

# *Evidence for Predation and Pastoralism at Prolonged Drift: a Pastoral Neolithic Site in Kenya*

by

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*This important paper offers a fresh and stimulating approach to the interpretation of a large faunal assemblage from an excavated site. There are interesting implications in regard to present-day land use — an aspect of archaeology to which too little attention has been paid. The principal author, Dr Gifford is Assistant Professor in The Board of Studies in Anthropology, University of California.*

Prolonged Drift (GrJi 1), lying on the flood-plain of the Nderit River, south of Lake Nakuru (figs. 1, 2), is a rich Pastoral Neolithic site that yielded well over a quarter of a million artefacts and the largest faunal sample yet to be analysed from such a site in East Africa. With many wild ungulate species and a substantial minority of domesticates, the faunal assemblage from Prolonged Drift may well represent the debris of an economic system no longer extant in the region, as might logically be expected of a site deriving from the earliest phases of food production in East Africa.

This paper has two main aims. First, it reports in detail the principal author's analysis of the Prolonged Drift fauna, including analytic methods, findings, and basic inferences to be derived from the findings. Second, it will attempt to construct a framework for viewing the economic evidence from Prolonged Drift and from other sites for which any such evidence is available. This will be a necessarily tentative essay in evaluating the extant evidence for Pastoral Neolithic economic patterns in the light of relevant ecologic and ethnographic information. Our discussion, and our associated attempts at model-building, should be understood as intended to stimulate discussion among colleagues interested in the origins of food producing economies in East Africa, rather than as a definitive statement of opinion.

The first section of this paper briefly outlines the historical, cultural, physical, and temporal context of the site. The second section discusses methods employed in the faunal analysis, while the third presents basic data derived from the assemblage, as well as primary inferences from these data. The fourth section presents a discussion of alternative types of subsistence strategies which may have been practised in the Central Rift region during the times in question.

## **Context**

### *Historical Background*

The faunal assemblage from Prolonged Drift was recovered in 1969–70, during a 4½ month excavation campaign, as part of a larger cooperative research project, funded by the National Science Foundation (U.S.A.), in the Nakuru basin of Kenya. The project, directed by Glynn Isaac, had as its research objectives detailed study of the late Pleistocene and Holocene stratigraphy of the region, reconstruction of its palaeoenvironmental history, and placement of archaeological sites in this spatial and temporal framework (Isaac, *et al.*, 1972; Butzer, *et al.*, 1972; Richardson and Richardson, 1972; Washbourne-Kamau, 1971, 1975).

The site was discovered while two of us (G.L.I. and C.M.N.) were surveying

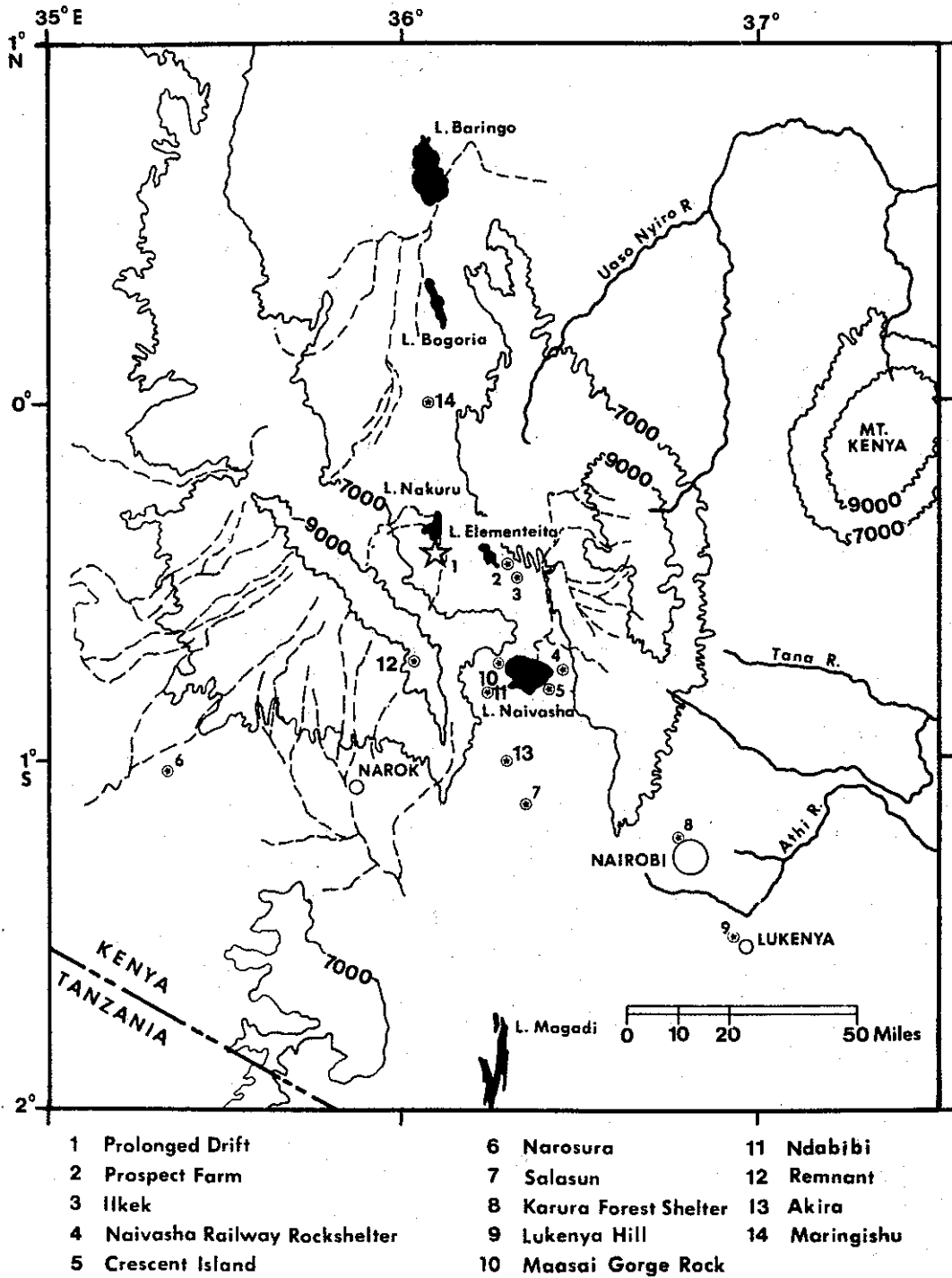


Fig. 1. The Central Rift and adjacent regions, showing pastoral Neolithic and contemporaneous sites.

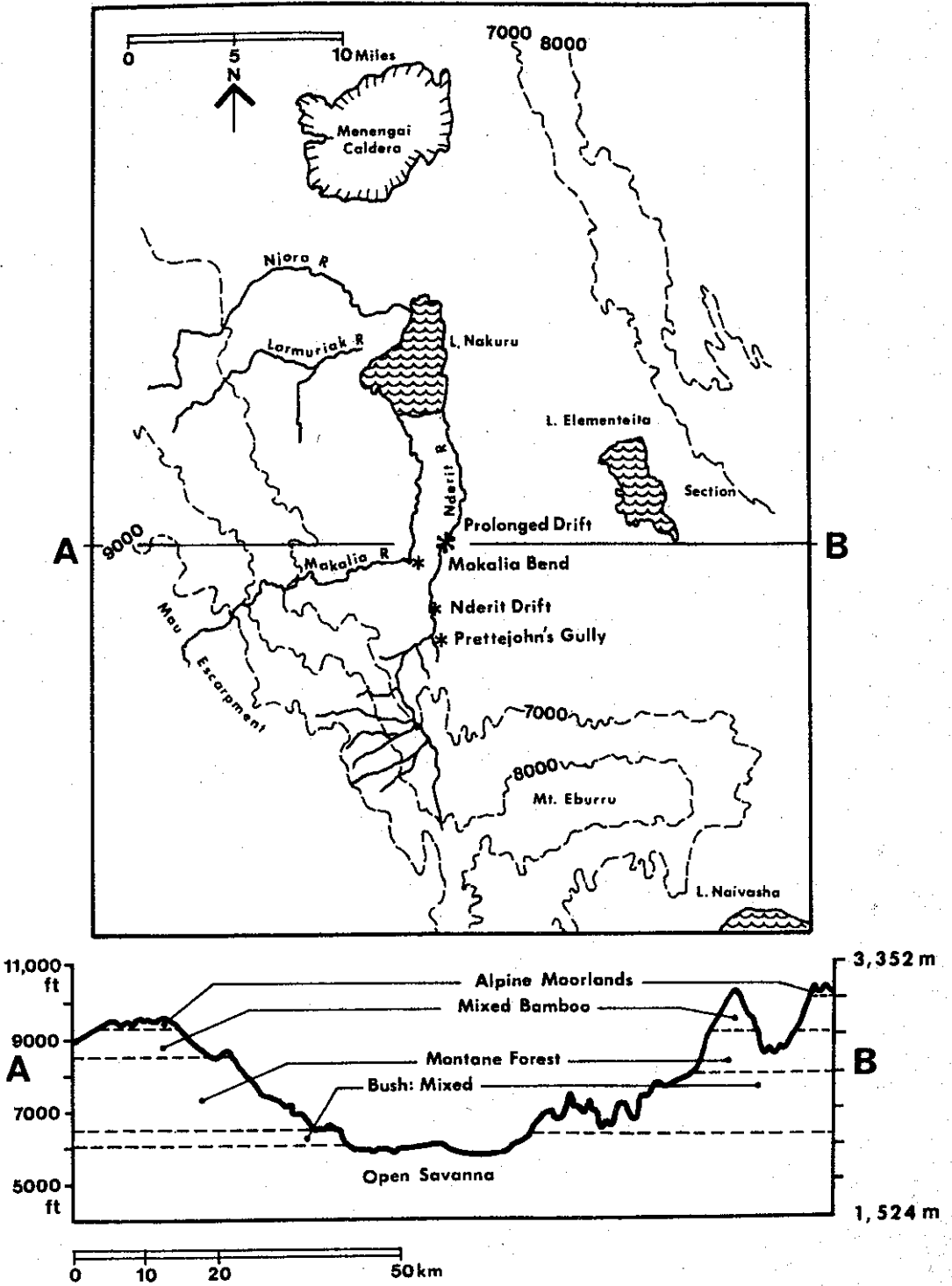


Fig. 2. The Nakuru Basin, showing Prolonged Drift and nearby sites; heights in feet. Profile taken through Prolonged Drift locale shows vegetation zones.

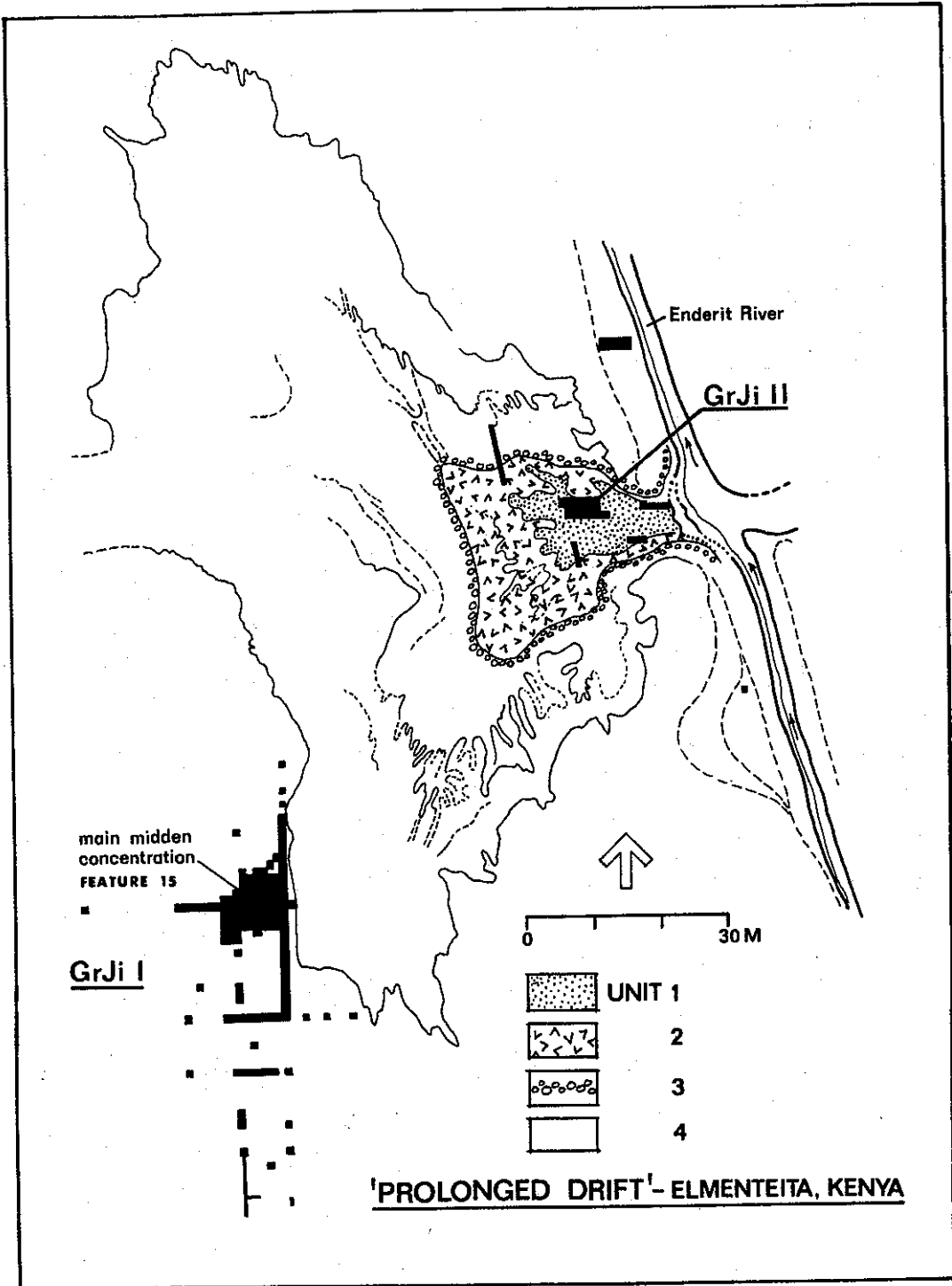


Fig. 3. Prolonged Drift site plan, showing Feature 15 and two main trenches and the outcrops of the stratigraphic units.

in the Nderit River valley; we noted a substantial scatter of obsidian artefacts, bone fragments and potsherds lying on a low shelf below a small erosion scarp in the uppermost half metre of the brown silts which form the top unit of the local sedimentary sequence. A long trench subsequently excavated at right-angles to the outcrop confirmed the existence of abundant stratified archaeological materials, with a dense concentration of bone and artefacts at approximately 50 cm below the surface. Because of its location and artefactual content, Grji 1 was, when first located, assumed to be Long's Drift, excavated by L.S.B. Leakey in the 1920s and the type-site of the Kenya Wilton industry (Leakey, 1931). However, Dr Leakey visited the site during excavation and concluded that it was not, in fact, Long's Drift, whereupon Glynn Isaac changed its name to Prolonged Drift. However, because of this site's location and typological similarity to the site Leakey sampled and because of our failure to locate Long's Drift, we still consider that there is a possibility that local topography and vegetation had changed sufficiently in the intervening forty years that Dr Leakey was not able to recognize his old site. However, under the circumstances, it seems best that the site investigated by us have a separate designation.

Since the site promised to yield a substantial and well preserved sample of Neolithic occupation debris, we decided to engage in a major recovery programme. The excavations at Prolonged Drift were supervised by Charles Nelson, assisted by Steven Gourlay. Areas on either side of the original trial trench were opened, revealing a localized patch of bone and artefacts, which was designated 'Feature 15'. Flood-plain silts above and below this major horizon also contained similar archaeological materials. Although these were generally distributed through the section in a diffuse pattern, there were indications of another, less dense horizon some 15 cm above Feature 15. The excavation was expanded to expose most of the dense concentration and to ascertain its limits. It was found to be irregular and elongate, vaguely crescentic in form, with its concave side to the south-east. The jumble of materials had all the aspects of a midden, or some type of secondary refuse deposit, adjacent to areas nearly free of debris. Throughout this paper we proceed on the basic assumption that Feature 15 is some type of refuse dump. The excavation, plotting, and lifting of Feature 15, more or less in its entirety, proved so time-consuming that insufficient time remained for adequate sampling of the adjacent 'clear' areas. Clearly further excavation is needed to ascertain the archaeological characteristics of this zone, which may have been a 'living or open activity area'.

Trenches were excavated outward from the main concentration in order to secure some information on its surroundings. One metre square soundings were also excavated at arbitrarily chosen points around Feature 15 (fig. 3) Two of these encountered other patches of refuse which resembled the main feature. Two additional trenches were opened at these points (S 43 metres and S 51 metres, fig. 3) to secure more information. Like Feature 15, these concentrations appear to be dense accumulations of secondary refuse, with no internal features.

In all, some 225,000 lithic artefacts were recovered from the site, as well as over 165,000 bone fragments and numerous ceramics. Analysis of the faunal assemblages was begun in Berkeley, and potentially identifiable pieces were studied in 1974 by Diane Gifford, principal author of this report, at the Kenya National Museum in Nairobi.

#### *Topographic and Geographic Setting*

Prolonged Drift is situated in the plains flanking the middle reaches of the

Nderit River, which runs north into Lake Nakuru (fig. 2, Pl. XIIIa). In the vicinity of the site the river flows through a steep-sided canyon, some 9 m deep, incised into the flood-plain. In normal years the Nderit is a perennial stream, but in dry years its flow may cease, with water in the river-bed being confined to a series of stagnant pools. For several miles to the north and the south of the site, the sides of the canyon are so steep that it is effectively impassible to ungulates. The few points, like that at Prolonged Drift, where animals can and do cross have been altered by their traffic into characteristic amphitheatre-like embayments on both sides of the river (fig. 3, right). European settlers in the area used the Afrikaans word *drift* ('ford') to designate these crossing points, hence its use in many site names in the region.

The Nderit canyon diminishes in depth downstream. Four to five kilometres north of Prolonged Drift, the stream ceases to flow in an incised course, issuing at that point on to a seasonally swampy flood-plain without well-defined drainage channels. As will be noted in the section on Stratigraphy and Sedimentary Context, the site probably formed in a situation more comparable to that of these lower reaches of the present stream than to that of its present local environment.

At present the well-drained valley plains in the vicinity of the site bear vegetation which ranges from wide expanses of open grass to grasslands densely studded with bushy acacia and leleshwa trees (*Acacia spp.*, *Tarchonanthus camphoratus*). Thomson's gazelle (*Gazella thomsoni*) are common on the grassland and impala, dikdik, and steinbok (*Aepyceros melampus*, *Rhynchotragus kirkii*, and *Raphicerus campestris*) in the bush. Cattle are presently grazed both on the open plains and in the more brushy country. Seasonally flooded areas near the lake itself are dominated by fever trees (*Acacia xanthophloea*), with patchy growth of bushes and some grassy glades. In the absence of direct palynological evidence, we are unable to know whether the vegetation around the site at Prolonged Drift was as tree- and brush-dominated as topographically similar reaches of the Nderit drainage are today, or whether the recent recession of saline Lake Nakuru over the area conditioned a more salt-tolerant, grassy plant community. Pollen spectra from Lakes Naivasha and Nakuru (Richardson and Richardson, 1972; D. Livingston, pers. comm.) do not indicate drastic differences between the vegetation of the last few millennia B.C. and that of the present-day region.

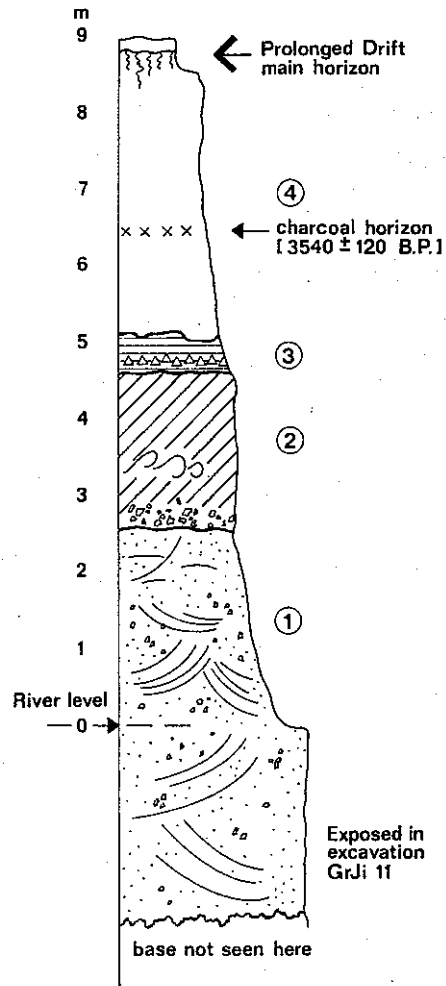


Fig. 4. Generalized stratigraphic column in site locale.

