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Experimental Implement Manufacture and Use; A Case Study from Olduvai Gorge, Tanzania

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Phil. Trans. R. Soc. Lond. B 1981 **292**, 189-195
doi: 10.1098/rstb.1981.0027

Phil. Trans. R. Soc. Lond. B **292**, 189–195 (1981) [189]
Printed in Great Britain

Experimental implement manufacture and use; a case study from Olduvai Gorge, Tanzania

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[Plates 1 and 2]

Experiments involving the manufacture and use of stone tools are described. The original tools that served as models came from two sites in upper bed IV at Olduvai Gorge, Tanzania. The following conclusions are drawn. Widespread use of terms such as 'crude' or 'refined' in describing stone tools tells us nothing of the technical level achieved by the makers of the assemblages. The different qualities of the available raw materials, the forms in which they occur and how they function when used may have influenced the tool maker's designs and the morphology of the tools. The experiments suggest uses for the tools that are relevant to our understanding of what is found on some archaeological sites.

Introduction

The terminology that the Palaeolithic archaeologist uses owes a great deal to the recent experimental manufacture and use of stone tools. Without experimental work we would not be able to suggest what tools might or might not have been used for. This experimental work is particularly important when we consider that virtually all our evidence for the technology and material culture of early hominids for about $1\frac{1}{2}$ Ma consists of stone tools and their *debitage* of manufacture.

Several 'common sense' rules have been set out by Coles (1973, pp. 15–18) that experimental work must follow if results are to provide useful information. These experiments, though they can never provide definitive evidence (except in conjunction with microwear analysis (see, for example, Keeley & Newcomer 1977), do suggest the possibilities or impracticalities of any given method of manufacture or suggested use of a tool, and provide a framework of suggestions within which the archaeologist can view his material.

In this paper it is assumed that efficiencies noted by myself during tool manufacture and use apply also to early tool makers. It seems reasonable to suggest that early tool makers must have 'balanced' their industry with raw material availability, time, and required tool performance, in short, that they arrived at some equilibrium with their environment (see Spier 1970). We already know how lithic industries can reflect a scarcity or abundance of raw materials by exhibiting 'wasteful' methods or intensive use and reuse of materials. They must reflect not only the stages in between these extremes, but other factors as well. A wasteful or inefficient approach that did not reach some equilibrium with its resources would presumably not have lasted very long. In looking at the archaeological record we inevitably see most clearly the long-lasting successes. The Developed Oldowan and Acheulean industrial complexes, for example, must have been efficient in this sense and in equilibrium with their environments, i.e. 'successful', to have lasted as long as they did.

Here I will describe some of my experiments involving tool replication and use. The original tools that served as models come from two sites in upper bed IV at Olduvai Gorge, Tanzania. The raw materials used (phonolite and basalt) were collected from the same sources as those used by early tool makers and, after much experimental work, the general 'style' of hand axes from each site was duplicated. All of the flaking to be discussed was carried out by direct free-hand percussion with a hammer stone. Drawing on the results obtained, I show several things: first, that the widespread use of terms such as 'crude' or 'refined' in describing stone tools tells us nothing of the technical level achieved by the makers of the assemblages; secondly, that the different qualities of the available raw materials, the forms in which they occur, and how they function when used, may have influenced the tool makers' designs and thus the morphology of the tools; thirdly, that the experimental work that I carried out suggests uses for these tools that are relevant to our understanding of what is found on some archaeological sites.

Figures 1 and 2, plate 1, show edge and side views of hand axes from WK and HEB in upper bed IV. The two specimens have very different basic morphologies: the tool from HEB is large, symmetrical, with straight edges, and shows flat flaking on each face. The WK hand axe has an unretouched primary flake edge, little secondary retouch of the main flake blank, and deep flake scars. A large number of the hand axes from WK incorporate primary flake edges in the finished tool. Secondary retouch of the tool blank (generally large flakes) is minimal and an average scar count for the WK sample is 10.5 per specimen (Leakey 1975). The HEB hand axes show extensive invasive secondary flaking and an average scar count for these tools is 20 (Leakey 1976). The WK hand axes are thicker in relation to their breadth and generally shorter than those from HEB.

