TOWARDS THE INTERPRETATION OF OCCUPATION DEBRIS: SOME EXPERIMENTS AND OBSERVATIONS[1]

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INTRODUCTION

Archaeological studies of Pleistocene culture have undergone a marked change of emphasis during the past few decades. To an increasing degree, scholars are turning away from a narrow concern with artefact morphology and are making determined attempts to investigate the behaviour patterns of early man. The extent, content and patterning of debris and human disturbances discovered by excavation form the basis for inferences regarding aspects of culture such as size of resident groups, hunting practice, diet, duration of occupation, patterns of settlement and movement, craft practices, and tool usage.

Ambitious attempts to reconstruct accurately and systematically these aspects of behaviour demand an exceedingly fine exegesis of the excavated documents. The eager archaeologist frequently finds himself tempted, or even obliged, to invoke evidence from site features for which the determining processes have never been investigated. In this situation archaeologists must either run the risk of dependence on a priori reasoning and untested assumptions, or they must undertake the investigations of relevant processes by experiment or systematic observation.

Attention has recently been drawn to the value of such investigations by several authors, and their publications illustrate the diversity of phenomena and methods which are liable to be involved in such an approach to archaeological problems. The following serve as examples:

1) The experimental earthwork on Overton Down in England (Jewell and Dimbleby 1966).

2) A detailed analysis of Hottentot bone refuse (Brain 1967, n.d.).

3) Records of the contents and features of abandoned Bushman camps (Lee 1965, n.d.).

This paper reports on the preliminary stages of investigations which were initiated as a response to difficulties encountered in the interpretation of Acheulian sites at Olorgesailie in Kenya[2] (Isaac 1966, n.d.). The specific problems treated are:

1) Methods of discriminating between humanly determined site patterns and fluvial rearrangements of occupation debris.

2) The dispersal of bone debris from an area of concentration.

3) The proportional representation of skeletal parts in bone aggregates accumulating under known conditions.

I. EFFECTS OF STREAM PROCESSES ON STONE AGE OCCUPATION DEBRIS

The majority of occurrences of Middle Pleistocene cultural remains have an alluvial sedimentary context. Even material stratified within formations loosely termed "lake beds" tends to be associated with fluviatile silts and sands. Notable examples of important archaeological sites with such a sedimentary environment include Torralba and Ambrona (Butzer 1965), Kalambo Falls (Howell and Clark 1963), Isimila (Howell *et alia* 1962), many Olduvai sites (Hay 1963), Natron (Isaac 1967), and Olorgesailie (Isaac 1966). At all of these sites there are good reasons for inferring that the grouping and deposition of much of the occupation debris is due primarily to human activities: it is believed that the material is in "primary archaeological context" (Kleindienst 1961:35-37). However, in all these cases there remains the possibility that the composition and disposition may have been affected to some extent by hydrological processes.

Criteria which have previously been employed for discriminating between anthropological and hydrological patterning include the following:

1) The size grade of the sediment in which artefacts are embedded. Gravels are regarded as clear evidence of movement and transport.
2) Bedding features such as conspicuous signs of erosion, scour and current bedding, are used to distinguish disturbance.
3) *État physique* of the material: abrasion and rounding may denote transport and hydrological rearrangement.
4) Orientation of elongate pieces: a preferred orientation is indicative of current or wave action (Howell *et alia* 1962; Kleindienst 1961:36).
5) The presence of groups of flakes from the same core, etc., would show a low order of disturbance.

In addition, evidence of sorting according to size might be applied as a discriminant on *a priori* grounds, but apart from mention by Isaac (1966:139) I am not aware of its use.

These criteria are perfectly adequate for distinguishing extreme cases. Thus the position of artefacts dispersed within gravels can safely be regarded as primarily due to hydrological factors, while the arrangement of pieces on a level undisturbed palaeosol or clay horizon is usually preserved as an occupation pattern which has undergone a minimum of mechanical distortion. However, we have at present no way of evaluating marginal cases. For instance, we are uncertain of what reliance to place on the archaeological association and patterning of occupation debris resting on a surface with low relief, and covered by a sheet of fine alluvial or colluvial sand. We cannot afford to ignore such marginal cases because, as already indicated, they constitute a majority of the sites with promising palaeoanthropological evidence. Further evidence from site locations in basins of sedimentation suggests that Acheulian men frequently selected camp sites on the sandy substratum of shallow ephemeral streams and washes (Clark 1966:209; Isaac 1966:142, n.d.). It is therefore clear that we require experimental data on such questions as the following:

1) The extent to which occupation debris can be moved and rearranged by water currents without showing any of the well known stigmata.
2) The behaviour of large rock particles such as artefacts, artificially deposited in a *milieu* where the transported sediment is entirely of sand and silt grades.
3) The conditions under which material is either dispersed or concentrated by stream action.

While some of the data compiled by hydrologists and geomorphologists are very pertinent to these problems, it seems clear that the abnormal morphology and unusual composition of occupation debris coupled with the exacting demands of the archaeologist necessitate specially designed experiments and measurements.

A start on these problems was made by the instigation of field trials on the shore of Lake Magadi, Kenya (Lat. 1° 55' S, Long. 36° 15' E). The experimental material which was to be observed under more or less known fluvial conditions consisted of 100 concrete casts of five distinct forms of Acheulian handaxes and cleavers plus a quantity of rough lava flakes ranging from approximately 3 - 10 cm. in greatest dimension. The casts weighed approximately three-quarters of the weight of the lava originals. During a period of a few months from November 1964 to April 1965, these casts and flakes were laid down in a series of five experimental plots. These were sited at points along the braided course of an ephemeral stream channel draining the Lendarut Hills and passing down a narrow steep-sided fault graben. Observations suggest that the stream only flows in flash floods when a thunderstorm falls on the hills. During the period of observation this did not occur more than once or twice in a year, though unfortunately there is no means of recording the number and intensity of spates. As the watercourse approaches the lake, the valley widens and the channels become broader and more extensively braided (Pl. 1). Thus it can be predicted that variously placed experimental plots experience different intensities of current in the same flood. Up to the present only those plots (Numbers

2 and 3) in the narrow channels have definitely been moved by water. When a very high intensity spate occurs, it is anticipated that the material on these plots will be swept away and lost, but the other plots should then respond to current action without complete dispersal.