### *Stratigraphy and Sedimentary Context*

A simplified local stratigraphic sequence is shown in figure 4. The archaeological horizons with which this report is concerned are situated within brown, sandy/clayey alluvial silts. We infer that this sedimentary unit is the downstream lateral equivalent of the Mukiri Beds (Makalia Formation) defined at Nderit Drift (Bower *et al.*, 1977). These beds overlie lacustrine diatomites which in turn rest on a 2 metre thick layer of reworked grey volcanic ash and pumice. The ash, hitherto known as the 'Makalia Ash', covers medium fluvial sands that contain a Middle Stone Age site, GrJi II, shown in figure 4 (Isaac *et al.*, 1972; Merrick, 1975).

The brown alluvial silts of the site did not display any bedding, imbrication, size sorting, or selective alignment. From this, and from the lack of traces of fluvial effects on the midden, we infer that the site was covered by slow-moving floodwaters. The location of the river-course which went overbank and inundated the site is not known, but it may well have been close to that of the present river channel, some 50 to 60 metres east of the site. Since the Nderit today never rises out of its canyon to inundate the surrounding plain, we infer that the site was formed prior to deep incision of the gorge. Our knowledge of the regional stratigraphic sequence leads us to suggest that the site was formed under the following circumstances:

1. During the mid-Holocene, the shoreline of Lake Nakuru stood approximately 40 to 50 m above its present level. At some time between  $4040 \pm 140$  (GX-440) and  $3540 \pm 120$  (N-821) B.P., the lake began an oscillating contraction in size, shrinking to its present somewhat fluctuating level of 1760 m (5700 ft).

2. As the lake waters withdrew north, the proto-Nderit laid down a series of deltaic and flood-plain deposits over the gently sloping valley floor, in pace with the retreating shoreline of the lake (the Mukiri and Wairimu Members of the Makalia Formation, Bower *et al.*, 1977). It was during this time that the site was created and buried in fluvial sediments.

3. When lake level fell below a certain height, headward erosion began to incise a canyon through the previously deposited sediments, eventually contributing to the exposure of the deposits at Prolonged Drift. Incision of the gorge was proceeding just prior to  $1370 \pm 140$  B.P. (GX-4300).

As noted previously, artefacts and bones lay scattered throughout the silts, but a series of spatially restricted concentrations form distinct archaeological entities. At a depth of about 50 cm below the surface of the plain lies the horizon in which three concentrated patches of debris were detected, of which Feature 15 was the most thoroughly investigated (Pl. XIIIb). Between these concentrations was a more dispersed scatter of occupation debris. For the purpose of this report, this entire level is designated the 'main horizon'. Some 20 cm above the northern concentration of bone (Feature 15), a second horizon of archaeological materials was encountered, which yielded obsidian artefacts in a density similar to that of the lower horizon but which contained much less bone. Such bone as was recovered from this level was less well preserved, probably due to the action of soil-forming processes.

Soil formation has been underway on the sediments containing both horizons since their deposition and the subsequent abandonment of the flood-plain, a period of time between 1500 and 2500 years. No laboratory studies of the soil have been performed, but some general observations on its structure and effects may be made. Over most of the site and its vicinity, soil formation appears to have involved the downward eluviation of clays. The uppermost soil horizon consists of a relatively loose, sandy unit, with very weak platy structure and a weak tendency to break

into crumbs. At the base of this unit is a grey, leached horizon devoid of visible structure; this unit is separated from the B horizon below by a conspicuous break in the profile, apparently caused by the action of the clay-rich B horizon. The B horizon's propensity to alternately shrink and swell has produced this clear undulating surface, separating it from overlying units. This horizon displays vertical cracking and a blocky structure, which tends to break down into firm crumbs or sub-angular plates. Ped surfaces are coated with skins of organic colloids, clay, and free silt grains, suggesting that the soil is still in the process of forming. The B horizon grades down into a little-altered C horizon of alluvial silts.

Bones lying in the B horizon were frequently shattered in place by the swelling, shrinking, and cracking of the matrix (see *Condition*). However, it appears that in those areas where the bone mat was very dense, compositional and textural differences locally inhibited the development of the B horizon. In these areas, a thicker A horizon intergrades directly with the underlying parent silts. Bone disintegration is thus much less extensive in the densest parts of the midden concentrations.

### *Cultural Affinities*

Prolonged Drift is one of a suite of sites in the Nakuru/Naivasha basins which have recently been characterized as 'Pastoral Neolithic' (e.g. Bower *et al.*, 1977; Onyango-Abuje, 1977a, 1977b; Ambrose, in press). Like other such occurrences in this and adjacent parts of East Africa, the site assemblage is characterized by a combination of pottery, stone bowls and other ground stone forms, domestic stock and a variable but heavily microlithic flaked stone component that bears strong overall resemblance to Late Stone Age industries of the same region. The lithics from Prolonged Drift are almost entirely of obsidian, undoubtedly from local sources. The shaped tools are dominated by backed microliths, especially crescents, and by small convex end scrapers. Burins, becs, and casually-formed scrapers are also well represented (Nelson, 1973). While the industrial ascription 'Kenya Wilton' given by L.S.B. Leakey to the Long's Drift assemblage has now been superseded, the lithics from Prolonged Drift do resemble those series which used to be referred to this category. With the exception of a few sherds resembling Narosura ware (e.g. Bower *et al.*, 1977; Wandibba, 1981), most of the ceramic fragments from Prolonged Drift were undecorated and hence not attributable to any of the recently-defined Pastoral Neolithic wares.

A number of other Pastoral Neolithic sites have been recognised in the Nakuru-Naivasha region (fig. 2). These include the site complex in the Fifth Formation at Nderit Drift, Lion Hill Cave, Masai Gorge Rock Shelter, Crescent Island Causeway and main sites, and the Gilgil River site. Further south are Ndibibi, Akira, and the Salasun Rock Shelter. North toward Lake Bogoria lies the site of Maringishu and west of Lake Baringo the open site of Ngenyn (Hivernal, 1975, 1980). Recently, Stanley Ambrose (in press) and Charles Nelson (1980) have divided these sites and certain others found in the adjacent western highlands of the Rift into two groups, each tending to be associated with different altitudinal and vegetational zones. The two groups also display distinct lithic and ceramic assemblages. The upland series of occurrences is the so-called 'Elmenteitan Culture' of L.S.B. Leakey (1931), and has been designated the Elmenteitan technocomplex by recent authors. The suite of lowland-oriented sites, of which Prolonged Drift is a member, are so industrially diverse as to preclude, at least to date, a formal industrial ascription, but are referred to as the 'Savannah-Oriented Pastoral Neolithic'.



### Dating

Determination of the age of the site remains something of a problem. During excavation fine particles of charcoal were encountered and collected. From them a series of three composite samples were compiled which grouped small samples from adjacent squares and levels. These were submitted to the C<sub>14</sub> laboratory at the University of Washington, Pullman. The results ranged between greater than modern C<sub>14</sub> activity (102.7 per cent: WSU-1203) and an apparent age of 120 ± 200 (WSU-1204). From this we conclude that perhaps charcoal from recent bush fires had migrated down soil cracks.

A series of three samples of the non-identifiable bone fragments was then submitted. Two of these showed similar modern or near-modern levels of C<sub>14</sub> content, with values of 100.9 per cent modern and 112 per cent modern (WSU-1237 and 1234). However, sample WSU-1242 gave a result of 1260 ± 160 b.p. (= c. 700 a.d.). This could conceivably be a valid age determination, but we have been disinclined to attach undue significance to any single age value where other samples from similar contexts have given results which are clearly not valid estimates of the age of the site.

The characteristics of the material culture are, as explained above, 'Pastoral Neolithic'. Most dated assemblages of the Pastoral Neolithic in Kenya and northern Tanzania have proved to date to the first millennium B.C. and the determined units extend from 3290 b.p. to 1255 b.p. We are inclined to the view that Prolonged Drift is probably of this general order of antiquity.

Additional C<sub>14</sub> dates have been determined from a sample of elephant-tusk ivory collected specially for the purpose of an age determination. The collagen fraction gave a date of 2530 ± 160 (GX-5735G); the apatite fraction gave a date of 2315 ± 150 (GX-5375A). These are probably the best estimates of the age of the site, but given the clear, unresolved problem of anomalous C<sub>14</sub> values, even this date should be treated with caution.

As reported in the section on stratigraphy, a bushfire charcoal horizon in the silts approximately 2 m below the main horizon yielded an age of 3540 ± 120 (N-821, Isaac *et al.*, 1972). This sets a maximum age for the occurrence.

### Analytic Methods

#### *Sampling and Reliability of Estimates*

As indicated in the brief narrative of field procedures, the osteo-archaeological sample with which the report deals was obtained by conventional selective methods which did not involve either a fully systematic sample or a random sample of the site-area. This means that it is not possible to assess formally the degree to which the sample analysed is representative of the site.

The assemblage of bones which has been analysed represents a very large proportion, perhaps 75 per cent of one particular midden within the site. Clearly we have very reliable estimates of the composition of that particular midden. Beyond that we have small samples of two other midden concentrations which provide the basis for at least informally assessing the degree to which the features determined for the Feature 15 midden recur in other refuse concentrations.

The conventional approach followed in the excavation of Prolonged Drift retrieved material mainly from a single area which was found to yield abundant material. This is in effect a form of cluster sample. It is a truism of sampling theory that cluster sampling yields best results when operating on spatial distributions of

items that are not differentially aggregated but rather are spread uniformly in space (e.g. Cochran, 1977; Read, 1975). This is definitely not the case in most archaeological sites. Recent computer simulation studies of D.P.G. and others (Ammerman, Gifford, and Voorrips, 1978) indicate that the differential clustering of materials in space may seriously affect the precision of composition estimates (e.g. relative proportions of different animal taxa) even when probability-based sampling strategies and unrealistically large sample sizes (25 to 50 per cent of site area) are employed.

In the most basic terms, results of these studies appear to indicate two things: (1) that probability-based sampling strategies are no magic guarantees of estimate accuracy; (2) that the amount of the assemblage sampled is probably more important than the mode by which the samples are drawn, in terms of yielding more precise and accurate (in the strict definitions of those terms) composition estimates. Albert Ammerman, in fact, has devised a non-random cluster-sampling scheme which, in terms of composition estimates only, yielded a more precise and accurate series of estimates (Ammerman, Gifford, and Voorrips, 1978). This method sampled squares previously ranked in order of the highest densities of surface materials (and assumed sub-surface materials). This strategy, repeated a total of 20 times in simulations, produced slightly biased composition estimates, but at the same time yielded the most precise (i.e. least dispersed about the true value) estimates per number of squares dug. This strategy probably 'works' because it increases sample size at the swiftest possible rate. Mention of these experimental studies is made here because the latter approach is roughly parallel to that followed by many traditional excavation campaigns, albeit less stringently — i.e. the preferential excavation of the 'richest' areas of a site.

Excavation of only the 'richest' areas of a site has lately been criticized because of its tendency to direct attention away from actual activity or occupation areas and towards deposits of rubbish or secondary refuse (e.g., Flannery, 1976; Gallagher, 1977). However, if one's primary goal is maximum recovery of materials reflecting technological or economic behaviour, then rubbish heaps are optimal sampling locales for that purpose. Prolonged Drift is an extreme example of such a recovery strategy; about 75 per cent of the bones that constitute Feature 15, comprising some 165,000 elements, was excavated. Moreover, the distribution of taxa and body parts within Feature 15 is essentially even, with no statistically discernible clustering (see page 00). Hence this is an optimal situation for cluster sampling.

The foregoing discussion is intended to condition both the authors' and the reader's use of the ensuing sections of this paper, in which composition estimates are extensively employed, in two ways. The first quantities used in this paper are essentially estimates of the characteristics of one particular midden concentration. Until more extensive, suitable samples of other middens and other bone assemblages have been taken, the absolute value of the composition estimates cannot be taken to represent in any hard and fast way a general site-specific 'reality'. The use of these figures in inter-site comparison and in the modelling of subsistence patterns must therefore be cautious and tentative.

#### *Identification and Quantification*

Preliminary processing in Berkeley of all bone specimens, under the supervision of L.K. Olson, isolated potentially identifiable bone for further analysis. Minimally identifiable pieces and non-identifiable scrap were counted and weighed, and evidence of burning, if present, was recorded. Potentially identifiable elements were

processed using the reference collection of the Kenya National Museum (Nairobi) Osteology Department. In addition to the data noted for less identifiable pieces, a variety of other attributes was recorded for identifiable bone. These included, in addition to anatomical and taxonomic identification, surface condition of the bone, presence or absence of butchery marks, of repetitive patterns of fracture, of gnawing, of joins between fragments of the same bone, and of articulation between different elements in one anatomical unit.

Bovoid elements either too fragmentary for positive specific attribution or of little specifically diagnostic value were assigned to one of five size categories created by L.K. Olson in her preliminary analysis: very small (5–15 kg); small (16–35 kg); medium (40–60 kg); large (70–250 kg); and very large (300–850 kg). Fragmentary bovid teeth, as well as certain other diagnostic pieces, could often be assigned to tribe or genus. In three cases, however, this was insufficient to distinguish between two members of the same taxon known to be present in the sample (viz. *Connochaetes* and *Alcelaphus* of the tribe Alcelaphini, *Bos* and *Syncerus* of the tribe Bovini, and *G. thomsonii* and *G. granti*, of the genus *Gazella*). These elements were recorded at the appropriate supra-specific level of identifiability.

Likewise, many equid elements were not morphologically distinguishable below the generic level. These were separately grouped in analysis. However, since only one of 201 specifically attributable elements (a heavily worn M<sub>2</sub>) was even possibly not derived from *Equus burchelli*, all post-cranial bones originally attributed to *Equus* sp. were lumped with *E. burchelli* dentitions and phalanges. The tooth approached *E. asinus* in morphology, but formed one end of a continuum of wear with positively identifiable *E. burchelli* molars.

Some elements, such as ribs and very fragmentary vertebral and/or axial fragments, were, due to time considerations, sorted only to size categories within the taxon 'Mammal'.

The principal author found that some bovid post-cranial elements, notably certain of the carpals, tarsals and phalanges, could be matched with those of comparative specimens of known species with good reliability. For example, calcanea and astragali of the eland, if certain anatomical features were preserved, could be readily distinguished from those of the roughly like-sized buffalo. Likewise the Alcelaphines (but not individual species) and the domestic cow could be distinguished on the basis of some bones of the fore- and hind-extremities. In some cases such distinctions were impossible, as with fragmentary elements of impala and Grant's gazelle.

Such elements were simply assigned to the appropriate size category of the family Bovidae. These data were recorded and processed using a computer coding format developed for vertebrate remains by Gifford and Crader (1977). Sorted files of these data yielded tabulations and distributional data presented in this article.

Minimum numbers of individuals (MNI), used in intra- and inter-site comparisons, were reckoned in the following manner. The most numerous anatomical elements for nearly all ungulate species represented at GrJi I were teeth. This allowed a more precise reckoning of minimum numbers for each species than would be allowed had another anatomical region than maxillae and mandibles been represented. The steps followed are outlined below. First, teeth were divided into the following four relative eruption/wear categories:

- I = completely unworn deciduous teeth, here inferred to be 'neonate';
- II = deciduous teeth in wear, M<sub>I</sub> either unworn or with minimal wear, here inferred to be 'juvenile';

- III = adult teeth in all but the most extreme stages of wear, here inferred to be 'adult';  
 IV = adult teeth in the most extreme stages of wear with little or no enamel above the roots, here inferred to be 'aged'.

Compared to Schaller's (1972) eight to ten dental wear classes, this system is extremely crude. In essence it only separates out a few actual age classes (i.e., newborns, sub-adults, aged) from an otherwise undifferentiated mass of ages which, in the larger ungulates, may cover over ten years' span. More precise evaluations of enamel height were made for well-preserved teeth, but time considerations precluded analysis for approximate age in years.

Second, the most numerous left or right tooth element within each of these dental-wear classes was determined and used as the MNI estimate for that class. Special care was taken to attribute teeth possessed by two adjacent dental-wear classes (e.g. M1 in ungulates) to their most probable class. Specific problems in differing levels of taxonomic identifiability were also considered in this reckoning. For example, all fragmentary molars attributable only to the Alcelaphini were considered to determine if these would increase the total for either *Connochaetes* or *Alcelaphus* molars.

Third, the MNI totals for all dental-wear classes of a species were summed to obtain the total MNI for each species. The overall effect of this procedure is to increase the estimated number of individuals relative to the MNI estimate derived from an ungrouped species assemblage. However, these totals are in turn considerably lower than those to be derived from age estimates based on enamel-wear studies. A graphic example of this fact was supplied with Chris Hillman's analysis of six eland teeth recovered from the site. On the basis of his extensive knowledge of eland dental development and attrition, Hillman (personal communication) determined that five separate individuals were represented, while the MNI reckoning outlined, based on the same teeth, yielded only two individuals. These considerations underline the fact that MNI figures are handy units of comparison, but they should not be assumed to reflect the 'true' number of animals of given species processed at a site, nor should they be used as the basis of such even more tenuously derived statistics as meat weights and kilocalorie estimates.

Recently, Donald Grayson (1978) has pointed to various methodological problems in the use of MNI statistics in inter- and intra-site comparisons. Specifically, he notes that the proportional relation between overall number of bones in a taxonomic category and the MNI figures for that taxon changes with sample size so that as the sample size increases each addition to the set of identified elements has progressively less effect on the MNI statistic. For example, a taxon represented by one identifiable element will have a MNI of 1, but one represented by twelve elements is highly unlikely to have a MNI of 12, or even of half that, due to the statistical chances against drawing 12 identical elements. Grayson further notes that comparisons of abundance should be made only among taxa that have roughly similar proportional relations between the total number of identifiable pieces and the derived MNI statistic, a relation which may be expressed as a ratio of the MNI divided by the total number of elements attributable to that taxon (E). At present, however, there is no widespread agreement regarding the best way to define the range of MNI/E statistics which may permissably be compared (e.g. Grayson, 1978). Table 1 presents these figures for Prolonged Drift. It may be noted that nearly all species with high MNI figures have roughly similar MNI/E ratios;

these more numerous species will be the ones most cited in comparisons in ensuing sections.

While not a matter to be pursued further in this paper, one may note that the causes of variability in MNI/E statistics for taxa with roughly similar numbers of elements are as yet poorly understood. These may include variation in the processes of acquisition and processing of potentially diagnostic elements; for example, the 'schlepp effect', to be discussed in a later section, may influence the MNI/E statistic differentially for both wild and domestic species.

Table 1

*Ratios of minimum number of individuals (MNI) to total number of identifiable pieces (E) for various taxa.*

TAXON	MNI	E	MNI/E
Cattle	22	250	.088
Kongoni	18	232	.077
Wildebeeste	17	241	.070
Zebra*	16	340	.047
Thomson's gazelle	15	165	.090
Grant's gazelle	11	106	.103
Impala	7	35	.200
Caprines	5	50	.100
Eland	4	37	.108
Buffalo	2	11	.181
Warthog	1	14	.071
White Rhino	1	4	.250
Giraffe	1	6	.166

\* Number of zebra elements altered downward to include only those pieces comparable to bovid bones identifiable to species level.

### Overall Composition of the Assemblage

A total of 165,426 pieces of bone were recovered in the excavation, comprising about 133 kg in weight (Table 2). Of these specimens, the vast majority (152,229 pieces; 82,254 kg) were unidentifiable, or minimally identifiable scraps of teeth, vertebrae, and long bone shafts (Table 2). A total of 3,705 pieces were sufficiently well preserved to permit some level of anatomical and taxonomic identification. The majority of taxonomically identifiable elements derive from medium to large ungulates.

#### Condition

The vast bulk of even the identifiable bone in the GrJi I assemblage is fragmentary. The only bones recovered in complete or nearly complete condition were the relatively small, dense bones of the carpus and tarsus, manus and pes. Teeth were also fragmentary, for the most part. This degree of fragmentation is not uncommon in bones from archaeological sites (e.g. Daly, 1969; Onyango-Abuje, 1977a). To a great extent, it is due to the processing activities of the site inhabitants; which will be discussed in detail later in this article. However, in the case of

Prolonged Drift, post-depositional soil action has acted to further break up the bone specimens. The soil matrix of the midden possessed a high proportion of clay, which formed in peds in and around many of the objects; with repeated cycles of wetting and drying, these peds expanded and contracted considerably. The effect of this process upon bones surrounded and invaded along split-lines of this clayey matrix was to 'explode' many of them in place, into assorted fragments. A chi-square test of the occurrence of this trait with regard to stratigraphic level indicates that it is strongly associated with the main bone mass of Feature 15 itself, meaning that a very significantly greater ( $P = \text{less than } .001$ ) number of bones in Feature 15 were shattered by soil action than were above or below the Feature (see Appendix II). In most cases such 'soil-shattered' bone was recovered as a unit and glued together. This process was especially time-consuming in the case of hypsodont ungulate teeth, which normally 'exploded' along their vertical columns of enamel.

