment from Mousterian *Helix caesareana* shell	Sediment from Mousterian *Helix caesareana* shell	Sediment from pierced *Nassarius gibbosulus* shell
Layer	A	A	B1	B1	B2	B2	B	B	to determine
Major element composition (%)									
SiO_2	22,9	21,4	10,4	9,92	20,6	19,0	16,1	15,5	14,2
Al_2O_3	5,87	5,86	2,70	2,63	1,77	1,74	3,64	3,60	3,59
Fe_2O_3 (t)	3,27	3,37	1,59	1,64	0,97	0,95	2,08	2,12	2,09
MgO	0,749	0,726	0,914	0,884	1,30	1,27	1,31	1,30	1,50
CaO	33,9	31,6	45,9	43,4	42,2	39,4	40,2	38,3	40,7
Na_2O	0,234	0,213	0,095	0,083	0,124	0,104	0,163	0,199	0,185
K_2O	0,608	0,646	0,402	0,412	0,308	0,302	0,545	0,559	0,654
TiO_2	0,517	0,497	0,266	0,252	0,169	0,161	0,374	0,361	0,364
P_2O_5	11,3	11,1	1,48	1,43	1,86	1,79	2,06	2,02	1,62
MnO	0,114	0,114	0,026	0,026	0,019	0,020	0,039	0,040	0,038
Trace element composition (ppm)									
As	2,78	4,22	1,42	4,38	1,38	4,09	1,74	3,30	1,51
Ba	181	184	98,4	101	76,4	77,6	127	115	86,0
Be	1,21	1,02	0,473	0,400	0,358	0,285	0,803	0,592	0,795
Bi	0,076	0,060	0,042	0,062	0,026	0,119	0,306	0,047	0,070
Cd	0,704	0,712	0,477	0,458	0,171	0,125	0,377	0,246	0,429
Co	12,1	14,3	7,55	9,17	2,89	3,49	6,65	7,24	5,68
Cr	56,9	43,1	39,4	31,2	19,1	15,7	44,7	30,5	33,9
Cs	1,78	1,34	0,753	0,597	0,444	0,359	1,02	0,725	0,965
Cu	69,6	79,3	23,8	15,2	27,3	24,8	29,0	34,0	27,2
Ga	12,1	8,68	5,45	3,93	3,51	2,63	8,64	5,39	7,66
Hf	1,73	1,45	0,799	0,712	0,472	0,437	1,22	1,02	0,651
Li	16,7	10,1	7,27	4,22	5,40	3,38	9,68	6,00	9,18
Mo	3,69	2,95	0,627	0,447	0,435	0,291	0,811	0,365	0,587
Nb	11,4	10,7	5,04	5,03	3,03	3,36	8,12	7,09	5,73
Ni	72,5	75,0	15,0	14,6	14,1	14,4	26,1	22,0	18,1
Pb	7,15	6,27	12,4	15,6	2,93	2,23	10,8	5,49	5,66
Rb	24,2	25,3	11,5	12,9	7,59	8,94	17,6	17,0	15,7
Sc	7,17	6,39	3,22	3,08	2,01	1,92	5,43	4,14	4,69
Sr	199	188	114	112	211	199	219	202	125
Ta	0,784	0,846	0,283	0,306	0,132	0,205	0,412	0,492	0,246
Te	0,039	0,109	<0.012	<0.012	<0.012	0,039	0,074	0,030	<0.012
Th	4,09	4,18	2,02	1,93	1,20	1,14	3,39	2,48	2,69
Tl	0,179	0,166	0,106	0,108	0,067	0,098	0,215	0,151	0,111
U	8,29	7,66	1,47	1,30	1,70	1,44	2,80	1,93	1,47
V	58,9	56,8	26,8	28,3	17,9	19,4	40,5	34,7	38,0
W	0,700	0,755	0,372	0,429	<0.017	0,193	0,604	0,428	0,333
Y	19,2	13,9	8,82	6,23	5,90	4,51	12,6	8,34	12,5
Zn	237	239	52,5	53,9	48,5	52,1	81,3	68,0	72,0
Zr	32,3	68,2	51,2	33,1	46,5	22,0	65,8	44,8	28,3
Rare Earth Element composition (ppm)									
La	17,9	17,2	8,7	8,10	5,8	5,54	14,2	11,0	11,8
Ce	34,5	33,7	17,4	16,4	11,4	10,9	28,7	22,6	23,9
Pr	4,44	4,24	2,14	1,98	1,42	1,37	3,57	2,75	2,98
Nd	17,3	17,0	8,26	8,00	5,60	5,38	13,9	10,9	11,7
Sm	3,55	3,43	1,69	1,62	1,12	1,08	2,86	2,20	2,42
Eu	0,894	0,828	0,440	0,381	0,310	0,277	0,697	0,547	0,620
Gd	3,69	3,14	1,74	1,48	1,18	1,01	2,95	2,04	2,53
Tb	0,557	0,465	0,278	0,221	0,184	0,154	0,454	0,314	0,394
Dy	2,83	2,49	1,37	1,15	0,921	0,789	2,19	1,60	1,98
Ho	0,548	0,502	0,261	0,229	0,177	0,158	0,412	0,322	0,379
Er	1,69	1,41	0,839	0,625	0,549	0,435	1,30	0,890	1,20
Tm	0,220	0,196	0,103	0,086	0,067	0,058	0,178	0,119	0,153
Yb	1,41	1,26	0,670	0,554	0,431	0,378	1,05	0,777	0,984
Lu	0,209	0,182	0,098	0,076	0,066	0,053	0,153	0,111	0,143

Table S1. Skhul sediment data

Reference

S1. S. E. Gebhardt, R. G. Thomas, *Nutritive value of foods* (United States Department of Agriculture, Beltsville, 2003).