At each of the plots (Numbers 1, 2, 3, and 5) 24 to 25 concrete casts were laid out according to a rectangular grid pattern within a channel. Spacing ranged from 30 to 50 cm. Numbered specimens of the casts of the five variant biface forms were placed in series along the grid lines, with the long axes forming a regular, graded series around the points of the compass. Thus at the outset of the experiment each plot showed a regular orientation pattern without any preferred direction. The orientation of each piece was known (Fig. 3). The remaining plot (Number 4) was prepared by marking out a two metre square, and throwing pieces in from each side. At plots 2 to 5, a recorded number of rough lava flakes was placed in the spaces between the concrete casts.

Return visits have been made at approximately one year intervals. The results at the end of the first year, during which time probably only one mild flow had occurred, were as follows:

Plots 1, 4 and 5: All situated in broad, extensively braided channels with a sand/silt bed. No change apart from very slight settling into the bed.

Plot 2: Situated in a narrow channel with a sandy substratum. Showed the following changes:

1) Pieces had moved only trivial amounts from their initial position.
2) Many pieces were tilted and had sunk into scour hollows (Fig. 1 and Pls. 2 and 3).
3) There was some increase in the number of pieces lying transverse to the current.
4) Twenty-one flakes out of an initial 48 flakes appeared to have been washed away. It is possible that some of these were buried

in the sand, but this could not be checked without breaking up the experiment.

Plot 3: Situated in a narrow channel with a hard smooth substratum. Showed the following changes:

1) All but four pieces had moved from their initial position or orientation. Mean distance moved 2.3 metres; median 0.8 metres.
2) Three clusters had formed with two to four pieces lying in contact (Fig. 3).
3) Pieces had become partially reorientated with a preferred orientation transverse to the current (Fig. 2). A χ^2 test showed a probability of *ca.* five percent only for the observed distribution of orientation given a nul hypothesis of no preferred orientation. All ten isolated, transported pieces were transverse to the current, while pieces in clusters either lay transverse (three cases) or axially (three cases).
4) Selective removal of flakes from the neighbourhood of the grid had occurred. The initial proportion, large pieces:flakes, was 24:45 and changed to 15:13.

After the lapse of another year, a visit by one of us (R. J. Clarke) indicated the following further changes:

Plots 1 and 5: Little change. Minor rearrangement of pieces may have been due in part to animal foot falls as indicated by the presence of dung at both sites.

Plot 4: Pieces were almost entirely embedded in sandy silt with little visible sign of movement.

Plot 2: Pieces were now almost entirely buried in the sand with little or no further movement or reorientation save for apparent (but not measured) increases in tilt. One piece lay on edge in the sand with its long axis sub-transverse to the current.

Plot 3: The pieces were now dispersed along *ca.* 75 metres of the channel with only a small imbricate cluster of four pieces remaining near the grid. Seventeen specimens were recorded as lying transverse to the current and seven were axial. Of these seven, four were lying on the sloping gravel banks bound by the channel. Actual orientations could not be measured in the time available.

Summary of Indications

1) Acheulian artefacts may under some circumstances become buried within a channel by silt and sand without appreciable disturbance (Plot 4 as observed 10.20.65 by R.J.C.).

2) Large artefacts resting on sand appear to be very sensitive to current action and readily become embedded in the sand with pronounced upstream tilts. One specimen even came to lie on edge with the long axis transverse to the current. This phenomenon has been observed on excavated Acheulian sites at Olorgesailie, Isimila (Howell 1961:121), Latumne (Clark 1966:209). Alignment transverse to the current or axial to it may also occur under these conditions, but was not proven. The observation of burial and rotation is corroborated by the results of flume experiments with cobbles and sand (Fahnestock and Haushild 1962).

3) Where Acheulian biface forms are dispersed by movement down a channel with a consolidated bed, they can be expected to show a strong preferred orientation transverse to the current. There may be a less marked alternative alignment axial to the current. This observation is in accord with other records of the behaviour of elongate rock particles in streams (Kelling and Williams 1967; Pettijohn 1956:250).

4) Under both sand bed and hard bed conditions, flakes may be preferentially removed from an association of large artefacts and flakes.

It must be emphasized that the field trials here described are quite inadequate to form a secure basis for interpreting Pleistocene occurrences. However, the preliminary results serve both to demonstrate the value of such experiments and to indicate certain additional experiments and measurements which will be required before interpretation can be placed on a secure basis.

It is apparent that in this experiment, entire ignorance of current velocities over the various plots make it impossible to discriminate between the effects of current and substratum in determining disposition and dispersal. Further, since this experiment was initiated the author has become aware of an important factor not previously taken into account, namely, the spacing of the large rock particles in the channel. It has recently been demonstrated (Leopold, Emmett and Myrick 1966:209-215; Langbein and Leopold n.d.) that there may be important interactions between particles in a current, so that the competence of a given rate of flow to move large rocks decreases markedly when these lie in close proximity to one another. This interaction appears to result in the grouping of rocks along a channel into more or less evenly spaced gravel bars or stone concentrations which correspond to kinematic waves (Lighthill and Whitham 1955a, 1955b). It will clearly be necessary to compile field and laboratory data to permit discrimination between concentrations of stone due to the localisation of human activities, and those due to the kinematic wave effect.