Table 2

*Summary of the overall composition of the sample of faunal remains analysed from Prolonged Drift.*

CATEGORY	NUMBER	(%)	KG WEIGHT	(%)	NUMBER BURNED	(%)
Maximally identifiable	3705	(2.24)	35.13	(26.49)	37	(1.00)
Minimally identifiable	9492	(5.74)	15.20	(11.46)	13,261	(8.20)
Tooth fragments	8760	(5.30)	5.43	(4.10)		
Vertebra fragments	351	(0.21)	3.50	(2.64)		
Appendicular fragments	381	(0.23)	6.26	(4.72)		
Non-identifiable scrap	152,229	(92.02)	82.25	(62.04)		
<b>TOTAL</b>	<b>165,426</b>	<b>(100)</b>	<b>132.58</b>	<b>(100)</b>	<b>13,298</b>	<b>(8.04)</b>

The surface condition of the specimens in the bone assemblage varied. Most specimens, although moderately friable and soft, possessed fresh, sharp articular surfaces and edges of fractures, being in surface appearances very similar to unweathered bone. Another group of specimens, however, displayed considerable

evidence of chemical alteration, with rounded and eroded articular and break surfaces. In addition, the latter group often displayed a relatively lighter colour. These types of bone alteration are not typical of weathering undergone by mammal bone exposed to the elements on the surface but rather of post-depositional alteration. A chi-square test of the relationship of such alteration to stratigraphic levels indicated a highly significant association ( $P = \text{less than } .001$ ) between the degree of this alteration and vertical provenience, with most altered bone being either in the zone above Feature 15 or in the sparse scatter below it. This could be interpreted in one of two ways. First, bones below and above the Feature were closer to land surfaces, one extant prior to the creation of the midden, the other after its creation, and hence more prone to leaching in an active zone of soil formation. Second, Feature 15 was itself in such a zone, but due to the density of its bone formed its own chemical and physical environment, which tended to resist such alterations. Only one bone specimen of some 165,000 displayed the weathering cracks and flaking patterns typical of advanced sub-aerial alteration. Since these patterns seem to develop on medium to large mammals' bones within six months of exposure in various parts of eastern Africa (Behrensmeyer, 1978; Gifford, 1980), it is inferred that the Prolonged Drift assemblage was covered within a relatively short time after its generation.

Other modification of the bone from Prolonged Drift is obviously due to human agency and includes butchery marks and burning. These will be discussed in a subsequent section.

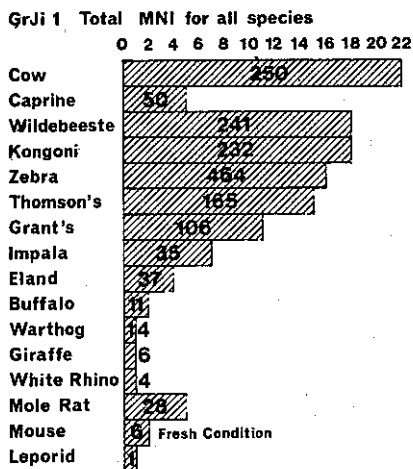


Fig. 5. Overall species composition of the Prolonged Drift assemblage, expressed in minimum number of individuals (MNI) with numbers of identifiable specimens entered within the bars.

### Taxonomic Composition

The faunal sample from Prolonged Drift is composed primarily of the remains of large ungulates, wild and domestic. Summarized in terms of MNI estimates (fig. 5; Table 3; Appendix 1), the assemblage includes a preponderance (63 per cent) of ungulate species in the 70–250 kg live weight range (fig. 6). This size range includes cattle, wildebeeste, kongoni and Burchell's zebra. A considerably smaller proportion (fig. 6; Table 3; Appendix 1) is derived from ungulates the size of Grant's gazelle and impala. Another 16 per cent of the assemblage is derived from ungulates the size of Thompson's gazelle and caprines. Very large bovids in the 300–800 kg range (eland and buffalo) are represented by only five individuals (4 per cent). Larger

Table 3

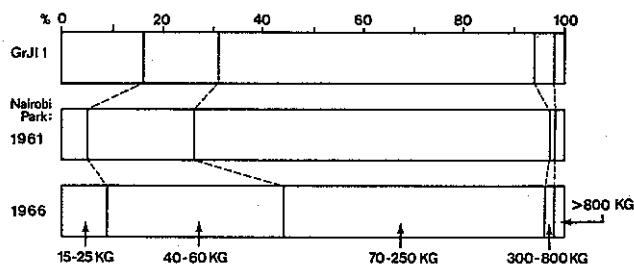
Minimum numbers of individuals (MNI) in each age class for each species in the entire sample. Entries are arranged in descending order of MNI. The column marked 'diagnostic' records the body part from which the MNI figure was derived.

TAXON	AGE CLASS	PIECES	MNI	DIAGNOSTIC
Domestic Cattle	Neonate	8	1	—
	Juvenile	40	5	DUP4(R)
	Adult	168	10	LM3(R)
	Aged	34	6	LM3(R)
			250	22
Kongoni/Hartebeeste	Neonate	9	3	DUP4(R)
	Juvenile	48	6	UM1(L)
	Adult	175	9	UM2(L)
	Aged	0	0	—
			232	18
Wildebeeste	Neonate	3	2	DLP2(L)
	Juvenile	32	2	UP4(R)
	Adult	198	11	LM2(R)
	Aged	9	2	LM2(L)
			241	17
Common Zebra	Neonate	31	3	DUP3(R/L)
	Juvenile	49	4	DLP3(R)
	Adult	366	7	LM3(R)
	Aged	18	2	LP3/4(R/L)
			464	16
Thomson's gazelle	Neonate	11	2	DLP4(R)
	Juvenile	13	3	LM2(R)
	Adult	132	8	UM3(L)
	Aged	9	3	LM2(L)
			165	16
Grant's gazelle	Neonate	0	0	—
	Juvenile	0	0	—
	Adult	105	10	LP4(R)
	Aged	1	1	LI2(R)
			106	11
Impala	Neonate	0	0	—
	Juvenile	2	2	LM2(R)
	Adult	33	5	LM2(R)
	Aged	0	0	—
			35	7
Domestic Caprine	Neonate	0	0	—
	Juvenile	6	2	LM1(L)
	Adult	44	3	LP3(R)
	Aged	0	0	—
			50	5
Eland	All ages	37	4	AST(R)
Buffalo	All ages	11	2	LM3(R)
Giraffe	All ages	6	1	
Warthog	All ages	14	1	
White Rhino	All ages	4	1	
Leporid	All ages	1	1	
Mole Rat	Juvenile	3	1	MAN(L/R)
	Adult	25	6	MAN(R)
		28	7	



individuals are represented by one giraffe and one white rhinoceros. Ungulates smaller than Thomson's gazelle are not represented in the sample, with the exception of one phalanx of a dikdik/steenbok-sized bovid, in very fresh condition, that is almost certainly modern in derivation.

Fig. 6. Relative abundances of various weight classes of herbivores in the Prolonged Drift assemblage (based on MNI proportions) and Nairobi Park (based on two animal censuses).



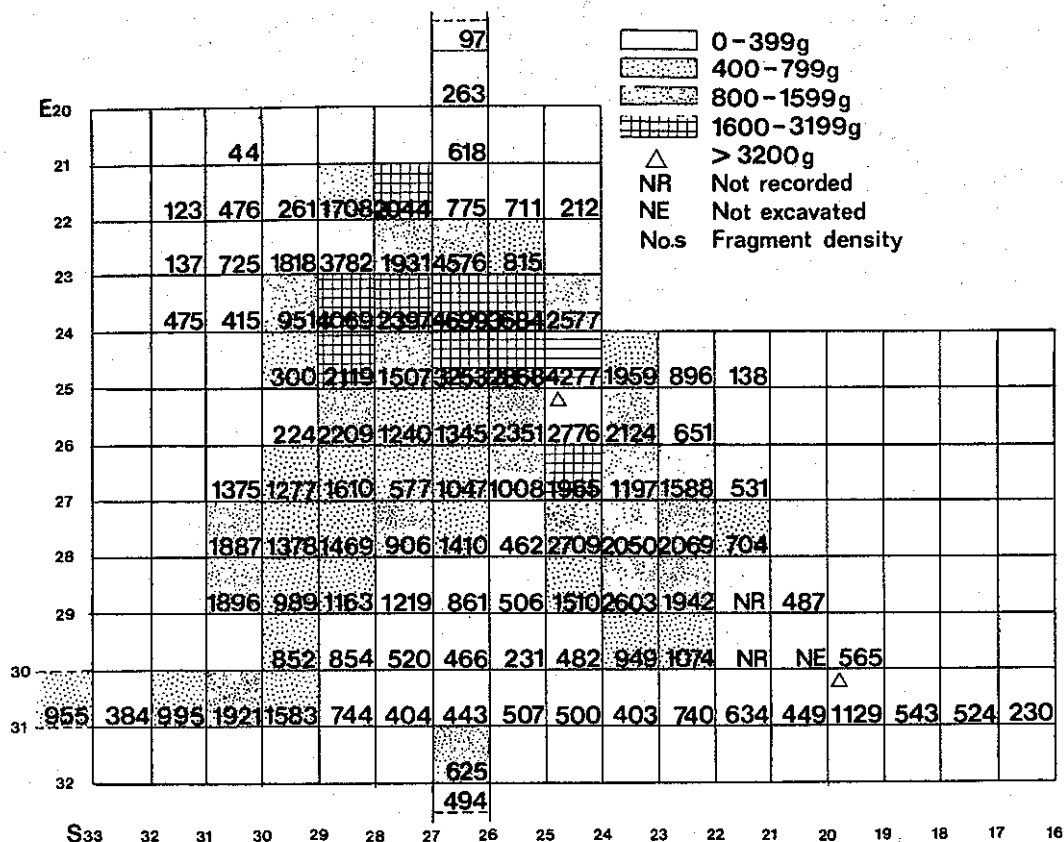
Inferences to be derived from the structure of the wild and domestic ungulate assemblages will be discussed in detail in later sections of this article. However, some general observations on particular species may be made here. Although differing somewhat in elevation, rainfall pattern, and vegetation, Nairobi National Park provides the nearest contemporary faunal suite against which to compare the osteological sample from Prolonged Drift. While numbers of zebra, wildebeeste, and, to a lesser degree, kongoni fluctuated considerably over the past twenty years (e.g. Foster and Kearney, 1967; Hillman & Hillman, 1977), these species, along with the less variable impala, Grant's and Thomson's gazelle populations, form the most numerous species in this parallel fauna. The relative proportions of these species, and of eland, buffalo, warthog, and giraffe, in the Prolonged Drift sample essentially reflect their proportions in the Nairobi Park fauna.

However, there is one ungulate present in Nairobi Park in numbers roughly equal to giraffe and eland (Foster and Kearney, 1967) and in relatively much greater numbers in Nakuru National Park (Kutilek, 1974), which is absent from the Prolonged Drift sample. This is the waterbuck (*Kobus defassa*). Its absence, and the constitution of the assemblage as a whole may be due to a number of factors, to be discussed in a later section (*Predation*).

The species composition of the Prolonged Drift sample reflects several other noteworthy bio-geographic or evolutionary points. First, although early European records report seasonally dense ungulate concentrations in this part of the Rift Valley, the wildebeeste was not frequently observed as far north as Nakuru (e.g. Percival, 1928, p. 129; Stewart & Stewart, 1963). It is present in the Prolonged Drift sample in great abundance and likewise was reported from the nearby Crescent Island site and from Naivasha Railway Shelter by Onyango-Abuje (1977a, p. 296). These faunal samples may therefore reflect a prehistoric range for wildebeeste substantially different from that encountered by nineteenth-century European explorers and settlers. Comments on possible explanations of this absence will be presented in subsequent sections.

Likewise, the occurrence of the white rhino in the Prolonged Drift sample reflects a former distribution of the species not historically documented. The ascription, made on the basis of a  $P_3$  and  $M_3$ , is certain (J.M. Harris, personal communication). One may note that other documentation exists for the occurrence of this grazing species in regions it did not inhabit in the nineteenth century (Foster,

1967). Rock-paintings in northern Tanzania, tentatively attributed to Late Stone Age gatherer-hunters, include 'textbook quality' representations of white rhino in a region it has not historically occupied (Fosbrooke, 1980).



### GrJi1 - PROLONGED DRIFT - KENYA

Fig. 7. Densities of non-identifiable bone, by weight and number of pieces, in Feature 15.

While the inference is at present based on only a few fragmentary remains, evidence from Prolonged Drift and another site in the Nakuru-Naivasha region indicate the existence of an extremely large variety of giraffe in the Holocene. Tooth fragments from Prolonged Drift were, although not sufficiently preserved to be measured, substantially larger than that of the largest male *G. camelopardalis* in the Kenya National Museum collections, an observation supported by Dr J.M. Harris of that institution (personal communication). J.C. Onyango-Abuje recovered in his excavations at Crescent Island certain giraffe podial elements which were likewise outside the size-range of extant giraffes (personal communication). These data are extremely fragmentary and only suggestive at our present state of knowledge, but point to the potential value of archaeological faunal samples in tracing biogeographic or evolutionary change through time (e.g. Frison, 1974).

### Spatial Relations

The distribution of bones in the Prolonged Drift deposit may be examined in both horizontal and vertical perspectives. As noted previously, excavators encountered consistently low densities of bone in the silts above and below the dense bone concentrations, both in the main cutting and in the two trenches.

#### GrJi I - MAIN CUTTING

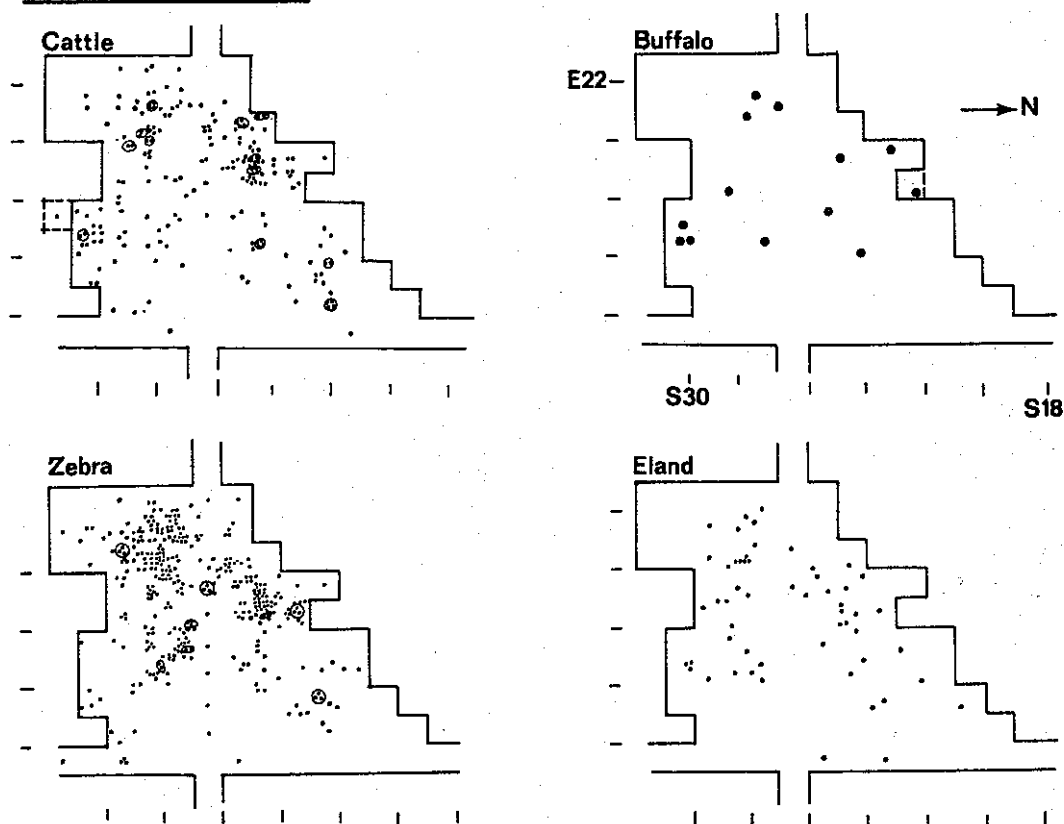


Fig. 8. Distributions of taxonomically identifiable elements for selected species: (a) cattle, (b) buffalo, (c) zebra, (d) eland.

These may represent elements that have migrated vertically from the denser bone features due to rodent activity or other disturbances of the sediments. Alternatively, these bones may derive from the 'background noise' of the area's bone distribution. A third alternative is that these occurrences represent stratigraphically overlapping fringes of dense midden accumulations similar to Feature 15. In an effort to test which of these alternatives was most likely, we ran a chi-square test on the frequencies of remains of various animal species above, below, and within the Feature 15 concentration. Taxonomic groups assessed were domestic cattle, a group of 'wild nomadic grazers' (WNG), ungulates which would tend to migrate into the area more or less simultaneously in great numbers during a restricted season (Thomson's gazelle, kongoni, wildebeeste, zebra), and a group of 'wild resident bovinds' (WRB), ungulates which would tend to remain in the area in lower densities year round (impala, buffalo, eland). Comparisons of these groups indicated a

significantly higher concentration of bones of wild nomadic grazers and lower concentration of remains of *Bos* and wild resident bovids in the midden itself than above or below it (Appendix IIc).

Another question is whether the midden itself, although relatively thin (more or less 20 cm), displays any discernible differences in the vertical distribution of elements of various species within it. Subjectively, the midden appeared to be a homogenous jumble of bones. However, since the vertical relation of objects in a site is a classic index of their temporal relation, it was deemed necessary to test whether any vertical segregation of elements of different taxa existed. Another chi-square test was run, using the same taxonomic index groups as in the first test, for three arbitrarily defined 5 cm levels within the main accumulation Feature 15. Chi-square comparisons of the raw frequencies of occurrence of these taxa in three stratigraphic levels within Feature 15 showed no significant differences in their vertical distributions. While these results do not negate the possibility that certain species were deposited in the midden at different times, they indicate that the stratigraphic resolution achieved by digging in m (sq) x 5 cm excavation units was not sufficient to detect intra-level deposition events.

Due to the nature of the provenance data from the site, no nearest-neighbour analysis or other forms of statistical spatial analysis were performed. No strong preferential horizontal clustering of osteological remains was found within Feature 15, either for specific element types, or for given taxa, in detailed examination of eighteen plots of various taxa's identifiable bone. There were, however, a few areas in the main cutting in which the same elements of different individuals of the same species showed a slight tendency to cluster, namely a number of alcelaphine ankle bones (left calcanea, astragali, naviculocuboids) along the line dividing units 24/24 and 24/25. These may represent individual processing events in which animals taken at one time were processed together (cf. Frison, 1974). By comparing figure 8 with figure 7 it can be seen that peaks of bone densities in identifiable bone generally correspond with those of less identifiable pieces. Figure 8c presents the distribution of major element classes for a very common taxon, the zebra. Figure 8a shows the distribution of the bones of domestic cattle, while figs. 8b and 8d show those of two much less well represented species of very large wild bovids.

## Modification

### *Cultural Modification*

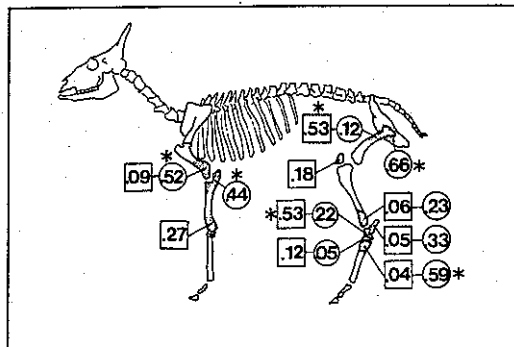
Several types of modification were common on identifiable elements of the Prolonged Drift assemblage. These form a set of distinctive patterns with regard to certain anatomical regions of the animals processed at the site, from which may be inferred a number of points regarding the butchery and culinary practices of the site's creators.

Of some 3700 identifiable elements, only 37 (one per cent) exhibited traces of burning, whereas 8.2 per cent of the minimally identifiable bones were burned (Table 2). This contrast reflects the greater tendency of burned elements to fragment into less recognisable pieces. Due to the small size of the sample, burning damage to identifiable pieces can only be said to display certain trends in the treatment of various cuts of meat. For example, five of thirteen burned elements of small/medium bovids are calcanea, located at the natural point for severing the upper and lower hind leg (Appendix IIe). Burning on the calcaneum was noted by D.