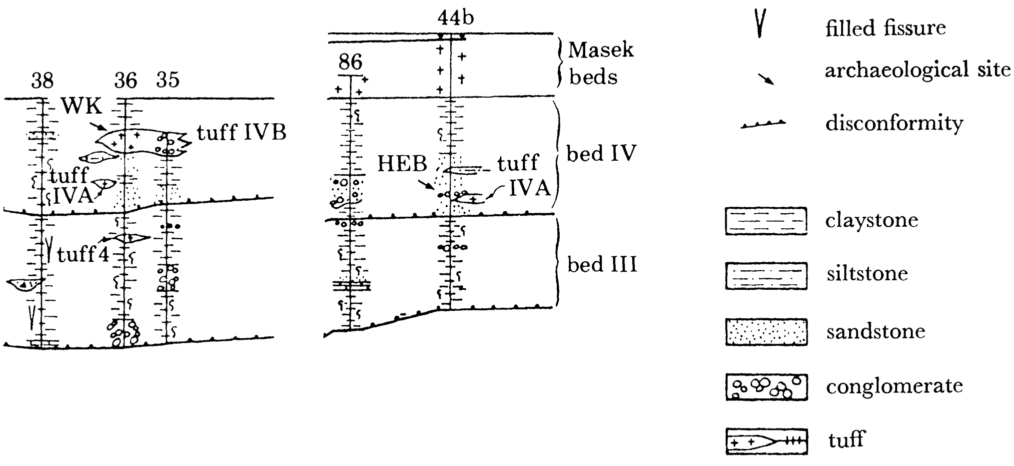

FIGURE 5. Stratigraphic relationship of sites WK and HEB. (After Hay (1976, fig. 41).

In short, the HEB tools appear more 'refined' than those from WK. Had they occurred in unstratified surroundings, the small basalt tools would almost certainly be considered the older on the basis of a general technical simplicity or 'primitiveness' that they seem to represent. In fact, as figure 5 shows, the HEB site occurs stratigraphically lower in the section than WK and is therefore the older of the two. I suggest that the thickness : breadth ratios, scar counts, retouched edges, and flat flaking are more a reflection of the qualities of the raw materials from which the tools are made than indicators of technological sophistication (Jones 1979).

In the course of my experimental work at Olduvai I duplicated the WK and HEB types of hand axe and used them for various activities. The following paragraphs discuss the differences between phonolite and basalt, both in their occurrence and their flaking properties, and show how these differences might have affected the tool makers' approach to each.

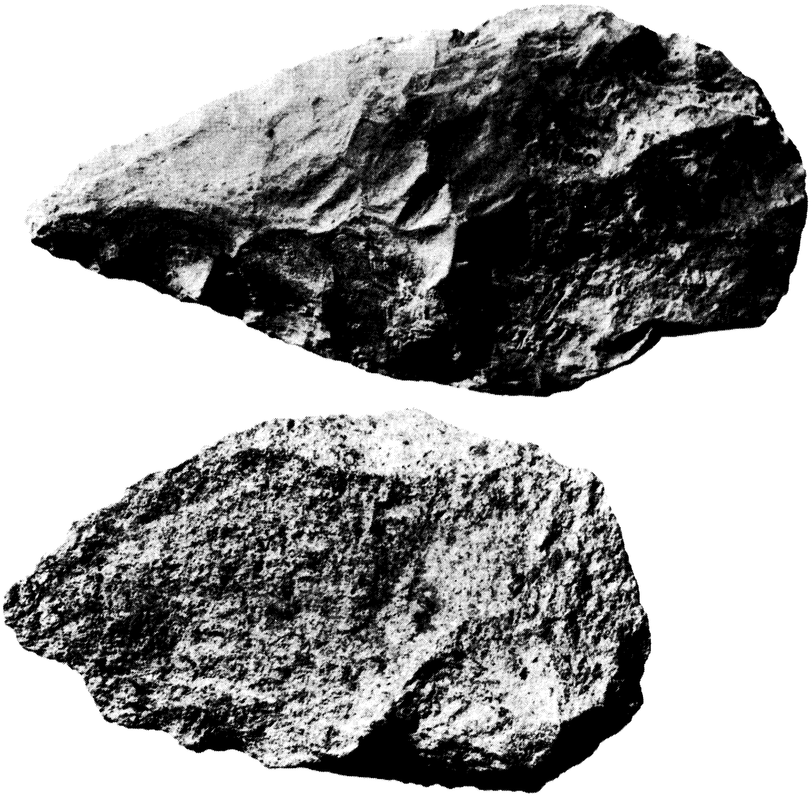

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FIGURE 1. Edge views of two hand axes from bed IV, Olduvai Gorge. The one on the left is made of basalt and from WK (total length 12 cm). The tool on the right is from HEB and made of phonolite.