Leopold _et alia_ (1966:213-214) have also reported that under commonly occurring conditions of transport in ephemeral streams, large rock particles tend to be deposited at the surface of sand and finer gravel beds. The distinguishing concommitants of this effect need to be described, because interpretations based upon it are directly opposed to those which would otherwise be indicated by the observations at Plot 2, or the data of Fahnestock and Haushild (1962).

Further investigation of the following aspects of this problem is required:

1) The threshold rates of flow needed to transport (a) bifaces, and (b) flakes in relationship to (i) substratum, and (ii) spacing of pieces; followed by field trials to discover under what conditions, if any, these two classes of artefacts might become partially segregated.
2) The effect, if any, of particle spacing on (i) orientation in

relation to the current, and (ii) on tilting in cases where burial occurs.

3) The operation of the kinematic wave effect under the special circumstances where large particles are present only in limited quantities through the agency of man. Under what conditions does concentration as opposed to dispersal occur?

4) Determination of the effects of the trampling on concentrations of artefacts under alluvial circumstances.

II. THE DISPERSAL OF BONE DEBRIS FROM AN AREA OF CONCENTRATION

The amounts of bone associated with artefact concentrations at Olorgesailie was found to vary greatly (Isaac n.d.). At many sites only small quantities of splinters and a few teeth were preserved. Geological circumstances at the sites are so uniform that differences in post-burial preservation are unlikely to be of any importance. Hence it was necessary to evaluate the extent to which low densities of bone on sites might be due to natural dispersive and obstructive agents rather than to the virtual absence of meat from the diet of the occupants. Preliminary observations have been made on (1) the scattering of bone by wild scavengers in the Olorgesailie area today, and (2) on the breakdown of bone due to exposure and weathering.

1) A locality was chosen in the comparatively undisturbed mixed Acacia-bushland surrounding the Olorgesailie site. Domestic bone refuse consisting of 23 "large" pieces and an unknown number of small splinters were dumped at a peg during October and November 1964. By the end of December only three small splinters could be found in the vicinity of the peg. Interpretation was complicated by the fact that the Masai had taken to driving herds of cattle across the selected area, so a new locality was selected and an area one yard square marked out. Fifty-five "large" bones and bone fragments, plus more than 60 bone splinters were dumped during the period March to April 1965. The category "large" bones

and bone fragments consists of the chopped off articular ends or decapitated shafts of cattle or pig bones, together with vertebra, pelvic fragments, rib fragments and phalanges. The greatest dimension of any piece was ca. 20 cm., and the minimum for the category ca. 5 cm. Fig. 4 shows the situation as it was recorded four months later in September. It can be seen that scavengers and various natural agencies had caused the major part of the refuse to be dispersed. In particular, all pieces of any appreciable size had been removed from the area. The limited size range of the chopped up bones employed in the experiment, and its limited duration, place severe restrictions on its value for archaeological interpretation; but it does seem clear that natural forces in Africa have considerable potential for dispersing bone and therefore that a presence of small numbers only of bone splinters on an excavated site does not preclude the consumption of fairly large quantities of meat. This conclusion has subsequently received corroboration from reports by L. S. B. Leakey (1965:98) and R. Lee (personal communication).

2) An experiment initiated by M. Posnansky in 1958 indicates that bone weathering may also be a factor in the dissipation of evidence for diet and economy even in an area with alkaline soil conditions and a dry climate. The skeleton of a sub-mature goat and a few cattle bones were laid out on the ground for observation. After interference by a scavenging hyaena, the surviving bones were protected within a low wooden frame, and covered with wire mesh. By September 1965, the condition of these (Pl. 4) had deteriorated to such an extent that the blades of both goat and ox scapulae had crumbled, leaving only the ridges, neck and articular surfaces. The unfused articular ends had fallen off the long bones. The cranium, mandibles, vertebra and many of the other bones were so cracked and friable that it seems certain that were they exposed to the normal accident of animal footfalls, nothing but small fragments would survive.

III. OBSERVATIONS ON THE COMPOSITION OF BONE AGGREGATES IN THE SUSWA CAVES

Interpretations of the composition of Pleistocene bone assemblages from Africa have given rise to an important anthropological and palaeontological controversy (e.g., Dart 1956, 1957a, 1957b; Washburn 1957; Ardrey 1961:195-199, 283-311; Brain n.d.). This controversy arose because bone assemblages at australopithecine and other sites departed markedly in their composition from a priori expectations: the observed relative frequencies of specific anatomical parts of various mammal groups did not correspond to the relative frequencies with which these parts occur in the skeletons of the animals. Dart (1956, 1957a, 1957b) claimed that the selective representation of certain bones could best be understood as a complex consequence of the use of bones as tools by the australopithecines. Washburn (1957) countered by reporting evidence from lion kill sites and hyaena lairs, showing that scavenging resulted in marked distortion of the proportions of skeletal parts to one another. Ultimately this particular controversy and wider problems in deduction of diet and behaviour patterns from archaeological bone assemblages depend on careful study of the composition of bone aggregates forming under known conditions.

With a view to contributing to the development of this knowledge, a study of the bone assemblages in the Suswa Caves in Kenya (Lat. 1° 9' S, Long. 36° 22' E) was initiated in March 1964, following a pioneer study by Mrs. S. C. Coryndon (1964). The work was undertaken by members of the staff of the National Museum and the Centre for Prehistory and Palaeontology, Nairobi (R. J. Clarke, G. Ll. and A. B. Isaac, A. MacKay, J. W. Simons). The writer was unable to continue the study beyond a four day reconnaissance expedition; however, as there is no immediate prospect of a full report, some of the indications given by the reconnaissance are reported here. Simons (1966) has already given a useful description of baboon bones associated with leopard lairs, together with an analysis of patterns of damage caused by gnawing.