Gifford among modern assemblages produced by pastoral Masai and Dassanetch, who cook leg units by skewering them and standing them for roasting close to an open fire. This method of cooking produces a pattern of burning damage which may be reflected in the small Prolonged Drift sample, with the proximal and distal elements in the leg joints (e.g. proximal femur, distal tibia and calcaneum) the only points damaged by burning. Notable also is the high frequency of burning damage to zebra cervical vertebrae (Appendix IIe), which may reflect special processing of this animal's neck.

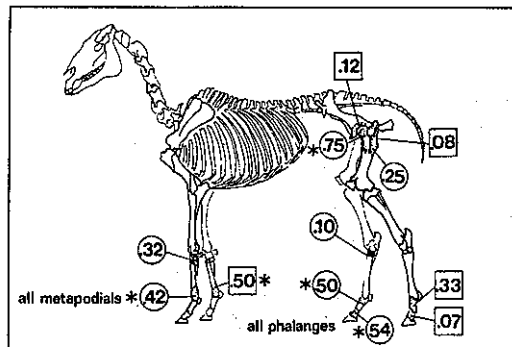
Cut marks, either single or multiple, appeared on 377 elements, and these were concentrated in particular anatomical regions. In bovids, these clustered around the elbow, wrist, hip, and ankle joints (see Appendix II a-c). Fig. 9 displays the rates of occurrence of cut-marks for better-represented bovid elements. In zebras a slightly different pattern emerges with fewer cut-marks on the elbow region, which is less tightly constructed than in bovids, and more evidence for detachment of the phalanges by cutting (fig. 9b, Appendix II d).

a. SMALL AND MEDIUM BOVIDS



Total bones in taxonomic category: 910

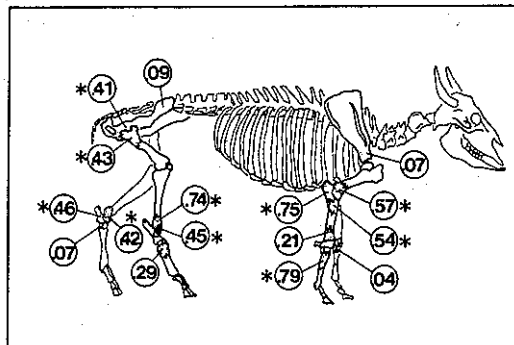
b. ZEBRA



Total bones in taxonomic category: 478

○ cuts  
 □ plane fracture surfaces  
 \* ratios over .40

c. LARGE BOVIDS - Cuts



Total bones in taxonomic category: 1506

d. LARGE BOVIDS - Plane Fracture Surfaces

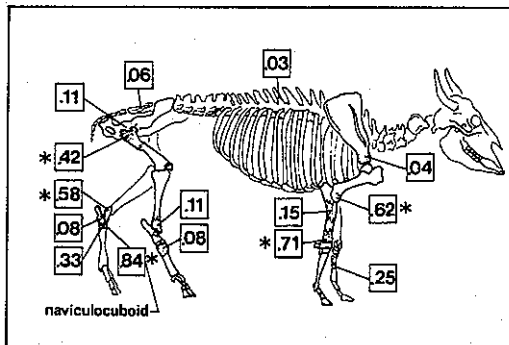


Fig. 9. Anatomical distribution of cut marks and plane fractures for various ungulates.

A distinctive form of fracture, characterized by an absolutely flat, plane surface penetrating through both compact and cancellous bone, and often found on extremely robust pieces (e.g. equid metapodials, eland phalanges) occurred on 217 elements. This type of damage clusters around the same joints as cut-marks, and

probably represents the results of heavy impacts by the same instruments as inflicted the cuts (fig. 9). These instruments were almost certainly not obsidian; the principal author is currently conducting experiments to investigate possible sources of this type of damage.

Metapodials of bovids and equids alike bear specific patterns of damage that appear to reflect the process of splitting the bones lengthwise, probably to extract marrow. Of fifty-four proximal fragments of metapodials displaying cut-marks, forty-nine were sagittally sectioned. Recovery of numerous bovid and equid phalanges and sesamoids in articulation indicates that these were regularly detached and discarded prior to the breaking up of metapodials. Unlike the phalanges of medium-to-large bovids from other sites analysed by the principal author, phalanges from Prolonged Drift were not regularly broken up for marrow extraction.

### Inferences

#### *Schlepp Effect*

Archaeologists are now familiar with the so-called 'schlepp effect' with regard to vertebrate element frequencies in site assemblages (e.g. Perkins and Daly, 1968). In the case of large animal kills away from a home base, heavier, less nutritious, and less useful bones tend not to be carried back to the base while lighter, more nutritious (e.g. marrow bones), or potentially useful elements are transported along with the meat of the animal to the site of consumption. In theory, one may distinguish assemblages which are transported and which thus reflect additive schlepp events from assemblages which are residual and thus show the effects of deleting schlepp events. Between these two extremes are sites at which both butchery and consumption took place. These will be 'neutral', inasmuch as they are neither enriched nor depleted by the schlepp effect. In the transported assemblages the frequency of 'schleppable' bones is relatively high, representing elements accumulated from various kill events and locales. Residual assemblages display low frequencies of 'schleppable elements'. If Prolonged Drift were merely a slaughter and/or butchery point in a large-scale meat processing chain, one would predict relatively low frequencies of portable, nutritious, or useful elements at the site. However, such bones, including limb bones and metapodials, are relatively common at the site (Table 4). Moreover, damage attributes previously mentioned indicate that a considerable amount of cooking, marrow extraction, and discard went on at the site, thus eliminating the possibility that the assemblage is predominantly a residual butchery site assemblage. Because the Prolonged Drift assemblage contained cattle and caprines, which could be expected to be slaughtered at the site and hence would not be subject to an intensive schlepp effect, one might expect the assemblage to be a mixture of the attributes of an accumulated and neutral (= non-schlepp) assemblage.

Despite the fact that cattle remains would seem to indicate on-site slaughter and butchery, this need not necessarily imply that the sites' creators were pastoralists themselves. Stolen domestic stock could conceivably be driven to the encampment and there be slaughtered.

In an effort to assess the relative degree of schlepp effect on various taxa represented in the assemblage, simple statistical comparisons were made of elements highly likely to be left at a butchery site with those highly likely to be schlepped. One of the problems encountered in this procedure resulted from previous decisions in the laboratory analysis. The principal author had grouped nearly all axial and appendicular fragments of bovids into sized-ranked classes (e.g. 'large Bovid'), rather

than seeking finer levels of taxonomic distinction. Since, for example, the axial skeleton elements of both domestic cattle and wild alcelaphines would be grouped in this category, certain problems arose in seeking to distinguish differences in schlepp effect among these species. In an attempt to address this problem, other, more taxonomically identifiable elements were sought which were believed to have different 'schlepp potentials'.

Table 4

Comparison of ratio of upper cheek teeth (UCH) to podials (POD) in various wild and domestic ungulates.

A. Basic data							
TAXON	UCH		POD		UCH/POD		
Alcelaphine	164		156		1.05		
Zebra	72		54		1.33		
Grant's	8		47		0.17		
Impala	7		12		0.58		
Thomson's	41		49		0.84		
Cattle	95		58		1.64		
Caprine	15		5		3.00		

B. Chi <sup>2</sup> statistics for comparison of UCH:POD in various taxa							
	Alcelaphine	Zebra	Grant's	Impala	Thomson's	Cattle	Caprine
Alcelaphine	—						
Zebra	1.034	—					
Grant's	24.009	26.468	—				
Impala	0.968	1.986	3.073	—			
Thomson's	0.697	2.380	13.319	0.194	—		
Cattle	12.159	1.305	37.575	4.209	7.192	—	
Caprine	3.359	1.604	22.447	4.322	4.559	0.495	—

$\underline{n}$  = significant (.05-.02 level)     $\underline{n}$  = highly significant (0.01-0.01 level)

It was assumed that upper cheek teeth of larger animals, because they are attached to the cranium, an element often left behind at butchery stations, might be a sensitive indicator of differing schlepp effects for wild versus domestic species. The maxillary region is attached to a heavy and relatively non-nutritious element, the cranium, and is furthermore not useful (unlike the mandible) as an implement. By the same line of reasoning, it was assumed that podial bones, that is carpals and tarsals, are highly likely to be transported from a kill site to a consumption site, either as parts of skins, of leg units, or simply in articulation with the nutritionally valuable and useful metapodials. Among the bovids, both of these sets of elements are distinguishable to at least the tribal level if not the species level, making them useful for a comparative test. Specifically, it was predicted:

(1) Animals regularly butchered on or near the site, that is, domesticates, would display a higher ratio of upper cheek-teeth (UCH) to podials (POD) than would wild species regularly butchered at a distance from the site and transported to it.

(2) The UCH/POD ratio for domestic species will significantly differ from that of wild species, but would not significantly differ within the domestic species.

(3) By the same token the UCH/POD ratio for wild species will not differ significantly from species to species within that group. However, reflecting their greater transportability, smaller wild species may display UCH/POD ratios closer to that of domestic species than do larger wild species.

Table 4 presents the raw data, plus a matrix display of chi-square statistics generated by comparisons of various pairs of wild and domestic species at the site. Prediction 1 is borne out by the comparison of ratios. Prediction 2 is generally borne out, but there are some exceptions, namely the lack of significant difference between zebra versus cattle and caprines. Caprines show the highest value for the UCH/POD but because of the small sample size, the significance of the difference for wild ungulates is less clear than for cattle.

Prediction 3 is also generally borne out, except in the case of Grant's gazelle, which has an extraordinarily low UCH/POD ratio, and hence generates a high chi-square statistic when compared to any other species. While only a tentative, untested explanation can be offered for this phenomenon, it may reflect differentially greater discard of the large-horned Grant's crania at butchery site. Interestingly, Thomson's gazelle, the smallest ungulate represented at the site, has a very similar UCH/POD ratio to that of alcelaphines ten times their size. Wild taxa in the assemblage therefore display aspects of a transported assemblage, with domesticates apparently displaying attributes of non-schlepped assemblage.

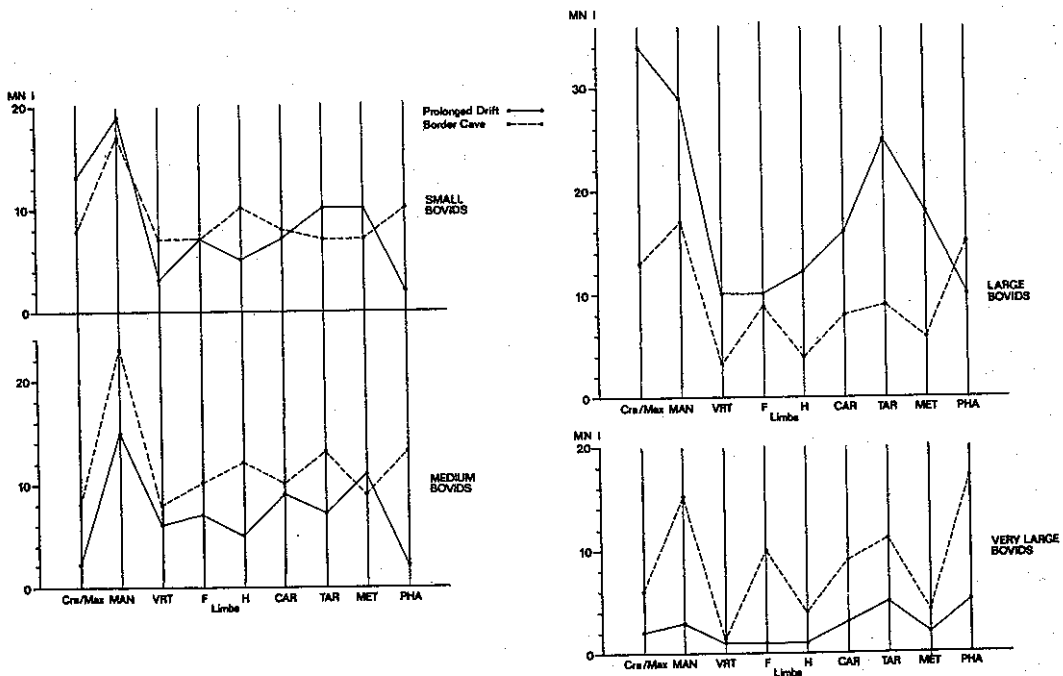


Fig. 10. Comparisons of element frequencies from Prolonged Drift and Border Cave (expressed as MNI per anatomical unit.)

To further isolate the effects of on-site butchery on assemblage structure, comparisons were made with a large assemblage known with assurance to have been derived solely from the hunting of wild ungulates. Figure 10 presents data on the frequencies of various elements and anatomical units for Prolonged Drift and from Border Cave, South Africa, analysed by Richard Klein (1977a). The data are



presented as minimum numbers of individuals determined for each of a series of anatomical units. The units may be thought of as forming general 'schlepp categories', with cranium, maxilla, and vertebrae of at least larger species, least likely to be schlepped and, as discussed above, carpals, tarsals, metapodials, and phalanges being most likely to be schlepped. The limbs fall between these two groups in portability.

First, as figure 10 shows, there is close similarity in the proportional representation of body parts. A series of tests has established that for most body parts the differences are not statistically significant ( $p > .05$  in chi-square and Fisher's exact probability tests). There seems to be some tendency for phalanges to be better represented at Border Cave, but only in the case of large bovid phalanges does this reach statistical significance ( $p < .02$ ). This difference between the two sites could reflect different butchery practices. Since phalanges at Prolonged Drift were often discarded whole in the course of on-site butchery, they might have also been discarded at a greater rate in the course of off-site butchery, as compared with Border Cave, leading to the observed disparity.

Second, within the Prolonged Drift assemblage the CRA + MAX to POD ratios are, with one exception, not significantly different among the several size classes of bovids. The exception was a significant (.05 level) difference between medium and larger bovids. The CRA/MAX category for large bovids at Prolonged Drift substantially deviates from that of all other bovid size classes at that site and at Border Cave. This may well reflect the high rate of entry of domestic *Bos* crania into the midden, compared to the wild species of either site (Border Cave does not contain domestic fauna).

Third, the overall similarity in frequency of anatomical units between these two sites, which are, among other things, situated in different ecologic and geomorphic settings, suggests that certain regularities exist in the formation of bone refuse middens. Foremost among these are consistent patterns in the durability, and hence survival potential of various bones (e.g. Binford and Bertram, 1977).

#### *Predation Patterns, Seasonality and Aspects of Ecology*

Assuming that the assemblage of wild animal bones was acquired more by hunting than by scavenging, the composition of the Prolonged Drift wild fauna, as expressed in MNI figures, may be examined for its implications regarding several facets of late Stone Age human predatory behaviour. Remarks in this section are, by virtue of the multiple uncertainties of sampling error involved with archaeological assemblages, necessarily tentative in nature, and are offered in hopes that future research may further elucidate some of these points.

First, the presence in an assemblage of neonate and juvenile dentitions of species with restricted birth-seasons can indicate the season(s) of the year over which at least some of the sample was acquired by the occupants of a site (e.g. Frison, 1974). Neonate dentitions were recovered from Prolonged Drift for four wild species: wildebeeste, kongoni, Thomson's gazelle, and Burchell's zebra. Wildebeeste in Nairobi Park are recorded as calving in a restricted season, given as January-February by Foster and Kearney (1967) and March-April by Rudnai (1974). Kongoni in both Nairobi Park and Tsavo East are reported to calve all year, with peaks in July-August and February-March (Foster & Kearney, 1967; Leuthold & Leuthold, 1975). Thomson's gazelle today calves in Nakuru National Park in December-January (Kutilek, 1974) and has a reported second birth-peak in June-July (Foster & Kearney 1967; Leuthold & Leuthold, 1975). The combination of evidence from these species would indicate that the acquisition of the animals which

did end up in the Feature 15 midden was going on through at least the first six months of the year (fig. 11).

Another line of evidence regarding the season of creation of the Prolonged Drift bone midden, admittedly more tenuous, is derived from historical records of ungulate migration in the Rift Valley. Percival (1924, 1928) reports that, prior to fencing of the region by European settlers, thousands of kongoni, Thomson's gazelle and Burchell's zebra would move south from Lakes Baringo and Bogoria (Hannington) to the Nakuru-Naivasha region 'at the end of the rains' (Percival, 1924, p. 293). Assuming that the author meant the rains which today begin in April and persist to July (Survey of Kenya, 1962), we can expect that masses of animals would be in the Nderit-Nakuru area sometime in the latter part of the first six months of the year. Percival notes:

'There is a spot between Mount Menengai and the forest where the trek is to be seen at its best, the animals being on their way past Nakuru toward Elmenteita' (1924, p. 331).

The reason for their good visibility in this zone, he adds, is that the walls of the valley narrow at this point, constricting and concentrating the masses of migrating animals. Percival further notes that some migratory species were particularly susceptible to human predation during their trek. Migrating Thomson's gazelle, he reports, were so unwary that they could be shot 'like so many sheep' (Percival, 1928, p. 169). Whether other game, such as wildebeeste and kongoni, were likewise less wary during their treks is not known. The non-migratory impala, although reported to be extraordinarily watchful (e.g. Percival, 1928), is more susceptible to predation during rutting season (February-March), when males are less wary and tend to remain within their territories when pursued (Schenkel, 1966).

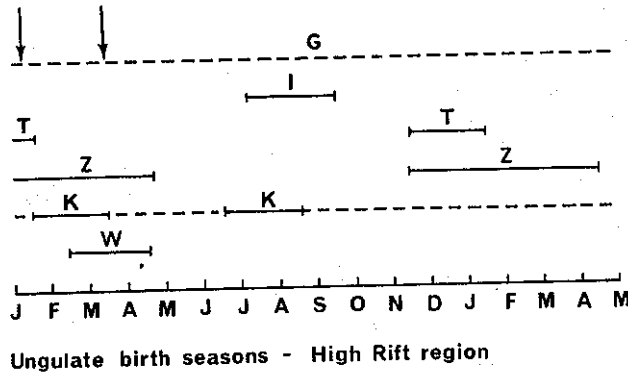
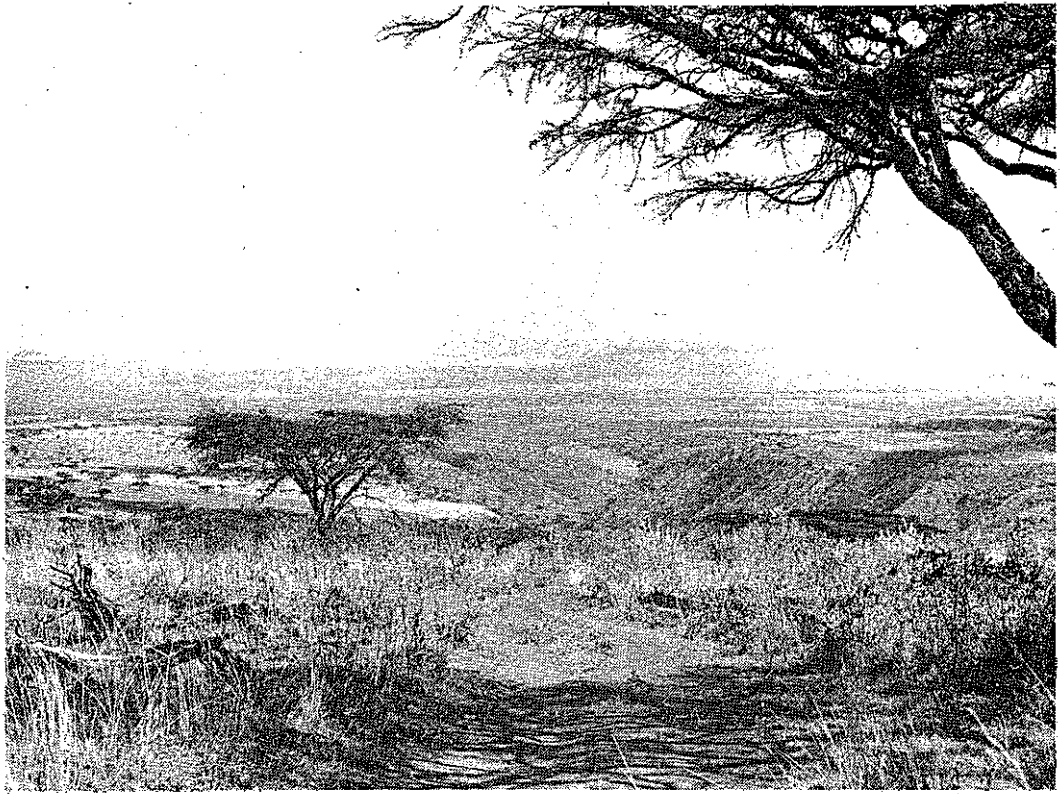


Fig. 11. Central Kenya birth seasons of various ungulates found in the Prolonged Drift assemblage.