FIGURE 2. The same two tools shown in plan view. Note the flat flaking on the phonolite tool on the right.

(*Facing p.* 190)

FIGURE 3. A basalt hand axe about 13 cm long, shown with the *debitage* of manufacture.

FIGURE 4. A phonolite hand axe made on a large flake shown with the *debitage* of manufacture. The tool is about 18 cm long.

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Occurrence of basalt and phonolite in the Olduvai area

Phonolite occurs on the surface at Engelosin (see figure 6 and Hay (1976)) in large blocks and slabs. Early tool makers generally made their tools on selected slabs or large flakes struck from blocks. The material is fine-grained, brittle and relatively easy to work.

Basalt was found by early tool makers in the form of large boulders and cobbles, from which flakes had to be struck as blanks for tool manufacture. These cobbles and boulders occur in seasonal river beds (figure 5), where the material has been deposited by river action as the waters came down from the volcanoes Lemagrut and Sadiman, south of the present gorge (Hay 1976). Although WK is very close to one of these channels, the tool makers would have had to go a considerable distance upstream to obtain boulders of the required size (R. Hay, personal communication).

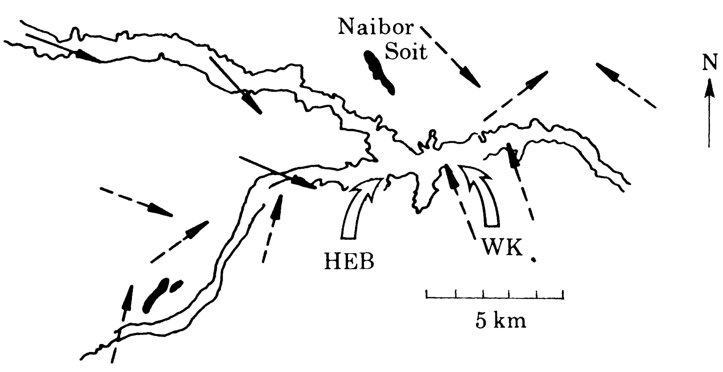

Figure 6. Map showing raw material sources and the drainage that brought basalt into the Olduvai area from the south. (After Hay (1976, fig. 64).) ——► Based on channel measurements; - - -► inferred on other grounds.

The removal of flakes from smooth, water-rounded cobbles is not easy and it took me a little more than a month to duplicate the results of the WK tool makers. The material is tough and the secondary hand axe trimming flakes are detached by large, swinging, follow-through blows.

Since the size and shape of these raw materials varies considerably at their sources and since the materials have very different mechanical properties, different techniques are required to make tools from them. Figures 3 and 4, plate 2, show experimental tools, together with *debitage* in each of these materials.

Further experimental work involved the use of the replicated tools for specific tasks. I have used tools of this type for wood-cutting and chopping and found that the cutting edges in both of these materials sustain so much damage in such a short time that I consider this an unlikely use for them. After some experimentation it became apparent that the main work for which these tools are suited is butchery. I have therefore concentrated most of my experimental work on this.

Butchery experiments

A more detailed account of my butchery methods and experiments has been published elsewhere (Jones 1980). Here I will briefly summarize the relative efficiencies of phonolite and basalt tools. Most of the butchery experiments were carried out on goats. Figures 7–9 illustrate some stages of the butchery experiments. My procedure was modelled on the traditional butchery methods used by the Wakamba workers at Olduvai. The various stages of goat butchery provide a good test of several of the qualities required of a butchery tool. These stages are: skin incision, skin cutting, skin removal, disjointing legs at the tops of the metatarsals and metacarpals, removal of intestines by sawing through ribs near the sternum and cutting belly muscle, and the final disjointing of limbs at shoulder and pelvis.