Mt. Suswa is a dormant volcanic caldera in which certain lava flows are riddled with ramifying tunnels, some opening to the surface through collapse holes, and "blow holes" (Glover *et alia* 1964). The numerous caverns have served as shelters for human groups in recent times, possibly Mau Mau bands, and for various other mammals, including hyaena and leopard (Coryndon 1964, Simons 1966, R. J. Clarke 1966:91-92). Recent mammalian bones are widely distributed in the caves, the densest accumulations, rodents excluded, always being in association with traces of human occupation. Other less dense accumulations occurred in dark recesses and "lairs," and can safely be regarded as the leavings of carnivores and scavengers. Still other bones are scattered on the scree cones of openings, and along the tunnels. These too can in the main be attributed to non-human agencies. Hyaena faeces are widespread, occurring both with man-made middens and also the other accumulations. Bones were counted and recorded at a number of localities in the caves; Tables I and II show summaries of findings for those localities with predominantly man-made middens and the predominantly natural accumulations itemised separately. The bone identifications were made rather cursorily in the field, so the table must be regarded as an approximation. For this reason also, the data presented have been restricted to the ungulates: antelopes and domestic stock including sheep; and no attempt has been made to subdivide this unusually comprehensive group

Detailed interpretation of data compiled in this cursory fashion should not be attempted, but certain crucial points stand out very clearly: namely that the proportional composition of both the man-made midden and the natural accumulation differ markedly from the proportional composition of the skeletons which were the source of the bones. Bone tool selection and use can be ruled out as a factor for both types of accumulation. The apparently reasonable assumption that bone assemblages ought to behave as random samples of the skeletons from which they derive is thus called into question. J. W. Simons (1966:67-68) showed that the baboon bones associated particularly with leopard lairs are also present in proportions radically different from expectation.

Since this study was carried out, Brain (1967, n.d.) has reported on a detailed investigation of Hottentot bone refuse, collected in South West Africa. This assemblage shows a very marked departure from primary anatomical composition, and Brain offers some explanation of this in terms of the structure, density and relative rate of maturation of the bones selectively over- or under-represented. Gnawing by dogs and possibly jackals appears to be the principal agent of selective destruction. At Suswa, hyaenas may well have been responsible for a similar process. Inskeep and Hendy (1966) have also reported an archaeological bone assemblage showing comparable though not identical patterns of selective distortion.

Discussion of these problems, and the mechanisms of selective destruction is also to be found in Lubbock (1865:183-184). Lubbock reports observations by Steenstrup of disparities in the relative representation of skeletal parts in Danish kitchen middens, and that Steenstrup had experimented with his own dogs, showing gnawing as a probable cause of destruction. Steenstrup had also pointed out the correlation of durable bones and bone parts with early ossification during growth. These pioneer studies have been overlooked in the intervening century, and the patterns have now been rediscovered by Brain.

The morphology of fractured bones in the caves has not yet been carried out systematically, but during the field work, numbers of jagged dagger and apple-corer like longbone segments were observed and collected.

It is not intended that this paper should be regarded as a refutation of the osteodontokeratic hypotheses of Dart. Data pertinent to the evaluation of the evidence for those hypotheses is merely presented, and the need for more rigorous studies stressed.

The Suswa bone accumulations deserve more thorough study; investigations of bone refuse surrounding contemporary habitation sites with various known dietary and butchering practices, settlement patterns and enviornmental conditions are also urgently needed. Comparable records of composition and fracture morphology in fossil bone assemblages from hominid-free contexts would also be of great value in assessing the meaning of patterns observed in both definite human and suspected hominid assemblages.

CONCLUSION

This paper has described a few simple experiments and systematic observations concerned with elucidating the processes involved in the formation of aspects of the archaeological record. It is to be hoped that such studies will become increasingly an important part of the archaeologist's and ethnographer's work.

NOTES

[1] With a contribution by R. J. Clarke.

[2] The work reported in this paper was done while the author was employed by the Museums Trustees of Kenya in the Centre for Prehistory and Palaeontology, under the direction of L. S. B. Leakey. The freedom to engage in such studies, and the use of transport and facilities is gratefully acknowledged. The work was a by-product of the investigations at Olorgesailie, which were partly supported by a National Parks subvention, and by grants from the Wenner-Gren Foundation, Boise Fund, British Academy and British Institute of History and Archaeology in East Africa. Mrs. A. B. Isaac has assisted extensively with the work of all these experiments and observations, and has prepared the diagrams.

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TABLES

I

Summary of bone counts made in the field at Suswa. Man-made but scavenger visited middens were recorded in cave 1, 2A, 2B, 10, natural accumulations in caves 6, 36, 14C. The expected numbers in the table are calculated from the cited number per skeleton. These numbers are generalizations for ruminant skeletons which form the vast majority of the series. The error introduced by including equids in the data seems likely to be less than that of excluding them on the basis of field identifications. Primate and carnivore bones have been excluded from the table.

II

Analysis of totals for long bones. (+) The difference between sums for portions of bones and the total representation of the bone is made up by intact bones.

TABLE I

	MAN MADE MIDDENS				NATURAL ACCUMULATIONS		
	No. per skeleton	Expected in 562 bones	Observed	Selective over (+) or under (-) representation	Expected in 158 bones	Observed	Selective over (+) or under (-) representation
Horn Cores (Equids are rare)	2	8.6	5		2.4	3	
Maxillae	2	8.6	18	+	2.4	12	+
1/2 Mandibles	2	8.6	99	+	2.4	12	+
Vertebra	42	181	50	-	51.1	13	-
Ribs	26	112	177*		31.6	13*	-
Scapulae	2	8.6	40	+	2.4	9	+
Innominate	2	8.6	23	+	2.4	10	+
Long bones**	12	52	142	+	14.6	47	+
Carpals/ tarsals	16	70	5	-	19.4	19	
Phalanges	24	104	3	-	29.3	20	
	130	562	562		158	158	
Skulls & cranial fragments	--	--	7		--	8	
Loose teeth			75			4	

*Fragments were counted making higher than "expectation" values understandable.