The age structure of wild ungulates, as reflected by MNI based on dentitions, shows a heavy predominance of older sub-adults and prime adults (fig. 12). This is probably not due solely to differential preservation of smaller elements, since deciduous dentitions and other immature elements of the smallest ungulate taxa are represented in the assemblage with some frequency (e.g. Table 3). If this sample is a reasonable reflection of animals acquired by the accumulators of the Prolonged Drift midden, it represents a pattern of predation similar to that reported by Marks (1973) for modern human hunters in Zambia, and that reported by Schaller (1972) and Rudnai (1974) for lions. Concentration on large sub-adults and adults in the



*a. A view of the Nakuru basin from the south. Prolonged Drift is roughly half way between the foot of the Eburu Ridge (foreground) and the lake (background). See fig. 1.*



*b. Erosion cutting into the ancient flood plain and the archaeological site. The line of trees behind marks the position of the small canyon in which the Enderit River flows; the ford (drift) is out of sight to the left.*



*a. The dense bone jumble of Feature 15 seen from the north-west.*



*b. Part of Feature 15 seen through a plotting frame with 20 x 20cm strung squares.*

70-250 kg size-range is typical of these modern populations. It is also the general pattern of predation inferred by Klein (1977a) for Late Stone Age hunters in southern Africa. This contrasts with predation patterns reported for spotted hyenas (Kruuk, 1972; Bearder, 1977), which appear to prey on very young, very old, or ill individuals, or for the African hunting dog, which focuses on smaller prey sizes (Estes and Goddard, 1967).

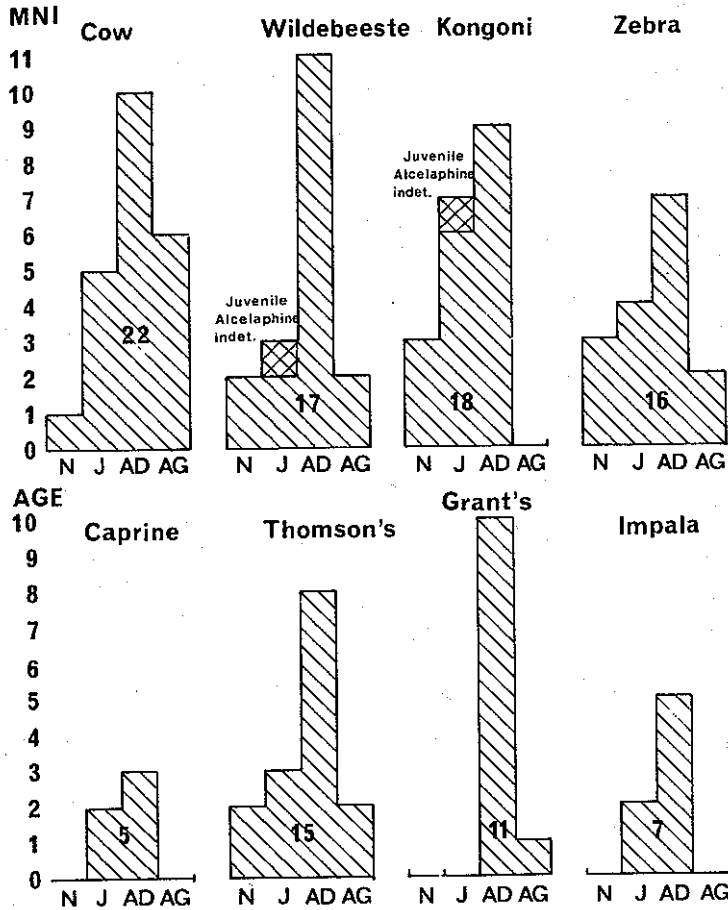


Fig. 12. Age structure in the Prolonged Drift assemblage, expressed as MNI in four gross age categories: neonate (N), juvenile (J), adult (AD), aged (AG).

Several points may be made in this connection. First, the 'take' of Prolonged Drift hunters is similar to that of carnivores twice human body weight (e.g. Schaller, 1972) and by human hunters armed with primitive firearms (Marks, 1973). Actually, the performance of hunters observed by Marks prior to acquisition of more modern rifles may not have been that much better than that of efficient Late Stone Age hunters, since the former had to stalk their prey to within '20 paces' before shooting with their antiquated firearms (Marks, 1973, p. 120). Second, concentration on large sub-adults and prime adults yields maximal 'payoff' in meat per kill (Marks, 1973). Third, the assemblage mainly consists of what might be termed 'low risk/high yield' species. The most common taxa in the wild component of the assemblage are animals which do not offer substantial threats of bodily harm

to human hunters. The formidable African buffalo, rhinoceros, and giraffes are rare in the assemblage, and the less aggressive but highly elusive eland only slightly less rare. However, while the Prolonged Drift wild fauna may seem to reflect a predation pattern of optimal efficiency, involving a strong orientation toward hunting open country species of medium-large size, comparison with actual abundances of ungulates of various sizes in Nairobi Park (fig. 6) reveals that the proportion of larger and smaller animals in the assemblage is not very different from their actual relative abundances in living populations.

A notable absence in the ungulate assemblage, as previously mentioned, is the waterbuck (*Kobus defassa*). While this browsing bovid is now probably over-represented in the Nakuru region in comparison to former times, due to historic exterminations of both grazing antelopes and predators (Kutilek, 1974), its complete absence from an otherwise roughly representative fauna structure merits consideration. Several possible explanations may be proposed:

(1) Waterbuck remains are not present in the archaeological sample because, unlike those of other ungulates, their bones were spatially segregated in a zone not sampled in the excavation.

(2) Waterbuck remains were present in the sample, but only in the form of fragmentary axial, appendicular, etc. fragments attributable only to a general bovid or mammal size category.

(3) Waterbuck elements were not included in the assemblage because the marsh and brushland habitats favoured by these animals did not exist within normal hunting range of the site during the time it was created.

(4) Waterbuck elements are not present in the sample because the species was not taken by people who formed the midden.

At present, the latter two explanations seem more likely than the first two. It is entirely possible that recent recession of Lake Nakuru resulted in a grass-dominated plant community, with no favourable waterbuck habitat in the area of the site.

A very interesting explanation for the lack of waterbuck in the sample, related to the third possible alternative, was proposed by Mark Stanley Price, who has studied species structure in Nairobi National Park and the adjacent Athi Plains (Stanley Price, 1974). He noted that, while waterbuck were relatively common in Nairobi Park, where domesticates do not normally forage, only two individuals of this species were observed in over 30,000 individual ungulates observed on the Athi Plains (Stanley Price, 1974, p. 137). He argued (p. 138) that caprines, by effectively eliminating dense stands of grass along riverbanks, destroy the habitat crucial to waterbuck reproduction, in which neonates are left by their dams during their first weeks of life. Clearly, consistent patterns of absence of waterbuck in domesticate-bearing archaeological assemblages would be of great interest in charting the evolution of competition between wild and domestic ungulates in this region.

Some credence may also be given to the last alternative explanation, as both European and African hunters of recent times are documented as selectively avoiding waterbuck due to the taste of its flesh. Percival (1928, p. 120) notes:

'It is horrible; the meat of even the youngest and most tender cow waterbuck is unspeakably nasty.'

While Percival alleges that distaste for waterbuck flesh was not shared by his African assistants, Marks (1973, p. 123) records the following statement concerning waterbuck flesh from a modern Zambian informant:

'We do not like meat from kudu, bushbuck, or waterbuck, since their flesh tastes 'cold'. Although we do occasionally eat the flesh from these, its taste is not as well liked as the former ones (warthog, impala, buffalo).'  
Relative palatability, then, could also have been a factor in prehistoric human predation on this species.

The absence of very small bovids (e.g. steinbok, dikdik, duiker) from the Prolonged Drift assemblage may likewise be due to a number of possible causes:

(1) Spatial segregation of elements of these animals in an area not sampled in excavation.

(2) Lack of favoured habitats of these species in the hunting range of the site.

(3) Lack of concentration on these species by the hunters whose taking formed the midden.

As with the case of waterbuck, both habitat-destruction and selective predation patterns may be entertained as potential explanations. Since such smaller, non-gregarious bovids of brush or forested habitats as these are most profitably taken by snares or traps rather than active stalking and killing (e.g. Klein, 1977b; Parkington, 1972), it is possible that hunters so heavily engaged in the latter form of predation did not practise the former while at the site.

#### *Domestic Species*

Remains of domestic species constitute only a fraction of the total faunal assemblage from Prolonged Drift. However, the most numerous single species at the site (in terms of the MNI) is the domestic cow. This combination of domestic and wild fauna in one assemblage, one not encountered in modern pastoral sites, is one of the most thought-provoking aspects of the assemblage and will be discussed in detail in ensuing sections of this paper. Several more general observations on the constitution of the domestic assemblage can be discussed here.

One may note several points of potential difference from the expected dietary debris at modern pastoralist settlements. The Masai and the Dassanetch peoples, with whom the principal author conducted ethno-archaeological research, basically follow a strategy of using small stock for milk and meat, slaughtering caprines for the family meat supply. Cattle are reserved for milking and bleeding in the dry season, and except for some male calves, are not regularly slaughtered for household consumption. Faunal assemblages associated with home settlements practising such patterns of husbandry are likely to contain a higher proportion of caprine remains than of cattle (Gifford, 1977). One may note that male meat-feasting, which often does involve slaughter and consumption of adult cattle, normally does not occur at, or contribute substantial debris to, the family settlements. The midden at Prolonged Drift yielded a MNI ratio of 22 cattle to 5 caprines (252/46 taxonomically identifiable pieces). The relatively large faunal sample (82.8 kg) from Crescent Island in nearby Lake Naivasha, yielded a similar pattern with a bovine MNI of 15, and for caprines 6 (Onyango-Abuje, 1977a, p. 328). Considerably smaller samples from Naivasha Railway Shelter and Hyrax Hill, however, do not display this ratio.

There are several possible explanations for the low caprine/bovine ratio at Prolonged Drift: Caprine elements do not appear in quantity in the sample because:

(1) These were spatially segregated from other bones, in a zone not sampled by excavation.

(2) These animals were not regularly slaughtered at the site, though living animals were present in considerable numbers.

(3) These animals were not present, and hence not available for slaughtering, in substantial numbers at the site.

At present, any of these explanations is tenable, although the first, in light of the amount of material recovered from the site, seems least likely. The second and third explanations, naturally, cannot be tested with the archaeological data at this site, though they can be tested against what is found at a whole series of contemporaneous sites.

Focusing on the relatively large bovine dental sample, some expectable and some unusual patterns emerge. Well-worn dentitions are more frequent among *Bos* than among wild herbivore species, perhaps reflecting the pattern of retaining animals past their prime, which is considered typical of traditional bovine husbandry in East Africa. However, there is a large proportion of teeth derived from large sub-adults and non-aged adults (fig. 12, Appendix 1). This reflects entry into the midden of animals of an age class one might not normally expect to be culled by pastoralists: breeding age adults. One must again consider the possibility of sampling error in creating this pattern in the data, but a similar one is reported for the *Bos* dentitions from Crescent Island (Onyango-Abuje, 1977*b*). Onyango-Abuje explains this pattern by invoking the dietary preference of East African peoples for mature animals. Whether this butchery pattern is unique to these two neighbouring sites or is distinctive of many Pastoral Neolithic sites can only be established through further careful analysis of fauna. The possibility that the pattern results from trade or theft of mature stock is discussed in a subsequent section.

### Site Function and Subsistence Practices

The accumulation of wild ungulate remains at Prolonged Drift is so substantial that few would debate the inference that the animals represented were taken by hunting rather than scavenging. However, the most numerous species represented at the site is, as noted previously, the domestic cow (fig. 5). This naturally leads to consideration of the actual economy of the Prolonged Drift people. The basic question is whether or not these people herded the domestic stock they slaughtered, that is, whether their economy combined predation on wild ungulates with some form of pastoralism, or whether domestic stock were acquired from other groups practising a pastoral economy in the region. Stanley Ambrose (in press) has argued that Savannah Pastoral Neolithic sites in the Nakuru-Naivasha area resemble those of modern pastoral Masai in topographic and ecologic setting, size and internal spatial patterning of debris. While these aspects of prehistoric settlement patterns may be similar to those of modern 'pure' pastoralists, the faunal data from both Prolonged Drift and Crescent Island (Onyango-Abuje, 1977*b*) indicate a substantially different subsistence base. If the inhabitants of Prolonged Drift were indeed combining predation on wild game with herding of domestic stock this would represent a subsistence strategy not recorded among any known group of 'pure' or mixed pastoral nomads in East Africa (e.g. Gulliver, 1955; Dyson-Hudson & Dyson-Hudson, 1969; Spencer, 1965; Carr, 1977; Jacobs, 1975). However, in view of the fact that subsistence systems incorporating domestic stock have evolved over time, a predatory-pastoralist economy should not be excluded from consideration. This combination has been tentatively proposed by John Bower (personal communication) for Pastoral Neolithic sites in the northern Serengeti.

The uncertainty about the overall subsistence pattern represented by Prolonged Drift is a part of larger uncertainties about economies and land use patterns in the Central Rift during the Neolithic. For instance, did two or more socio-cultural groups coexist, each practising a distinct mode of subsistence, as was the case at the time of European entry into Kenya? Answers to these questions will come from



future research of two types: recovery and comparative analysis of more large archaeological samples, especially biological remains, and synthesis of extant historical and ecological materials into detailed models of regional palaeoecology. The ensuing discussion of alternative explanations for observed patterning in the Prolonged Drift assemblage, and of models for subsistence and settlement in the Central Rift, will therefore raise questions which cannot at present be answered. Our aim is to delineate and elaborate critical areas for future research, as well as to provide perspectives on the implications of various alternatives presented.

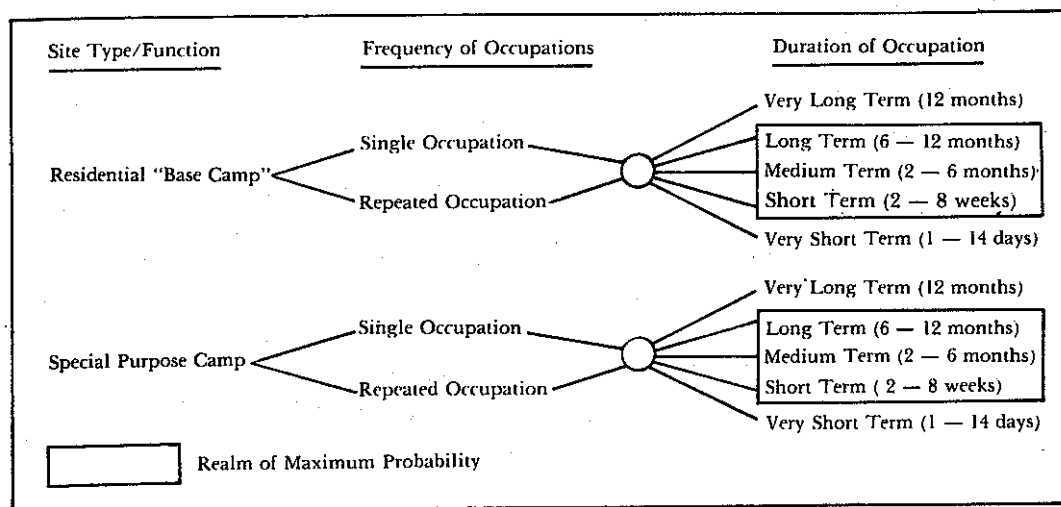


Fig. 13. Alternatives concerning the nature and function of the site.

It is appropriate to begin with a consideration of the nature and function of the site itself. Several possibilities are graphically presented in fig. 13. A few remarks need to be made concerning the nature of the alternatives presented. First, by 'residential base camp' we mean an encampment consisting of all, or of a demographically representative sample, of a local foraging unit (men, women and children). A behavioural corollary of this assumption is that a wide range of extractive, processing and maintenance functions will be expected to have been carried out in the camp. The diversity of these activities will be reflected in a wide range of artefactual and biological debris.

Second, by 'special purpose camp' we mean an encampment at which, by definition, only a restricted range of extractive, processing or maintenance activities of a local foraging unit were carried on. By ethnographic analogy, we expect that such a camp may well be constituted of a restricted age/sex segment of the total foraging unit. In the specific case of Prolonged Drift it is likely that the encampment would have included a substantial number of younger (hunting age) males. Specific alternative site functions we envisage include: hunting stand/kill site or a secondary butchery/meat 'transshipment' station. In combination with any of these three functions the site could have been a livestock meat-feasting camp.

Third, the time spans given to categories of duration of occupation are purely speculative and presented solely to provide some frame of reference for ensuing discussion. However, they are somewhat less than purely arbitrary, in that they are drawn from observations on duration of stay that typify various pastoralists and hunter-gatherers (e.g. Almagor, 1978; Gifford, 1977; Gulliver, 1955; Yellen, 1977).

than from those which typify site occupation spans of agrarian peoples.

Fourth, while addressing the questions of repetition and duration of occupation, it should be borne in mind that the real question we are asking is under what conditions the Prolonged Drift midden (which is the essential basis of the entire report) was formed. This differs from asking (and answering) the same question for the site as a whole. For example, in ruling out repeated occupation of the site as a likely contributing factor in the deposition of the midden, we are not extending the argument to the site as a whole, which may well have been reoccupied.

We have narrowed our possible options from the original twenty alternatives to considerably fewer (boxed area, fig. 13), through the comparison of a number of lines of archaeological evidence with expectations (or test implication) for each hypothesis. These pertain to both site function and to duration (and repetition) of occupation.

### Site Type/Function

The midden is inferred to be the product of a 'residential base camp', largely because of the very wide variety of debris it contains. The assemblage includes an abundance of geometric microliths, various scraper forms, a ground stone axe, ground stone vessels, pottery and beads. Presence of a half-finished stone bowl implies that this manufacturing process took place at the site. A wide range of subsistence and processing activities is implied by both artefact and food refuse. The range of items in the Prolonged Drift midden is as great as that encountered at any other Pastoral Neolithic site sampled to date, and hence makes interpretation as a 'base camp' appear the best working hypothesis. In addition, the fact that many eminently 'schleppable' bones came to rest in the midden (see *Modification*) would seem to argue against the midden having formed simply as an adjunct of a kill site or butchery/transshipment station.

Excavation did not reveal any structural remains or hearth features which might be construed as evidence of residential sub-units within the encampment. In view of the small area excavated away from the midden, however, this lack of evidence cannot be taken to mean that such features did not exist.

#### *Single Versus Repeated Occupation*

The uniformity of bone-weathering stages in the midden (see *Condition*) implies that most elements in the concentration were contributed over the same span of time, and that sub-aerial weathering of exposed bone during a hiatus in midden creation did not occur. This is in turn taken by us to imply that the midden probably formed during a single episode of occupation of the locale.

#### *Duration of Occupation*

Only rough lower and upper limits on our estimates of duration of occupation can be imposed. Again, we stress that we are actually referring to the amount of time over which the midden deposits in question formed. It would be entirely within the realm of possibility that occupation of the site locale could continue long after, for whatever reason, the Feature 15 midden ceased to be used as a refuse dump. This problem is best addressed by further excavation of this and similar sites. **Largely on the basis of bone weathering criteria, we adopt the working hypothesis that the midden (and most likely the entire area adjacent to it) was covered in flood deposits not much more than one year from the initial exposure of the bones to the elements. The remains of animals normally encountered in different habitats would**

seem to indicate a stay in the area of more than a few days, as would the presence of some quarter million pieces of flaked stone. Likewise, the evidence of such time-consuming activities as stone bowl manufacture at Prolonged Drift argues against a very brief occupation span.

Site structure also implies longer occupation spans, in that development of secondary refuse areas of the type we assume Feature 15 to be, and deliberate clearance of debris from other zones, as we assume created the relatively open spaces adjacent to the midden, are usually ascribed to longer-term occupations of delimited areas (e.g. Schiffer, 1976; O'Connell pers. comm.; Gifford, 1980). We have been mindful of the consideration, recently articulated by Binford (1978) that relatively short term, special-purpose mass processing stations can assume a highly spatially segregated aspect in a very short while (see also Wheat, 1972; Frison, 1974). The presence of so many wild ungulates in the midden leads us seriously to consider this possible explanation of the midden. However, the coincidence of so much debris, from a number of behaviourally distinct manufacturing and processing chains in one midden tends to persuade us that we are, truly, dealing with the midden, or refuse disposal area, of a residential camp.

In summary then, given the range of possible site types considered and given the distinguishing tests applied, we adopt the working hypothesis that the midden was formed as part of a base camp rather than as part of a special purpose outcamp. We conclude that meat from game animals was carried to and consumed at the camp while domestic animals were probably slaughtered in its vicinity. The scale and arrangement of the particular middens sampled imply reasonably long occupancy during the season in which the wild migratory ungulates were present (rainy season?), and the range of wild species represented probably reflects hunting forays into several of the different ecozones. The state of preservation of bones implies that the midden represents accumulation of not much more than one year prior to burial. We do not know whether the several different middens (Features 15, 16 and 17) are the residues of separate units within a single settlement, or whether they represent successive contiguous reoccupations.

We can now turn to the larger scale issues of modelling the subsistence and settlement system.

#### *Models of Prehistoric Subsistence Patterns*

The alternative explanations for the combination of cattle and wild ungulates at Prolonged Drift lead to a broader consideration of the subsistence and land use patterns that created this and other roughly contemporaneous sites in the Central Rift. The archaeological evidence can best be assessed through the use of models, informed in part by relevant ethnographic materials and in part by knowledge of ecological considerations. In the absence of prehistoric botanical remains, and even of reliable ethnographic data on wild plant food sources in the Central Rift, such models will naturally be biased toward animal resources and their exploitation. Since, however, herbivores play a major role in the diet of humans living in grassland environments, be they hunter/gatherers or pastoralists, models that emphasize human-animal interactions probably are reasonable representations of the history of subsistence in the area, of which Prolonged Drift was presumably only a part.

This examination of site function naturally leads to wider questions regarding the prehistoric subsistence/settlement systems in the Central Rift. This may be approached initially on the level of the site, by addressing alternative explanations for the most intriguing pattern of species representation at Prolonged Drift: the com-

bination of domestic cattle with abundant wild fauna and the paucity of caprines relative to cattle.

### *Subsistence Strategies*

When attempting to infer the actual subsistence practices of the Prolonged Drift people, we are unable to establish much with certainty. Evaluation of a regional subsistence and settlement system necessarily requires comparisons of suites of sites, representative of occurrences in the complete variety of ecologic zones tapped by prehistoric groups (e.g. Flannery, 1976; Foley, in press). Due to lack of such complete archaeological documentation for the Central Rift, we can at present only offer a discussion of hypothetical alternative subsistence patterns that could, on logical grounds, have been responsible for the structure of animal species' representation in the Prolonged Drift midden. Our discussion of these points is naturally complicated by questions raised from both linguistic and ethnographic materials (e.g. Ambrose, in press) as to whether groups practising several economic modes coexisted in the Rift during the Pastoral Neolithic, as was the case at the time of European entry into the region. We wish to clearly emphasize our perspective on this matter, which conditions our approach. Despite the linguistic and ethnic distinctiveness at the time of European contact, and despite the relative recentness of at least two groups' entry into the Central Rift, the Kikuyu, Masai and Okiek of the area clearly formed one regional economic unit, in which communication, exchange of foods and various commodities, and economic interdependence were all substantial (e.g. Blackburn, 1974). We wish to view the archaeological occurrences in the Central Rift of the last few millennia B.C. as the remains of a regional system of human adaptation. The fact that the regional system may have included a number of ethnically distinct groups between which communication and exchange took place, does not make it any less of an investigable system.

We do have a few points of near certainty that fundamentally condition and structure our approach to this problem. First, it is highly probable that hunting of wild ungulates formed a major part of the subsistence strategy of at least some of the human groups in the region. It is also highly probable, based on analogies with recent fauna in the area, that wild ungulates were available in great abundance in the Naivasha-Nakuru area only seasonally, with the immigration of herds of wildebeeste, kongoni, Thompson's gazelle and zebra during the rainy season. This necessarily implies that human groups preying on these species, as creators of Prolonged Drift apparently did, would have to respond in some way to these seasonal cycles of game movements. Second, it is clear that domestic stock were present in the Nakuru-Naivasha region at the time the site was formed. It is assumed, therefore, that at least some human groups in the area were practising some form of livestock management, and that the local ecosystem had already undergone some alteration as a result of the appearance of domestic bovines and caprines.

These 'basic facts' provide an overall perspective for viewing two aspects of human subsistence in the Central Rift of Pastoral Neolithic times. The first aspect of the subsistence system to be considered is the actual combination of food resources and associated food-getting practices, regularly used by the group that lived at Prolonged Drift. The second aspect to be considered is the effect of seasonal variation in food availability on human settlement patterns, especially on the size of home range, and on the timing and orientation of movements within it. Although these aspects are in fact inextricably linked, for the sake of clarity they will be addressed here in succession.

*Food Sources and Food-Getting Practices*

The Prolonged Drift assemblage contains a great number of wild ungulates, especially migratory grazing species, and a substantial minority of domestic species. The site is furthermore located on low-lying, cultivable land. Given these facts, we have constructed a logically acceptable series of alternative combinations of subsistence practices that could account for the assemblage structure and site location. These may be seen as a number of permutations of subsistence practices (Table 5).

Table 5

*Potential permutations of subsistence systems and mobility patterns.*

PERMUTATION	1	2	3	4
<b>SUBSISTENCE PRACTICES</b>				
Hunting	X	X	X	X
Acquisition of stock by trade/raid	X	X		
Ownership and management of herds			X	X
Seasonal cultivation		X		X
Gathering	X	?	?	?
<b>RELATIVE MOBILITY</b>				
High	X			
Moderate	X	X	X	X
Low				X

Permutation 1 could easily be designated a *hunting-gathering-trading* mode, somewhat like that recently practised by the Okiek of the western side of the Central Rift (Blackburn, 1970). This permutation necessarily implies the existence in the region of other groups, practising livestock management.

Permutation 2, a *hunting-cultivating-trading* mode, is not too unlike that of the recent Sandawe (Newman, 1970). Furs, hunted meat, honey, and agrarian products might be used as commodities in transactions with pastoralists, who in turn would provide the practitioners with livestock during the lean segments of their yearly cycle. This also naturally implies the existence of other groups, practising some form of caprine/bovine herd management in the region.

Permutation 3, a *hunting-pastoral* mode, is unknown in the recent ethnographic record of East Africa, though it appears to be a perfectly feasible option. Some hunting is practised by the Datoga of northern Tanzania and the Dassanetch (e.g. Carr, 1977; Umesao, 1969), but in no cases does hunting appear to supply a major part of the subsistence base.

Permutation 4, a *hunting-pastoral-cultivating* mode, is likewise not known from the ethnographic record of East Africa, although fishing and hunting of aquatic reptiles is known from the Omo Delta (Almagor, 1978). This permutation likewise need not imply the coexistence of any other subsistence pattern in the Rift in order to account for the nature of the midden.

At present, we cannot definitely ascertain which of these permutations is the most likely one in the case of Prolonged Drift. We can, however, discuss their im-

plications and suggest some lines of research which would lead to more definite conclusions.

Permutations 1 and 2 stipulate that the creators of the Prolonged Drift site acquired stock from pastoral neighbours, by fair means or foul. This is very difficult to ascertain through faunal analysis. If stock were obtained by raiding, one would expect an age/sex composition substantially different from that generated by culling practices of herd managers themselves (e.g. Klein, 1978). An unusual age distribution, involving higher numbers of prime age cattle than might be expected in the Prolonged Drift assemblage has already been noted. In raiding, cattle would be a more economic and swiftly driven target than sheep or goats; this might explain the other respect in which the assemblage differs from that which one might expect at a pastoralist site. Neither line of evidence is sufficient to adopt 'stock raiding' as a favoured hypothesis, but they do keep us from dropping that possibility altogether at this time.

Acquisition of stock through forms of exchange would be even more difficult to ascertain, since the age structure of traded beasts would probably reflect the culling decisions of the former owners. One test of the hypothesis would involve search for major phosphate and organic-enriched patches typical of cattle kraals at sites with a bovine component in the faunal assemblage. Consistent absence of such traces at a class of sites like Prolonged Drift could be taken as significant evidence for lack of stock-keeping by the creators. However, the problem still remains of whether we can ascertain that such consumption habits reflect the existence of ethnically distinct but interdependent groups. This can only be established after regional archaeological knowledge is sufficiently extensive to discern the existence of distinctive but interpenetrating material culture sets. Presence of 'foreign' items in otherwise distinct assemblages would constitute an indication of such interaction and might be ascertained through trace element analysis of clay sources for the various ceramic wares found in Pastoral Neolithic sites.

Whether subsistence included cultivation certainly cannot be assessed on the basis of the faunal evidence. In the absence of unequivocal cultivating implements in Pastoral Neolithic assemblages, this problem will have to be investigated through future efforts to recover plant micro-debris, including phytoliths (e.g. Pearsall, 1978), pollen analysis, seed impressions on pottery, etc. Demonstration of the consistent location of certain kinds of Pastoral Neolithic sites on prime cultivable land, and evidence for occupation during optimal planting and growing seasons, would likewise lend credence to this hypothesis. No evidence of the former kind has yet been recovered from Pastoral Neolithic sites, but it is noteworthy that a number of sites in the region are situated on flood plains where flood recession, rainfall independent cultivation would have been feasible (e.g. Nderit Drift, Stable's Drift, Gilgil River, and Prolonged Drift itself.)

Any hypothesis of seasonal shifts from reliance on wild migratory animal species to locally resident game and domestic stock could best be confirmed through demonstrating micro-stratigraphic segregation of domestic stock and resident game on the one hand from wild nomadic species on the other, or by establishing consistent differences between these groups' seasons of death, through tooth growth ring evidence, for example, or C<sub>3</sub>/C<sub>4</sub> pathway analysis of bone. As previously discussed, we failed to find stratigraphic segregation of taxa at Prolonged Drift. Thus far, the other more direct forms of analysis for season of death have not been undertaken on the Prolonged Drift sample. Nonetheless, we do regard cyclic seasonal alternation between hunted and wild game and slaughtered domestic stock as a highly possible explanation of the faunal composition of the site's assemblage.

### *Settlement Patterns and Seasonal Movements*

The permutations of possible subsistence bases proposed in the preceding section imply that their practitioners would have had to respond in some way to seasonal variations in the local availability of one or more major food sources. One common response among non-agrarian peoples is seasonal shifts in living sites. In our situation, fluctuations in the abundances of wild grazing ungulates is the most critical factor which has been considered in each permutation. However, temporal and spatial variations in optimal grazing areas, and in water sources for both stock and humans, strongly condition patterns of movement among pastoralists (e.g. Jacobs, 1975; Western, 1975). Cultivators naturally must orient their movements and durations of residence in relation to their crops' requirements and patterns of growth. As in the case of the subsistence base itself, evidence from one site will not suffice to determine which pattern or patterns of movements may be responsible for that occurrence. Evaluation of alternative models of home range and patterns of movement must await further detailed archaeological survey and sampling in the area.

In this section we will focus on basic questions of timing, relative extent, and orientation of group movements. Future research in both ethnological and archaeological areas should be aimed more closely at stipulating hypothetical home range sizes and settlement configurations within them. We can, however, propose certain predictions concerning the seasonality and content of sites representing the logical results of the various alternative strategies we consider.

The permutations in general subsistence strategy discussed above actually involve, even at the simplest level, a further number of alternatives in terms of yearly cycles of movement. The 'hunting-gathering-trading' strategy (permutation 1), for example, includes at least two possible alternatives in terms of mobility and home range. Since hunting of nomadic ungulates figures in all the permutations proposed, human responses to their movements will be discussed in some detail here.

### *High and Low Mobility Hunting*

While small numbers of these migratory grazing species may reside in an area year round, most traverse hundreds of kilometres in a yearly cycle of grazing. Human hunters, as any other predator, must respond to this seasonal round of movement of their prey. The basic question is the nature of the human response to this ecological fact of life. A number of alternative responses may be considered for human groups, but these essentially reduce to two major types. First, groups which prey on migratory ungulates may follow the animals through their yearly migrations. This is also the pattern adopted by nomadic lions of the Serengeti Plains (e.g. Schaller, 1972). Second, foraging groups may live in one geographic segment of these animals' migratory range year round, relying on other local resources when the nomadic ungulates are absent. This is the option taken by territorial pride-living lions on the Serengeti. In essence, the first strategy holds the subsistence pattern constant and varies the area of residence, while the second varies the subsistence pattern but not the area of residence. The second alternative includes not only a variant of the 'pure' hunting-gathering permutations, but essentially encompasses all other proposed alternatives in subsistence patterns too (Table 5).

In theory, Prolonged Drift could represent the faunal and artefactual debris of either of these two alternatives. Which alternative is more likely cannot be established until additional well-analysed reports on cultural and faunal materials from other contemporary sites are available. However, it is at present possible to define a number of important factors to consider in such an assessment. It is also

possible to offer predictions on distinctive differences to be expected in archaeological materials produced by each of these two contrasting subsistence strategies. The potential use of these criteria can be tested as more assemblages are analysed.

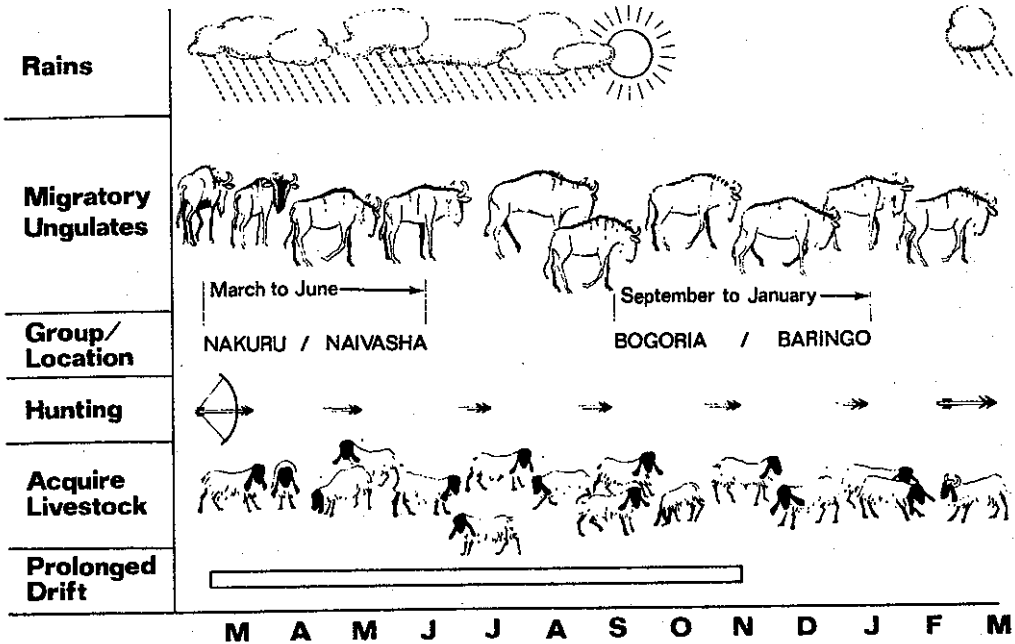
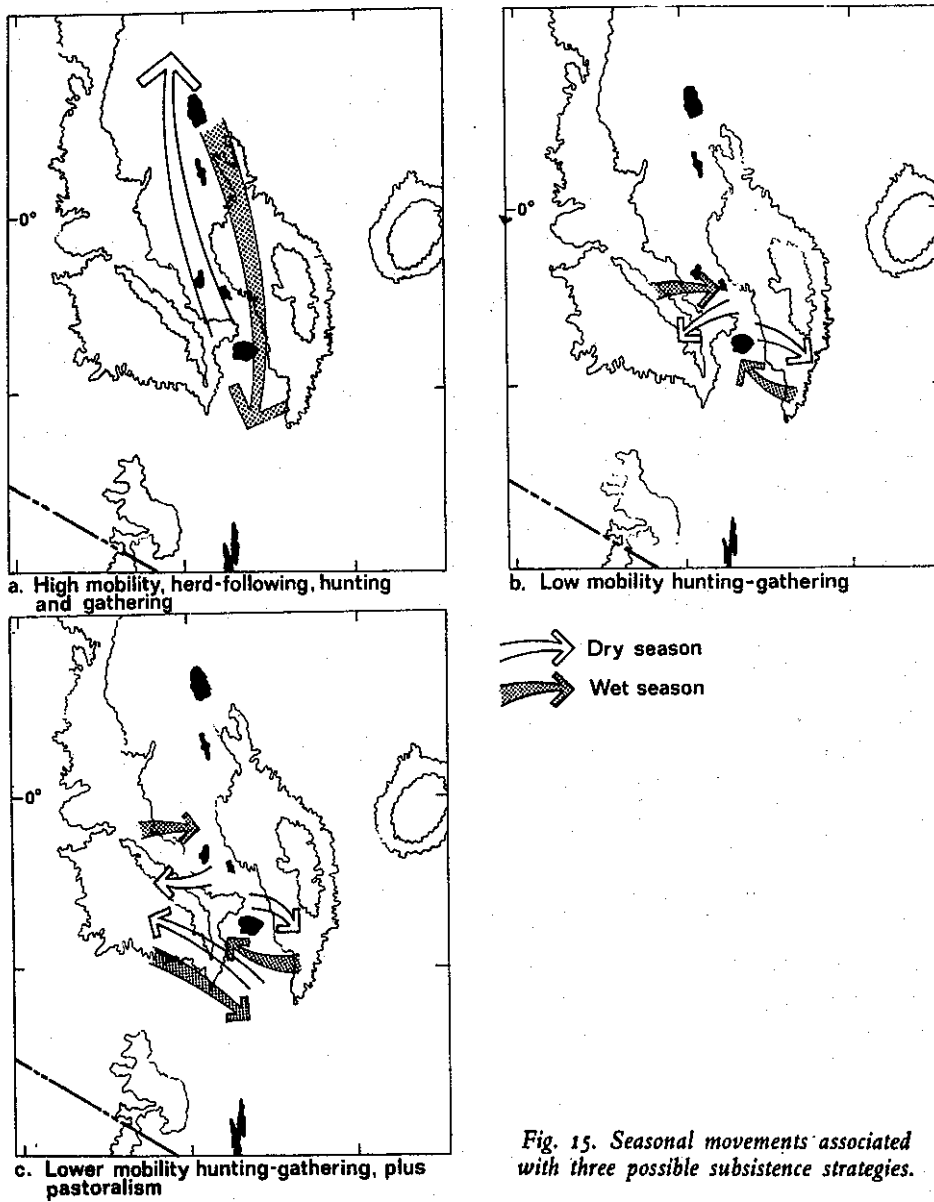


Fig. 14. Model of seasonal subsistence patterns associated with a herd-following strategy.

Foraging groups following the first alternative in the Central Rift would have to pursue a highly mobile hunting strategy. Roderick Blackburn (1974) in his work on Okiek hunters' ecology and social organization, notes that any group seeking to live entirely on the plains of the Central Rift would necessarily have had to be very mobile in order to ensure a good meat supply. Concentrating on migratory ungulates would involve a 'herd following', habituating form of predation, of the type envisaged by Sturdy (1975) for paleolithic reindeer hunters in Europe. Figure 14 presents a simplified scheme of the yearly subsistence this adaptation would involve in the Central Rift, and fig. 15 shows the proposed pattern of movement involved. In assessing the likelihood that this subsistence pattern could have existed in the Central Rift during the first millennium B.C., a number of factors must be carefully considered. None of these is sufficient to lead us to dismiss utterly this alternative as a possibility, yet many of them indicate that it might not be as likely as it initially may seem.

For this hunting pattern to be successful over the long run, it must yield sufficient prey to balance the energy demands of such a mobile life, demands which are sustained by all members of foraging groups, including women, children, and older, non-hunting males. Prey acquisition must also overbalance losses of local plant and animal food sources that cannot be tapped if long distance movements are undertaken. To assure regular acquisition of animals, maintenance of contact with prey herds is absolutely essential. This depends upon the visibility of herds, or the predictability of their movements in their foraging ranges. The relatively close steep walls of the rift in the Nakuru-Naivasha area may have channelled game along





highly predictable migration routes, while also providing lookout stations for observing daily herd movements from a distance. According to Percival (1924), ideal game-spotting conditions existed in this restricted segment of the migratory trackway. It follows that in other parts of the nomadic animals' yearly ranges, maintenance of contact would have required greater effort on the part of hunting groups. Given the considerable nocturnal mobility of migratory grazers, and the difficulties of herd relocation, we would expect that only extraordinary land configurations would permit herd following as a viable strategy. It is worth noting that historic Plains Indians of North America who preyed upon a similar nomadic grazer (bison) often had considerable difficulty in maintaining contact with herds, even with the added mobility afforded by horses (Wedel, 1961). One can only assume prehistoric hunters would experience even greater problems in this regard. Efficient meat distribution is another critical consideration in the herd-following strategy. Distances between kill and consumption sites must be kept sufficiently small so that energy expended in transport of meat is far outweighed by that gained through predation. The location of residential settlements must therefore respond mainly to the rate and magnitude of herd movements.