**See Table II

TABLE II

	MAN-MADE MIDDENS			NATURAL ACCUMULATIONS	
	No.	E	O	E	O
Humerus proximal			3		-
shaft			4		-
distal			19		6
	2	23.6	26	7.8	6
Femur proximal			-		2
shaft			2		3
distal			-		-
	2	23.6	4+	7.9	6+
Radius/ulna proximal			12		3
shaft			4		1
distal			3		1
	2	23.6	25+	7.8	7+
Tibia proximal			4		1
shaft			7		1
distal			16		6
	2	23.6	29+	7.8	10+
Metapodials proximal			40		11
shaft			6		-
distal			3		4
	4	47.5	55+	15.6	18+

FIGURES

I

Frequency distribution of observed angles of tilt. Maximum tilt on the plain of maximum projection was measured. All tilts had a marked upstream component. A: Specimens with long axes oriented between 45° and 90° to the current; B: Between 0° and 44°.

II

Frequency distribution of orientation to the current. Left: Orientation of apex distinguished. Right: Orientation of long axis without reference to apex and butt.

III

1: The layout used for Plot 3 and with minor variations for Plots 1, 2 and 5. 2: Disposition of pieces after current action (one flood?) during a year. Z denotes length of trajectory not shown to scale.

IV

Top: Bar diagram from center to left shows dispersal of large bones in the concentric divisions indicated. Bar diagram from center to right shows data for small bones. Bottom: Graphic representation of bone loss. All loss percentages are minimum values.

Fig. 1. PLOT 2 : <u>TILTING OF SPECIMENS</u>

A. Specimens transverse to the current. B. Specimens axial to the current.

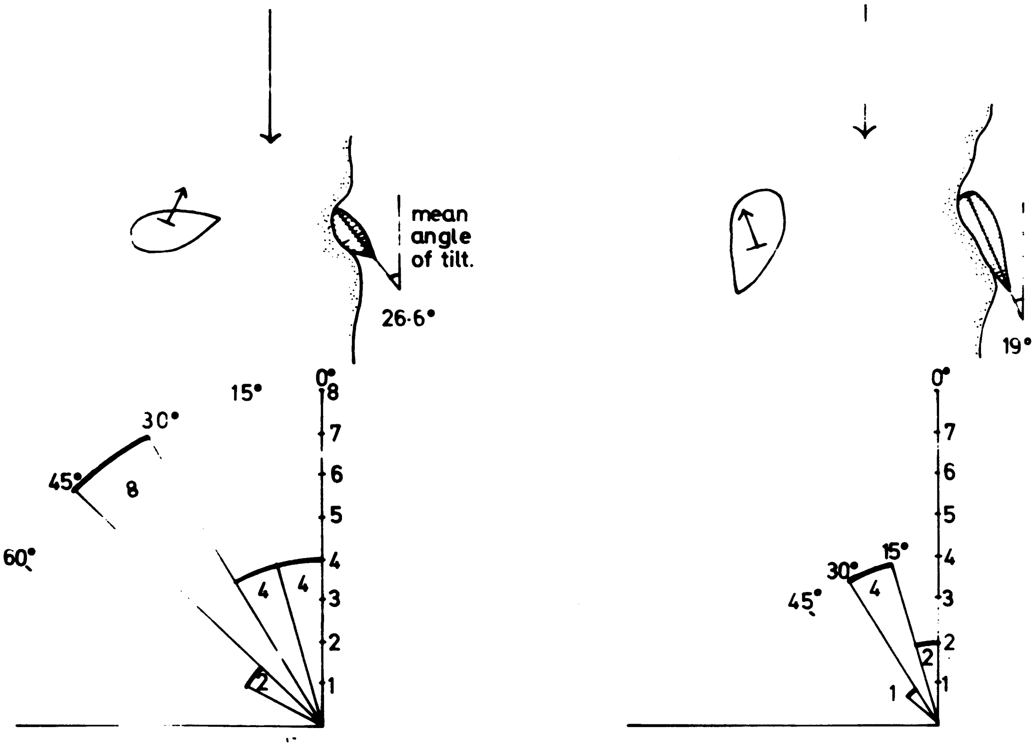


Fig. 2. PLOT 3: <u>ORIENTATION OF SPECIMENS.</u>

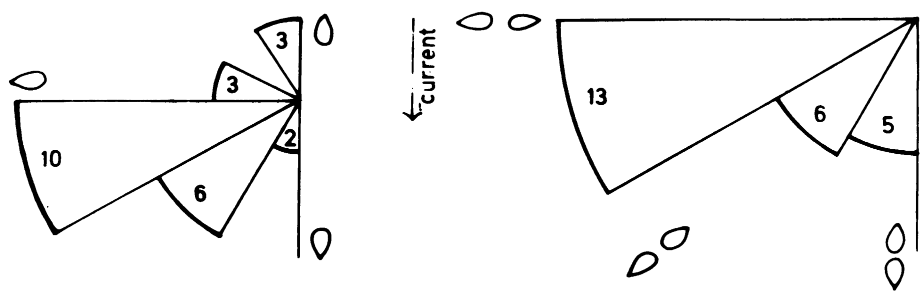
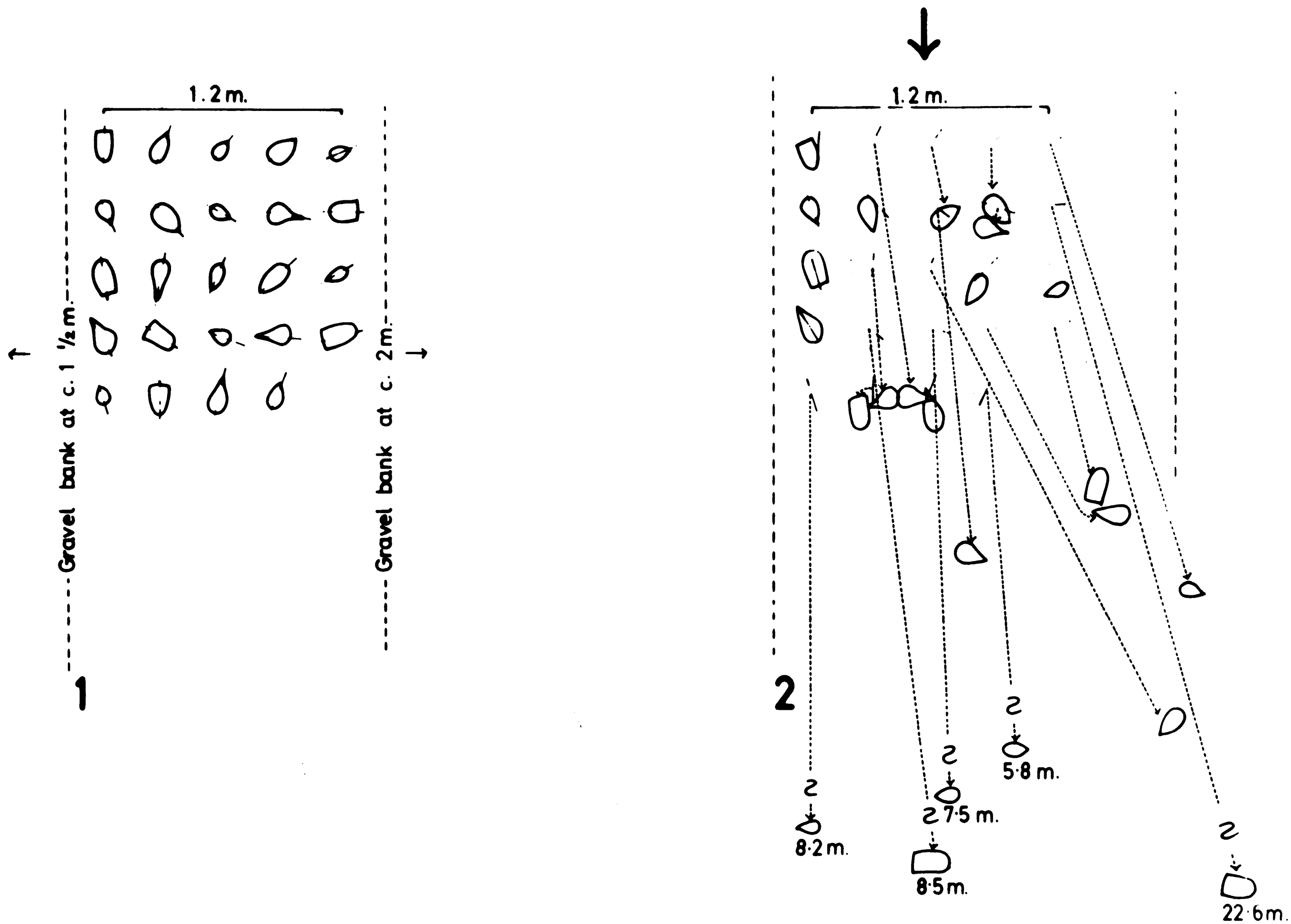
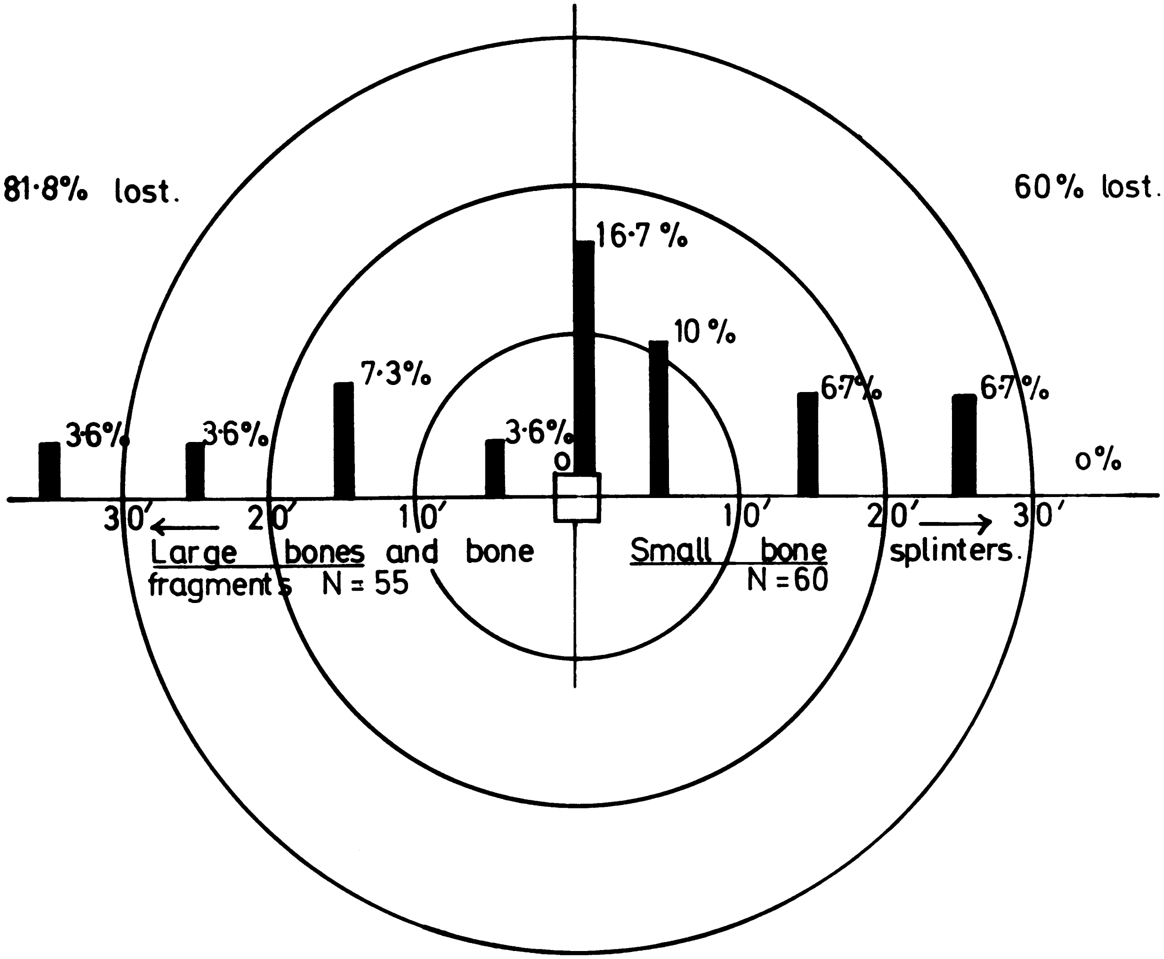