Clearly, the balance of success in herd following, with regard to both these critical factors, depends directly upon the rates and predictability of herd movements. Future research must establish, through analysis of local topography, written records, and modelling of pre-European grass growth patterns in the Central Rift, whether herd ungulate movements were likely to have been slow and/or predictable enough to permit herd following as a successful long-term adaptation.

One may also ask whether archaeological materials from sites like Prolonged Drift are likely to be those of highly mobile foraging groups. Without further faunal and artefactual comparisons, this question cannot be answered. However, as John Bower (1978) has noted, most so-called Pastoral Neolithic sites contain numbers of bulky items, including stone bowls and pottery, not normally considered to be highly portable. Since Prolonged Drift possesses all these hallmarks of the Pastoral Neolithic, the likelihood of association of such artefacts with a herd-following strategy must be weighed.

In assessing the likelihood that a herd-following strategy could have been a major adaptive pattern in the Central Rift, two other points must be considered. First, such an adaptation necessitates low densities of human predatory groups through the entire migratory ranges of the prey species. Direct or indirect competition with other hunting peoples would reduce the overall efficiency of this predatory pattern. One must also consider whether the existence of pastoralists, either 'pure' herdspeople or part-time hunters in the trackway would also reduce the viability of such an adaptation. It is clear that at the time the Prolonged Drift midden was created someone was keeping cattle in the area. It is possible that hunter-ungulate patterns of interaction and movement would be incompatible with domestic herd-management practices.

The second point to be considered in assessing the likelihood of this adaptation in the region is the long-term fluctuation in the population levels of the major prey species upon which mobile hunters would have to rely. As Hillman and Hillman (1977) have recently emphasized, nomadic grazers are particularly sensitive to the effects of drought and disease, undergoing massive oscillations in population in response to these stresses. Human hunters relying on these animals for a substantial part of their food base must necessarily respond to the long-term, recurrent, and severe fluctuations in their numbers. Peoples whose adaptation centered largely on these species would be extremely vulnerable to such boom-bust cycles.

Within the 'pure' hunting-gathering subsistence mode, another strategy is possible. This would involve the second alternative response to migratory grazer movements, with a smaller home range and greater variation in subsistence base through a yearly cycle. The second alternative involves a more restricted home range, with alteration between phases of predation on the migrants when they enter the range, and dependence on other resources when the migrants are absent. In the local region, this would probably involve a transhumant pattern of movement from thorn scrub/grassland borders up through forests to highland meadows in the drier months of the year and return to the grasslands or savannah-woodland with the onset of the rains, in much the same pattern as that followed by the modern Okiek (fig. 15b). Blackburn (1974) notes that the upper meadow regions are cold and extremely wet during the rains, and therefore unappealing to humans; it is also clear that the return of the migrating herds to the lowlands during the rainy season would act as a powerful magnet to hunting peoples. Blackburn describes Okiek home range sizes of up to 60 square miles (Blackburn, 1970), for some 50-80 people. In view of the fact that modern Okiek rely regularly and nearly totally on agrarian neighbours for starchy foods and periodically on pastoralists for milk and meat, it is possible that home ranges of hunter-gatherers without such intensely developed symbiotic relationships would have had a somewhat different configuration and size.

One objection to accommodating Prolonged Drift in this type of model arises from our present knowledge of contemporary archaeological materials in the region. As has been demonstrated by Stanley Ambrose (in press), sites in the uplands of the western side of the Rift seem to be characterized by a typologically different lithic industry which is designated Elmenteitan, and a distinctively different pottery style, from those encountered in more open environments, such as Prolonged Drift. To accommodate the archaeological data, one would have to posit that the practitioners of this adaptation changed their lithic and ceramic technology yearly as they moved into higher reaches of their range. While faunal materials from upland Elmenteitan sites have not been fully analysed, Ambrose (in press) contends that these may contain a higher frequency of cattle than do the plains sites, which would also argue against this alternative.

Future archaeological research in the Central Rift should recover evidence useful in assessing which of these proposed alternatives is consistent with the actual archaeological record. Future research may demonstrate the inadequacy of any of these possible models. As a step toward testing the acceptability of these models we have proposed a series of predictions regarding the nature of archaeological materials from Pastoral Neolithic sites in the Central Rift.

A. Supporting high mobility adaptations (herd following):

(1) The Bogoria-Baringo area will yield a suite of sites characterized by similar types of implements and facilities and similar to Prolonged Drift in the strong preponderance of nomadic grazers.

(2) Ceramics from sites containing high numbers of nomadic grazers in the Bogoria-Baringo basin will be both stylistically similar and derived in part from the same clay sources as those from similar sites in the Nakuru-Naivasha-Elmenteita region.

B. Supporting less mobile adaptations:

Hunting without domesticates:

(i) There will be a high ratio of wild nomadic ungulates to wild resident ungulates at some local sites, but a reversed ratio at other sites which nonetheless show signs of having been formed as part of the same socio-cultural system, reflec-

ting seasonal availability of migratory herds.

Hunting combined with domestic stock.

(1) There will be a high ratio of wild to domestic stock to wild migratory ungulates at sites near permanent water sources in the Central Rift.

(2) The ratio of wild resident ungulates to wild nomadic ungulates will be high at sites near permanent water sources in the Central Rift.

(3) There will be a low ratio of domestic stock to wild migratory ungulates at sites away from permanent water sources, or otherwise characterized by sedimentologic or taphonomic criteria as short term occupation sites.

(4) the ratio of wild resident ungulates to nomadic ungulates will likewise be low at these sites.

(5) As in A (2).

However, it should be borne in mind that both the Nderit and the Makalia are today semi-permanent streams and that there are perennial springs along the Rift scarp so that the grazing grounds of the Rift floor itself were probably never without watering points for humans and stock. We are unsure whether Prolonged Drift should be rated as near a permanent water source or not.

A second pattern is embodied in permutation 3 (hunting-pastoralism). As envisioned here (fig. 15c), this strategy would involve movement into high grasslands and areas of permanent water sources during the dry season, when livestock formed the major meat source, and return to the Rift lowlands with the rains, both to take advantage of new grass growth for domestic stock and to hunt the incoming wild herds. Uplands likely to have been used by pastoralists during the dry months include Mau Narok, Njoro, Bahati, and the Kinangop. The site of Narosura, with its high proportions of cattle and proximity to a permanent stream, might represent such a dry season settlement in such a system (Odner, 1972). Home range sizes of pastoralists pursuing such a pattern of movement might be somewhat greater than those of recently documented Masai, whose grazing patterns have been severely restricted, with environmentally destructive results, by political developments in their home areas (Jacobs, 1975). Cultivation of alluvial flats has been envisioned as necessarily combined with either hunting and collecting, or with hunting-collecting-pastoralism (permutations 2 and 4). Movements of peoples practising the former subsistence strategy would be much like those described for localized hunter-gatherers, while those of people practising the latter would be more like that of hunter-pastoralists. The need to plant and maintain growing crops on lowland alluvial plains might prolong the amount of time spent in the Rift lowlands, in contrast with the other, non-cultivating alternatives. Were it necessary to await harvest of crops on the lowland plains past the time that large herds of wild game had left the area, cultivators would have to supplement their diets with other food, including slaughtered livestock either owned or acquired from neighbouring stock owners. For modern mixed cultivator-pastoralists in Eastern Africa the beginning of the dry season prior to harvest is the time of greatest dietary stress, during which the most livestock are killed and consumed, whether in ritual or domestic contexts (e.g. Almagor, 1978). Figure 16 represents a hypothetical yearly subsistence cycle combining a number of these lower mobility subsistence strategies. We would note that, simply in terms of timing, there is no essential incompatibility among these various strategies, which would all strongly favour scheduling of stays in the Rift lowlands during the rainy season. There may, however, be other reasons why over the long run a highly diversified subsistence strategy of the type modelled in fig. 16 would not endure, as it clearly did not in the Central Rift. The 'fragility' of such an adaptation might be attributed to small degrees of scheduling conflict within the

alternative subsistence practices, or to the functioning of deviation amplifying mechanisms within the overall adaptive system (such as growth of either bovine or human populations), or the immigration of new peoples practising more highly specialized forms of food production. Further analysis of fauna artefacts and settlement patterns in the Central Rift will throw light on many of these currently problematic topics.

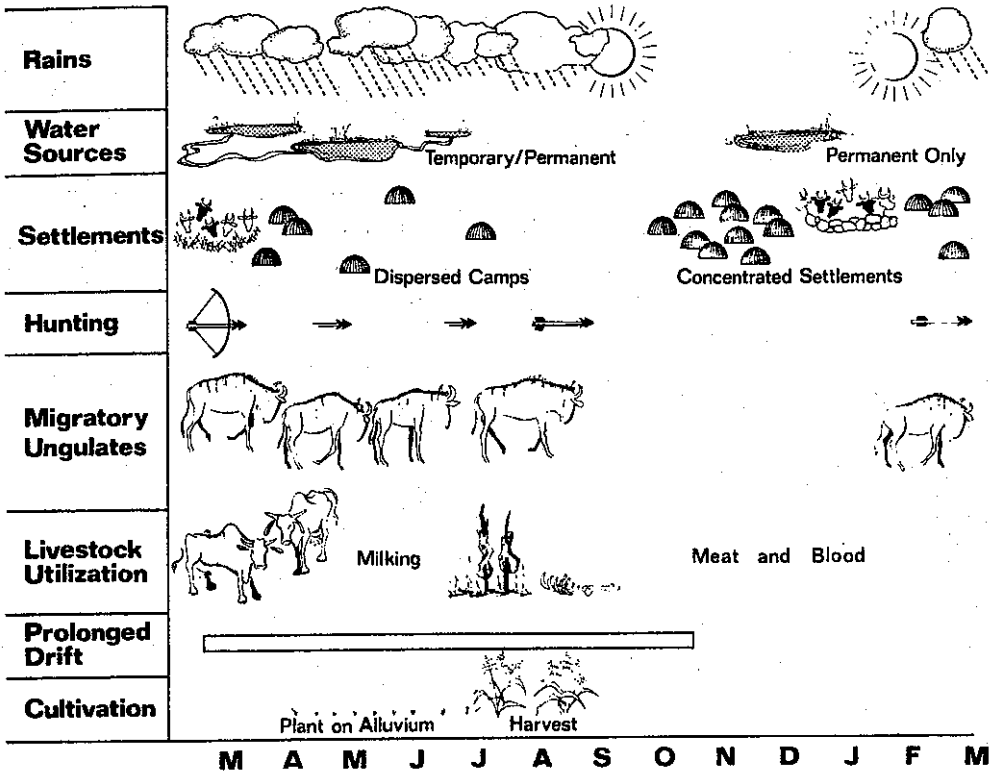


Fig. 16. Model of seasonal subsistence patterns associated with a hunting-pastoral-cultivating strategy.

### Conclusions

This report has sought to demonstrate the value and utility of comprehensive and detailed analyses of large faunal samples in assessing the nature of early food-producing economies in East Africa. Due to the current dearth of similarly analysed assemblages from other Pastoral Neolithic sites, many of the points raised in the foregoing discussion are necessarily speculative. We can, however, say that the Naivasha Railway Shelter, Prolonged Drift, Crescent Island and Narosura faunal materials indicate considerable variation in the species consumed at these sites, ranging from predominantly wild species through a mix of wild and domestic taxa, to preponderantly domestic species, respectively. We have argued that these differences may result from seasonal variations in subsistence practices, which may also have involved variations in patterns of movement and home base location. We have also considered the possibility that the diversity results from the co-existence

of several distinct systems of subsistence and land use. Further research into the nature of the Pastoral Neolithic and other putative food-producing economies in East Africa should take into account seasonal fluctuations in resource availability and attempt to discern the responses of prehistoric humans to them. As has been shown in other parts of the world, the transition from a gathering-hunting subsistence strategy to a food-producing one often entails substantial alterations in regional patterns of movement and settlement as well as in utilization of food species. Future research will, we hope, evaluate and improve upon the speculations we have offered here concerning these aspects of human existence in the earliest phases of food production in East Africa.

Analysis and evaluation of archaeological faunal assemblages like that from Prolonged Drift are of interest to persons concerned with contemporary patterns of land use in East Africa, and with the future of human subsistence in arid and semi-arid regions. Pastoralism constitutes an enduring and potentially viable mode of human subsistence in these areas, and archaeological materials provide our only insights into the evolution of the interactions of humans, animal species, and the land which ultimately led to the region's historically documented pastoral systems.

	Thomson's Gazelle	Cuvier's Gazelle	Small Horned	Grant's Gazelle	Impressa	Medium Horned	Wildbeeste	Kouprui	Albatrophe	Carib	Large Horned	Buffalo	Eland	Very Large Horned	Wambag	Giraffe	Antelope (all sizes)	Burchell's Zebra	Equid	Wildebeest	Manxrat	Small Mammals	Medium Mammals	Large Mammals	Very Large Mammals	
	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	L/R/T	
Homocore	1/2/4	---	---	0/0/4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Cranium	0/0/1	---	2/1/6	---	---	1/1/4	---	---	1/0/2	---	0/7/11	---	---	---	---	---	---	---	3/4/9	---	---	---	---	---	---	
Maxilla	---	---	1/0/1	---	---	---	---	---	---	---	1/0/1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Mandible	---	---	0/3/10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Upper Tib	24/10/40	0/9/15	---	3/5/8	0/2/8	1/0/6	41/37/78	22/21/43	7/4/21	49/43/95	0/0/23	2/4/6	1/1/2	---	2/2/4	---	---	---	0/0/1	---	---	---	---	---	---	
Lower Tib	19/37/56	16/7/24	---	15/31/46	1/10/11	0/0/9	53/43/97	38/35/74	2/6/8	40/59/100	0/0/40	2/2/4	1/2/3	---	1/1/2	0/0/5	---	41/38/80	4/1/6	0/1/1	---	---	---	---		
Atlas	0/0/1	---	0/0/1	---	---	0/0/2	---	---	0/0/1	---	0/0/1	---	0/0/1	0/0/1	---	---	---	---	---	0/0/1	---	---	---	---	---	
Axis	0/0/1	---	0/0/1	---	---	0/0/2	---	---	0/0/2	---	0/0/3	---	---	---	0/0/1	---	---	---	---	0/0/1	---	---	---	---	---	
Cervical	0/0/1	0/0/5	0/0/3	0/0/1	0/0/1	0/0/19	0/0/5	---	0/0/15	0/0/1	0/0/12	---	---	---	---	0/0/24	---	---	0/0/6	---	---	---	---	---		
Thoracic	0/0/1	---	0/0/8	---	0/0/8	0/0/16	---	---	0/0/4	0/0/1	0/0/33	---	0/0/1	0/0/2	---	---	0/0/4	---	0/0/6	0/0/15	---	---	---	---		
Lumbar	0/0/1	---	0/0/12	0/0/3	0/0/1	0/0/25	---	---	0/0/11	---	0/0/55	---	---	0/0/3	---	---	0/0/6	---	0/0/10	---	---	---	---	---		
Sacrum	---	---	---	---	---	---	0/0/7	---	---	---	0/0/8	---	---	0/0/3	---	---	0/0/5	---	---	---	---	---	---	---	---	
Rib	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0/0/5	---	---	---	---	---	---	---	---	
Sternum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0/0/1	---	---	---	
Scapula	---	---	4/7/11	---	---	8/8/21	1/1/2	---	---	---	8/12/25	---	---	1/0/1	---	---	---	2/1/3	1/0/1	---	---	---	---	---	---	
Humerus PX	---	---	2/1/3	---	---	2/0/2	---	---	---	---	1/1/2	---	---	1/0/1	---	---	---	---	---	---	---	---	---	---	---	
SH	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
DS	1/0/1	---	8/4/12	---	---	3/3/8	---	---	0/1/1	---	12/7/20	---	---	---	---	---	---	3/0/2	---	---	---	---	---	---	---	
Radius PX	1/0/1	---	4/4/8	---	---	5/4/9	---	1/0/1	---	---	17/8/25	---	---	0/1/1	---	---	---	17/8/25	---	---	---	---	0/0/1	0/0/2	---	
SH	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
DS	---	---	1/4/5	---	---	2/5/6	---	---	---	---	8/5/14	---	---	---	---	---	---	---	4/3/7	1/0/1	---	---	0/0/1	0/0/1	---	
Scaphoid	2/0/2	---	---	7/4/11	2/0/2	---	3/0/3	5/5/10	---	1/4/3	2/0/2	---	1/0/1	---	---	---	---	2/4/4	---	---	---	---	---	---	---	
Lunate	1/0/1	---	---	3/1/4	0/1/1	---	3/1/4	3/3/6	1/0/1	0/2/0	5/2/7	---	2/0/2	0/1/1	---	---	---	0/1/1	---	---	---	---	---	---	---	
Cleiform	2/0/2	0/1/1	---	2/0/2	---	---	4/0/4	0/4/4	1/0/1	0/1/1	---	---	1/1/2	---	---	---	---	1/2/3	1/0/1	---	---	---	---	---	---	
Magnum	0/1/1	---	---	2/3/5	2/0/2	---	4/1/5	2/5/7	---	1/3/6	1/0/1	---	0/1/1	---	---	---	---	0/4/4	1/0/1	---	---	---	---	---	---	
Ulnocarpal	---	---	---	3/2/5	1/0/1	---	2/8/8	4/3/7	2/1/3	2/6/8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Trapezoid	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pisiform	---	---	---	1/1/2	---	---	---	---	5/10	0/1/1	3/0/1	---	0/1/1	---	---	---	---	0/2/2	0/1/1	---	---	---	---	---	---	
Metacarpal F	1/3/4	---	2/0/2	---	---	---	---	---	1/2/3	2/3/7	11/9/20	---	---	1/1/2	---	---	0/3/5	---	---	---	---	---	---	---	---	
SH	---	---	---	---	---	---	---	---	---	0/2/2	---	---	---	---	---	---	0/1/1	---	0/1/1	---	---	---	---	---	---	
DS	0/0/1	---	---	---	---	---	---	0/0/1	0/0/1	0/0/3	---	---	0/0/1	---	---	---	1/3/4	---	---	---	---	---	---	0/0/3	---	
Pelvis	---	1/0/1	12/6/18	---	---	9/14/27	---	---	---	---	25/16/40	---	---	1/1/2	---	---	8/7/15	1/1/2	---	0/0/15	0/0/4	---	0/0/8	---	---	
Femur PX	---	---	2/4/6	---	---	6/2/11	---	---	---	---	---	---	---	1/0/1	---	---	8/1/9	1/2/3	---	---	---	---	---	---	---	
SH	---	---	---	---	---	---	---	---	---	---	1/1/2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
DS	---	---	0/1/1	---	---	1/1/2	---	---	---	---	2/4/6	---	---	---	---	---	---	3/2/3	0/1/1	---	---	---	---	---	---	
Tibia PX	---	---	2/0/2	---	---	2/1/3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
SH	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
DS	---	---	5/4/9	0/3/3	---	3/3/8	---	---	---	---	7/12/19	---	---	0/1/1	---	---	---	0/1/1	1/2/3	---	---	---	---	---	---	
Calcaneum	5/3/10	---	1/1/2	3/2/3	1/0/1	1/0/2	1/4/5	6/5/12	2/1/3	2/0/3	2/0/2	1/1/2	1/2/3	0/0/1	---	---	---	4/3/7	0/2/2	---	---	---	---	---		
Astragalus	6/6/12	1/1/2	3/4/7	3/2/3	0/2/2	0/4/4	6/8/14	12/6/18	7/8/16	5/6/10	3/2/6	---	3/4/7	1/1/2	---	---	---	3/6/9	---	---	---	---	---	---		
Navicular	5/6/9	1/1/2	1/0/1	---	---	3/2/3	6/1/7	6/4/10	1/0/1	3/0/3	1/1/2	1/0/1	3/3/6	1/1/2	---	---	---	---	---	---	---	---	---	---		
Navicular	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Cuboid	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Medial Cuneiform	---	---	---	---	---	2/0/2	---	---	0/2/2	---	1/1/2	---	---	1/0/1	---	---	---	---	0/2/2	1/0/1	---	---	---	---	---	
Lateral "	3/2/3	---	---	3/3/6	1/1/2	---	---	3/0/3	9/10/19	2/0/2	4/2/6	---	1/1/2	---	---	---	---	---	1/2/3	0/1/1	---	---	---	---		
Metatarsal PX	0/3/3	---	0/2/3	---	---	10/11/21	---	---	8/4/12	---	3/7/12	---	---	1/0/1	1/2/3	---	---	---	---	0/1/1	---	---	---	---		
SH	---	---	---	---	---	0/0/1	---	---	0/0/1	---	0/0/3	---	---	0/0/3	---	---	---	---	---	---	---	---	---	---	---	
DS	0/0/1	---	---	---	---	---	---	---	---	---	---	---	0/1/1	0/0/1	---	---	---	---	---	---	---	---	---	---	---	
Metapodial	---	---	0/0/1	---	---	0/0/6	---	---	---	---	0/0/15	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
SH	---	---	---	---	---	---	---	---	---	---	0/0/2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
DS	---	---	0/0/22	---	---	0/0/41	---	---	---	---	0/0/69	---	---	0/0/9	0/0/4	---	---	---	---	---	---	---	---	---	---	
Phalanx 1	---	---	0/0/17	---	---	0/0/27	---	---	---	---	0/0/111	---	---	0/0/25	0/0/1	0/0/1	---	---	---	0/1/3	1/4/11	---	---	---	---	
2	---	---	0/0/15	---	---	0/0/10	---	---	---	---	0/0/60	---	---	0/0/5	0/0/1	---	---	---	---	0/0/15	0/0/17	---	---	---	---	
3	---	---	0/0/5	---	---	0/0/7	---	---	---	---	0/0/26	---	---	0/0/2	0/0/1	---	---	---	---	0/0/12	0/0/1	---	---	---	---	
Patella	---	---	0/0/3	---	---	0/0/3	---	2/0/2	---	---	---	---	---	0/1/1	---	---	---	---	---	---	---	---	---	---	---	
Scamolds	---	---	0/0/4	---	0/0/17	---	---	---	---	---	0/0/184	---	---	0/0/13	---	---	---	---	0/0/16	0/0/3	0/0/1	---	---	---	---	

Appendix 1. Summary of major body part representation for taxa in the total Prolonged Drift assemblage (recent rodent species excluded). Total includes pieces for which size was not ascertainable, or where are not bilaterally symmetrical.

## Appendix IIa

The incidence of cuts, multiple cuts and plane fracture surfaces in small and medium bovids.

f = number of items showing the designated modification

N = total number of bones of that body part and taxon

P = proportion showing the modification ( $P=f/n$ )

## CUTS &amp; MULTIPLE CUTS

## PLANE FRACTURE SURFACES

ELEMENT	f	N	P	ELEMENT	f	N	P
Humerus (PX)	2	5	.40	Axis Cervical Vertebra 2	21	4	.25
Humerus (DS)	11	21	.52	Humerus (DS)	2	21	.09
Radioulna (PX)	8	18	.44	Radius (DS)	3	11	.27
Ulna (SH)	2	2	1.00	Femur (PX)	9	17	.53
Radius (DS)	4	11	.36	Patella	2	11	.18
Ulna (DS)	1	4	.25	Tibia (DS)	1	17	.06
Main Metacarpal (PX)	3	6	.50	Calcaneum	1	18	.05
Ilium	1	4	.25	Astragalus	17	32	.53
Acetabulum	23	35	.66	Naviculocuboid	5	42	.12
Pubis	1	2	.50	Main Metatarsal (PX)	1	22	.04
Femur (PX)	2	17	.12				
Patella	2	11	.18				
Tibia (PX)	2	5	.40				
Tibia (DS)	4	17	.23				
Calcaneum	6	18	.33				
Astragalus	7	32	.22				
Tarsal or Pes Bone	2	42	.05				
Main Metatarsal (PX)	16	27	.59				
Main Metatarsal (SH)	1	1	1.00				



Appendix IIb  
Modified bone: large bovids

CUTS & MULTIPLE CUTS				PLANE FRACTURE SURFACES			
ELEMENT	f	N	P	ELEMENT	f	N	P
Scapula (Blade)	1	9	.11	Atlas Cervical	1	2	.50
Scapula (Glenoid)	1	14	.07	Vertebra 1			
Humerus (PX)	1	2	.50	Thoracic Vertebra	1	38	.02
Humerus (DS)	12	21	.57	(Indet.)			
Ulna (PX)	9	12	.75	Sacrum	1	15	.06
Radius (PX)	7	13	.54	Scapula	1	26	.04
Radius (SH)	1	1	1.00	Humerus (DS)	13	21	.62
Radius (DS)	3	14	.21	Radius (PX)	2	13	.15
Carpal or Manus Bone	4	108	.04	Radius (DS)	10	14	.71
Main Metacarpal (SH)	3	4	.75	Main Metacarpal (PX)	6	24	.25
Main Metacarpal (DS)	2	4	.50	Acetabulum	3	27	.11
Ilium	1	11	.09	Ischium	1	2	.50
Acetabulum	11	27	.41	Femur (PX)	6	14	.42
Ischium	2	2	1.00	Femur (DS)	2	6	.33
Femur (PX)	6	14	.43	Tibia (PX)	1		1.00
Femur (DS)	4	6	.67	Tibia (DS)	2	19	.11
Patella	1	3	.33	Calcaneum	2	24	.08
Tibia (SH)	14	19	.74	Astragalus	37	64	.58
Fibulare	5	11	.45	Tarsal or Pes Bone	23	69	.33
Calcaneum	11	24	.46	Naviculocuboid*	16	19	.84
Astragalus	27	64	.42	Main Metatarsal (PX)	3	38	.08
Tarsal or Pes Bone	5	69	.07				
Main Metacarpal (PX)	20	38	.29				
Main Metacarpal (DS)	1	2	.50				

\* all anterior fragments

## Appendix IIc

## Modified bone: very large bovids

CUTS & MULTIPLE CUTS				PLANE FRACTURE SURFACES			
ELEMENT	f	N	P	ELEMENT	f	N	P
Carpal or Manus Bone	1	8	.13	Pelvis	1	2	.50
Patella	1	1	1.00	Carpal or Manus Bone	2	8	.25
Tibia (DS)	1	1	1.00	Calcaneum	1	4	.25
Calcaneum	3	4	.75	Astragalus	5	9	.56
Astragalus	5	9	.56	Tarsal or Pes Bone	5	16	.31
Naviculocuboid	2	9	.22				
Main Metatarsal (PX)	1	4	.25				
Main Metatarsal (SH)	1	1	1.00				
Main Metatarsal (DS)	1	1	1.00				

## Appendix IIId

## Modified bone: zebra

CUTS & MULTIPLE CUTS				PLANE FRACTURE SURFACES			
ELEMENT	f	N	P	ELEMENT	f	N	P
Occipital	1	5	.20	Occipital	1	5	.20
Scapula (Glenoid)	3	3	1.00	Radius (DS)	5	8	.63
Humerus (DS)	1	2	.50	Magnum	2	5	.40
Radius (PX)	1	4	.25	Metapodial (PX)	1	3	.33
Radius (SH)	1	2	.50	Pelvis	2	17	.12
Radius (DS)	1	7	.14	Femur (PX)	1	12	.08
Carpal or Manus	6	19	.32	Tibia (DS)	4	8	.50
Main Metacarpal (PX)	3	4	.75	Astragalus	1	9	.11
Metapodial (PX)	2	3	.67	Main Metatarsal (PX)	1	4	.25
Metapodial (DS)	5	14	.36	First Phalanx	10	30	.33
Acetabulum	9	12	.75	Second Phalanx	1	13	.07
Femur	4	6	.67				
Tibia (SH)	4	4	1.00				
Tibia (DS)	3	8	.38				
Calcaneum	3	6	.50				
Astragalus	6	9	.67				
Tarsal or Pes Bone	2	20	.10				
Main Metatarsal (DS)	3	5	.60				
First Phalanx	15	30	.50				
Second Phalanx	7	13	.54				

## Appendix IIc

Incidence and proportion of identifiable bones showing signs of burning.

ELEMENT BY TAXON	f	N	P/N
<b>ZEBRA</b>			
Axis Cervical Vertebra 2	4	6	.66
Cervical Vertebra	3	6	.50
Thoracic Vertebra (INDET)	1	13	.08
Lumbar Vertebra (INDET)	1	10	.10
Main Metacarpal (DS)	1	12	.08
Lateral Cuneiform	1	20	.05
<b>SMALL &amp; MEDIUM BOVIDS</b>			
Ramus	1	12	.08
Thoracic Vertebra (INDET)	1	28	.04
Lumbar Vertebra (INDET)	2	43	.05
Carpal or Manus Bone	1	42	.02
Femur (PX)	1	17	.06
Patella	1	11	.09
Calcaneum	5	18	.28
Naviculocuboid	1	42	.02
<b>LARGE BOVIDS</b>			
Temporal	1	1	1.00
Cervical Vertebra	2	34	.06
Thoracic Vertebra (INDET)	1	38	.03
Carpal or Manus Bone	2	108	.02
Tarsal or Pes Bone	1	69	.01
Main Metatarsal (PX)	1	38	.03

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## REFERENCES

- Almagor, U. 1978 *Pastoral Partners - Affinity and Bond Partnership Among the Dassanetch of South-West Ethiopia*, U. of Manchester Press.
- Ambrose, S. 1980 'Elmenteitan and other late pastoral Neolithic adaptations in the Central Highlands of East Africa', *Procs. 8th P.C.P.Q.S.*, Nairobi.  
in press 'The introduction of pastoral adaptations to East Africa', in S. Brandt, J.D. Clark (eds.), *Causes and Consequences of Food Production in Africa*, U. of California Press.
- Ammerman, A.J., Gifford, D.P. and Voorrips, A. 1978 'Towards an evaluation of sampling strategies: simulated excavation of a Kenyan pastoralist site', in I.H. Hodder (ed.), *Simulation Studies in Archaeology*, Cambridge University Press.
- Bearder, S.K. 1977 'Feeding habits of spotted hyenas in a woodland habitat', *E.A.W.J.*, 15, pp. 263-80.
- Behrensmeyer, A.K. 1975 'The taphonomy and paleoecology of Plio-Pleistocene vertebrate assemblages east of Lake Rudolf, Kenya', *Bull. Museum of Comparative Zoology*, 146, 10, pp. 473-578.  
1978 'Taphonomic and ecologic information from bone weathering', *Palaeobiology*, 4, pp. 150-62.
- Binford, L.R. 1978 *Nunamiut Ethnoarchaeology*, New York: Academic Press.
- Binford, L.R. and Bertram, J.B. 1977 'Bone frequencies and attritional processes', in *For Theory Building in Archaeology*, New York: Academic Press.
- Blackburn, R.H. 1970 'A preliminary report of research on the Okiek tribe of Kenya', *Discussion paper II, Institute for Developmental Studies*, U. of Nairobi.  
1974 'The Okiek and their history', *Azania*, IX, pp. 138-57.
- Bower, J.R.F. in press 'Settlement behaviour of late prehistoric cultures in East Africa', in S. Brandt, J.D. Clark (eds.), *Causes and Consequences of Food Production in Africa*, U. of California Press.
- Bower, J.R.F., Nelson, C.M., Waibel, A.F., and Wandibba, S. 1977 'The University of Massachusetts Late Stone Age/Pastoral Neolithic comparative study in Central Kenya', *Azania*, XII, pp. 119-46.
- Butzer, K.W., Isaac, G.Ll, Richardson, J.L. and Washbourne-Kamau, C. 1972 'Radiocarbon dating of East African lake levels', *Science*, 175, pp. 1069-76.
- Carr, C.J. 1977 *Pastoralism in Crisis: the Dassanetch and Their Ethiopian Lands*, U. of Chicago: Research paper no. 180.  
*Sampling Techniques*, New York: John Wiley.
- Cochran, W.G. 1977 *Having Herds*, U. of Stockholm.
- Dahl, G. and Hjoort, A. 1977 'Approaches to faunal analysis in archaeology', *American Antiquity*, 34, 2, pp. 146-53.
- Daly, P. 1969

- Dyson-Hudson, R. and Dyson-Hudson, N. 1969 'Subsistence herding in Uganda', *Scientific American*, 220, pp. 76-89.
- Estes, R.D. and Goddard, J. 1967 'Prey selection and hunting behavior of the African wild dog', *J. of Wildlife Management*, 31, pp. 52-69.
- Evans-Pritchard, E.E. 1940 *The Nuer*, Oxford University Press.
- Farrand, W.R., Redding, R.W., Wolpoff, M.H. and Wright III, H.T. 1976 *An Archaeological Investigation on the Lobo Plain, Baringo District, Kenya*, Museum of Anthropology, U. of Michigan, Technical Report 4.
- Flannery, K.V. 1976 *The Early Mesoamerican Village*, New York: Academic Press.
- Foley, R.A. *in press* 'Off-site archaeology: an alternative approach for the short-sited', in I. Hodder, G.Ll. Isaac, N. Hammond (eds.), *Pattern in the Past: Studies in Honour of David Clarke*, Cambridge University Press.
- Fosbrook, H.A. 1980 'The socio-economic life of the rock painters', *Procs. 8th P.C.P.Q.S.*, Nairobi.
- Foster, J.B. 1967 'The square lipped rhino (*Ceratotherium simum cottoni* Lydekker) in Uganda', *E.A.W.J.*, 5, pp. 161-67.
- Foster, J.B., and Kearney, D. 1967 'Nairobi National Park game census, 1966', *E.A.W.J.*, 5, pp. 112-20.
- Frison, G. 1974 *The Casper Site*, New York: Academic Press.
- Gallagher, J.P. 1977 'Contemporary stone tools in Ethiopia: implications for archaeology', *J. of Field Archaeology*, 4, pp. 407-14.
- Gifford, D.P. 1977 *Observations of Modern Human Settlements as an Aid to Archaeological Interpretation*, unpubl. Ph.D. Dissertation, U. of California, Berkeley.
- 1980 'Ethnoarchaeological contributions to the taphonomy of human sites', in A.K. Behrensmeier and A.P. Hill (eds.), *Fossils in the Making*, U. of Chicago Press.
- Gifford, D.P. and Crader, D.C. 1977 'A computer coding system for archaeological faunal remains', *American Antiquity*, 42, pp. 225-38.
- Gramly, R.M. 1972 'Report on the teeth from Narosura', *Azania*, VII, pp. 87-91.
- Grayson, D.K. 1978 'Minimum numbers and sample size in vertebrate faunal analysis', *American Antiquity*, 43, 1, pp. 53-65.
- Gulliver, P.H. 1955 *The Family Herds*, London: Routledge & Kegan Paul.
- Hillman, J.C. and Hillman, A.K.K. 1977 'Mortality of wildlife in Nairobi National Park during the drought of 1973-1974', *E.A.W.J.*, 15, pp. 1-18.
- Hivernel, F. 1975 'Preliminary report on excavations at Ngenyn', *Azania*, X, pp. 140-4.
- 1980 'An ethnoarchaeological model for the study of environmental use', *Procs. 8th P.C.P.Q.S.*, Nairobi.
- Isaac, G.Ll, Merrick, H.V. and Nelson, C.M. 1972 'Stratigraphic and archaeological studies in the Lake Nakuru basin', in K.W. Butzer (ed.), *Palaeoecology in Africa*, 6, Cape Town: A.A. Balkema.
- Jacobs, A.H. 1975 'Maasai pastoralism in historical perspective', in T. Monod (ed.), *Pastoralism in Tropical Africa*, Oxford University Press.
- Klein, R.G. 1977a 'The mammalian fauna from the Middle and Later Stone Age (later Pleistocene) levels of Border Cave, Natal province, South Africa', *S.A.A.B.*, 32, pp. 14-27.
- 1977b 'The ecology of early man in southern Africa', *Science*, 197, pp. 115-26.
- 1978 'A preliminary report on the larger mammals from the Boomplaas Stone Age site, Cango Valley, Oudshoorn district, South Africa', *S.A.A.B.*, 33, pp. 66-75.
- Kruuk, H. 1972 *The Spotted Hyena*, U. of Chicago Press.
- Kutilek, M.J. 1974 'The density and biomass of large animals in Lake

- Leakey, L.S.B. 1931 Nakuru National Park', *E.A.W.J.*, 12, pp. 201-12. *The Stone Age Cultures of Kenya Colony*, Cambridge University Press.
- Leuthold, W. and Leuthold, B.M. 1975 'Temporal patterns of reproduction in ungulates in Tsavo East National Park, Kenya', *E.A.W.J.*, 13, pp. 159-69.
- Marks, S.A. 1973 'Prey selection and annual harvest in a rural Zambian community', *E.A.W.J.*, 11, pp. 113-28.
- Merrick, H.V. 1975 *Change in the Later Pleistocene Lithic Industries in Eastern Africa*, Ph.D. thesis, U. of California, Berkeley.
- Nelson, C.M. 1973 *A Comparative Analysis of Thirteen Later Stone Age Sites in East Africa*, unpubl. Ph.D. Thesis, U. of California, Berkeley.
- 1981 'The Elmenteitan lithic industry', *Procs. 8th P.C.P.Q.S.*, Nairobi.
- Newman, J.L. 1970 *Ecological Basis of Subsistence Change Among the Sandawe of Tanzania*, National Academy of Science, Washington, D.C.
- Odner, K. 1972 'Excavations at Narosura, a stone bowl site in the southern Kenya highlands', *Azania*, VII, pp. 25-92.
- Onyango-Abuje, J.C. 1977a *A Contribution to the Study of the Neolithic in East Africa with Particular Reference to the Nakuru-Naivasha Basins*, unpubl. Ph.D. Dissertation, U. of California, Berkeley.
- 1977b 'Crescent Island', *Azania*, XII, pp. 147-59.
- Parkington, J.E. 1972 'Seasonal mobility in the Late Stone Age', *African Studies*, 31, 4, pp. 223-43.
- Pearsall, D.M. 1978 'Phytolith analysis of archaeological soil: evidence of maize cultivation in formative Ecuador', *Science*, 199, pp. 177-9.
- Percival, A.B. 1924 *A Game Ranger's Notebook*, London: Nisbet.
- 1928 *A Game Ranger on Safari*, London: Nisbet.
- Perkins, D. and Daly, P. 1968 'A hunters' village in Neolithic Turkey', *Scientific American*, 219, pp. 96-106.
- Read, D.W. 1975 'Regional sampling' in J.W. Mueller (ed.), *Sampling in Archaeology*, U. of Arizona Press.
- Richardson, J.L. and Richardson, A.E. 1972 'The history of an African Rift lake and its climatic implications', *Ecological Monographs*, 42, pp. 499-534.
- Rudnai, J. 1974 'The pattern of lion predation in Nairobi National Park', *E.A.W.J.*, 12, pp. 213-26.
- Schaller, G.B. 1972 *The Serengeti Lion*, U. of Chicago Press.
- Schiffer, M.B. 1976 *Behavioural Archaeology*, New York: Academic Press.
- Schenkel, R. 1966 'On sociology and behaviour in impala (*Aepyceros melampus* Lichtenstein)', *E.A.W.J.*, 4, pp. 99-114.
- Spencer, P. 1965 *The Samburu, a Study of Gerontocracy in a Nomadic Tribe*, London: Routledge & Kegan Paul.
- Stanley Price, M.R. 1974 *The Feeding Ecology of Coke's Hartebeest Alcelaphus buselaphus cokei Gunther, in Kenya*, unpubl. Ph.D. dissertation, U. of Oxford.
- Stewart, D.R.M. and Stewart, J. 1963 'The distribution of some large mammals in Kenya', *J.E.A.N.H.S.*, 24, pp. 1-52.
- Sturdy, R.A. 1975 'Some reindeer economies in prehistoric Europe', in E.S. Higgs (ed.), *Palaeoeconomy*, Cambridge University Press.
- Survey of Kenya 1970 *Atlas of Kenya*, 3rd Edition, Nairobi.
- Umesao, T 1969 'Hunting culture of the pastoral Datoga', *Kyoto J. of African Studies*, 3, pp. 77-92.
- Wandibba, S. 1981 'The application of attribute analysis to the study of Later Stone Age/Neolithic ceramics in Kenya: a summary of conclusions', *Procs. 8th P.C.P.Q.S.*, Nairobi.

- Washbourne-Kamau, C. 1971 'Late Quaternary lakes in the Nakuru-Elmenteita basin, Kenya', *Geographical Journal*, 137, pp. 322-35.
- 1975 'Late Quaternary shorelines of Lake Naivasha, Kenya', *Azania*, X, pp. 77-92.
- Wedel, W.R. 1961 *Prehistoric Man on the Great Plains*, U. of Oklahoma Press.
- Western, D. 1975 'Water availability and its influence on the structure and dynamics of a savannah large mammal community', *E.A.W.J.*, 13, pp. 265-86.
- Wheat, J.B. 1972 'The Olsen-Chubbuck Site; a palaeo-Indian Bison kill', *American Antiquity Memoire* 26.
- Yellen, J.E. 1977 *Archaeological Approaches to the Present*, New York: Academic Press.

### Summary

This paper reports in detail on the largest faunal assemblage yet analysed from a Pastoral Neolithic site. Prolonged Drift, located south of Lake Nakuru, Kenya, yielded over 160,000 pieces of bone, reflecting a mixture of wild and domestic species in one midden deposit. A substantial part of our discussion centres on the possible economic systems and practices that may have existed in the Central Rift during the first and second millennia B.C.