Fig. 3. PLOT 3.

Hard smooth substrate with local sand veneer.





DISPERSAL OF BONES AS OBSERVED 14 SEPT. 1965.

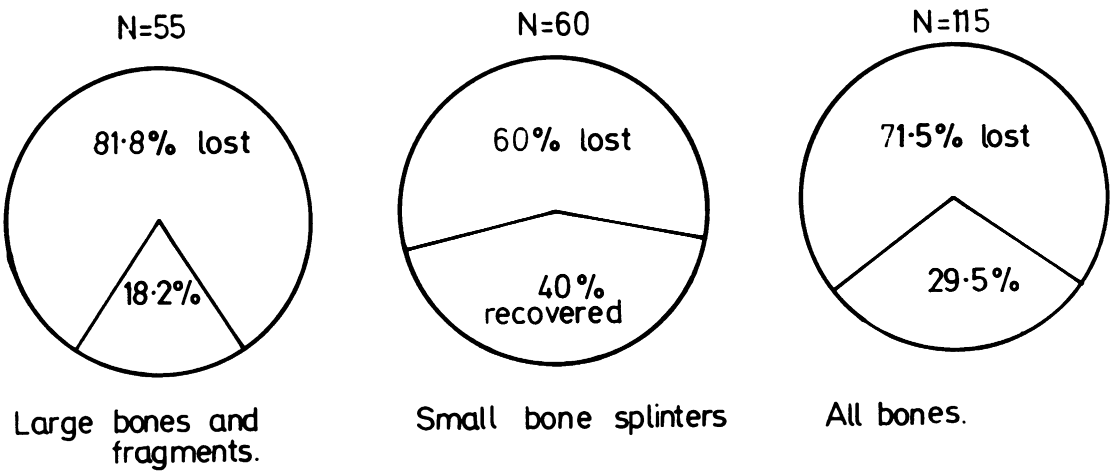


Fig. 4

PLATES

I

View southwards from the shore flats of Lake Magadi up the fault graben valley where the handaxe dispersal experiment was conducted. Plot 5 in the foreground; Plots 2 and 3 are in the distance where the valley narrows.

II

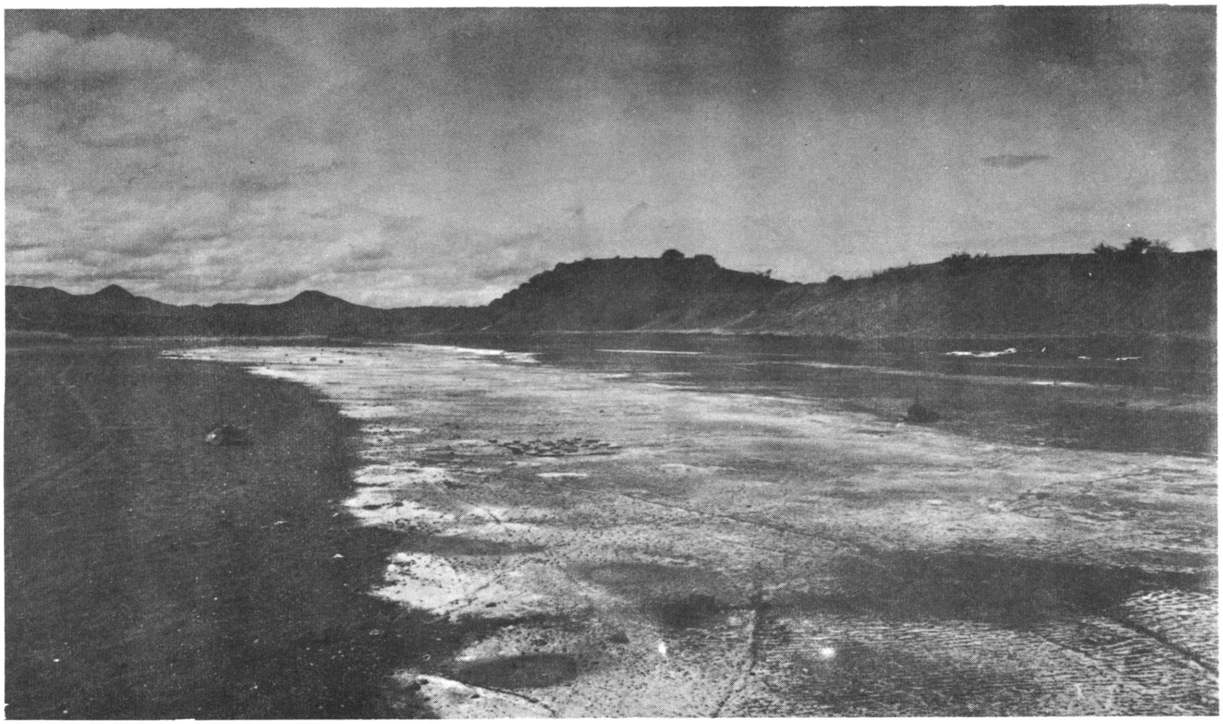
Plot 2 after one year and the passage of possibly a single mild flood. Pieces are tilting and sinking into the sand.

III

Oblique close-up of pieces in Plot 2, showing the upstream tilt as they subside into scour hollows.

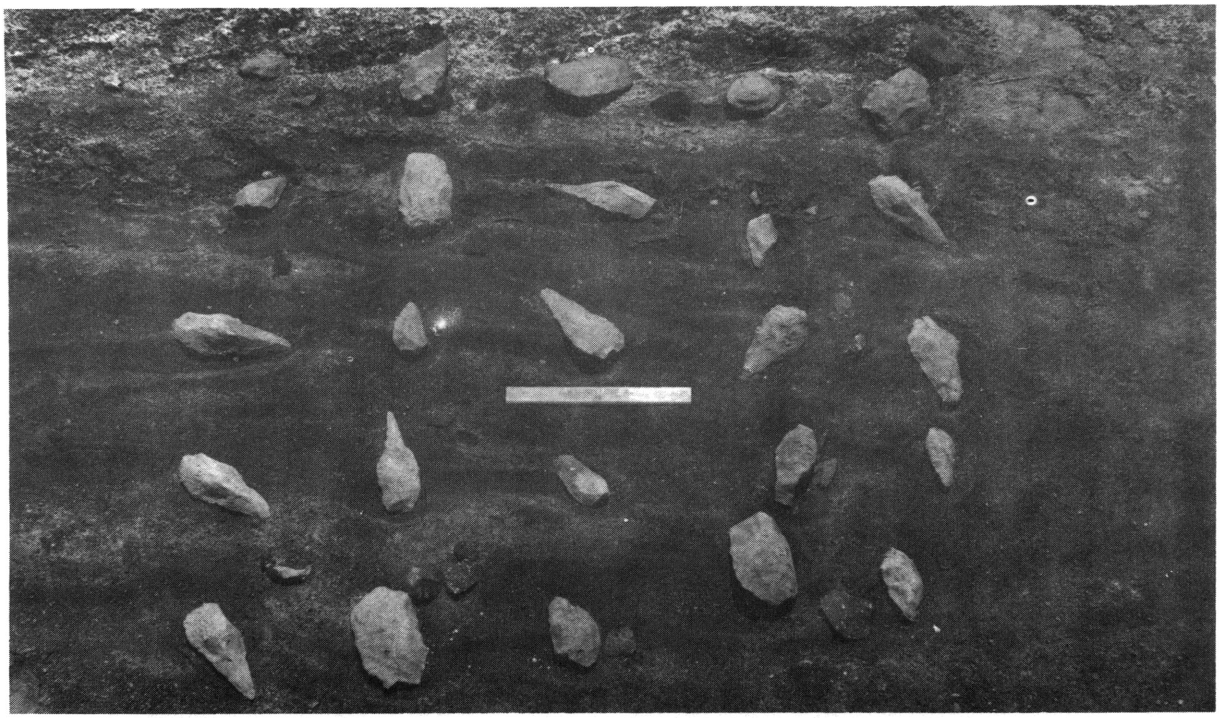
IV

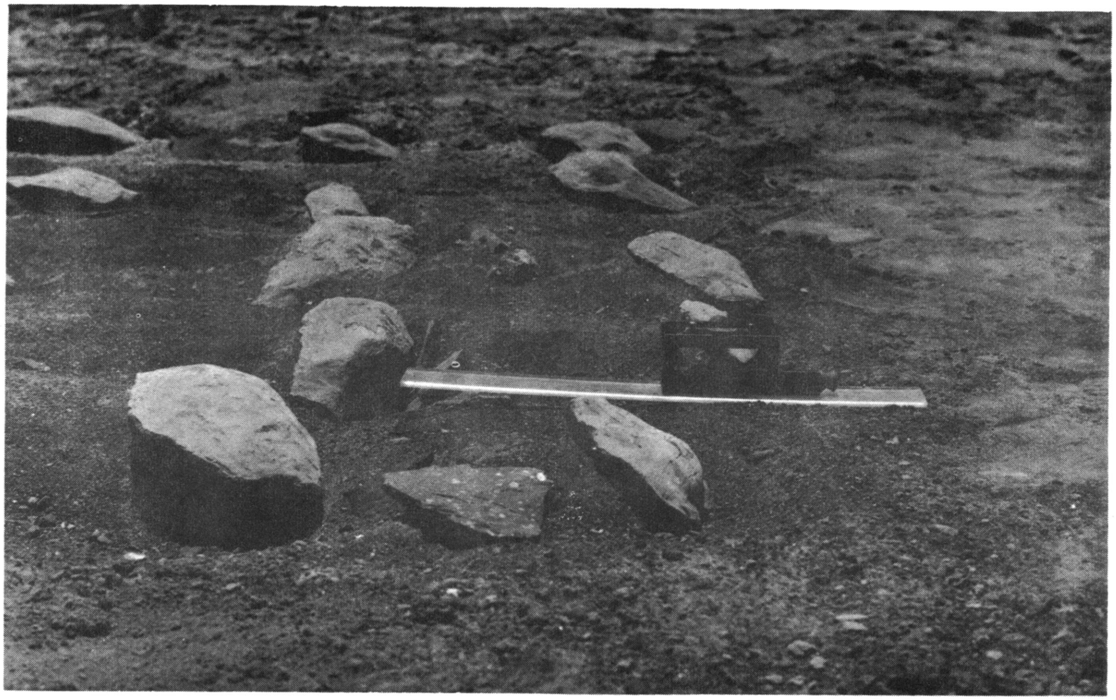
August 1965: the bone weathering experiment at Olorgesailie initiated by M. Posnansky in 1958. The disintegration of some bones and the extremely fragile condition of most others is clearly visible.



Pl. 1

Pl. 2





Pl. 3

Pl. 4