While using phonolite flake tools for butchery I found that the primary unretouched edges were sharp, brittle, and easily blunted. The retouched edge was stronger and a lot more work could be carried out with it. The phonolite biface of the HEB design could easily be resharpened by simply removing a second series of flakes from its edges.

The basalt primary flake edges are sharp, strong and not so easily blunted as phonolite. Basalt hand axes made in the style of those found at WK are small and difficult to resharpen. They are made on relatively small flakes and the retouched edges are not so efficient as those in phonolite.

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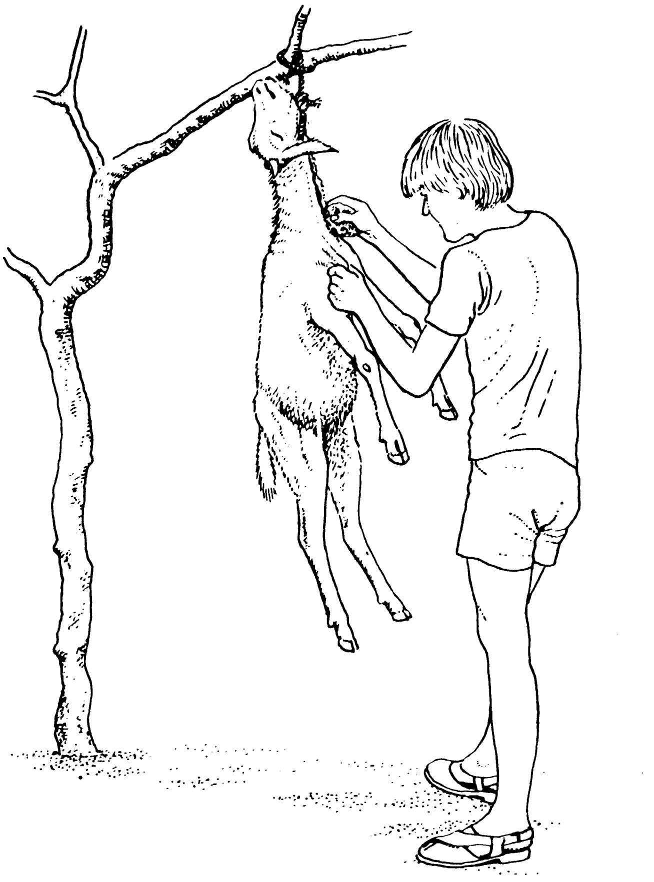

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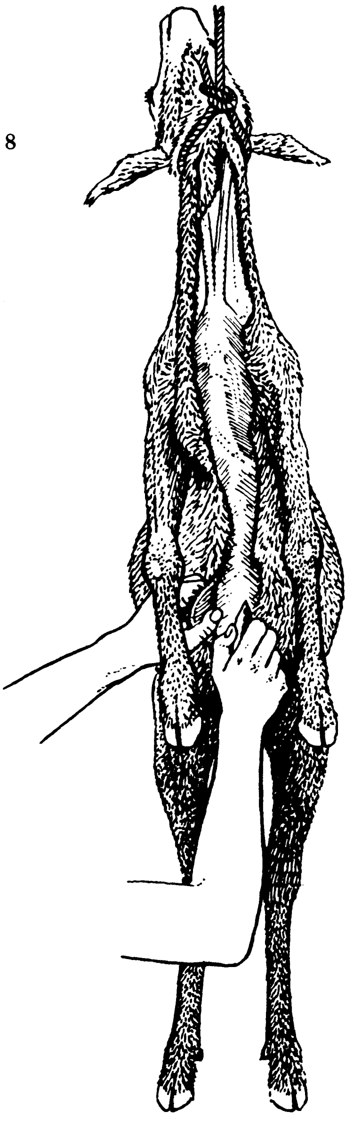

FIGURE 7. Experimental butchery followed the procedure used by the Wakamba workers at Olduvai (who use metal tools). The initial incision has been made with a flake and the skin is now being cut with a biface.

FIGURE 8. Showing the throat-to-tail cut that is the first stage of skin removal.

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In general it was found that hand axes have several advantages over the simple flake. In butchering a goat (let alone an elephant) many flakes are required, each having to be tightly gripped between thumb and forefinger (figure 10). The short cutting edge of a flake limits the amount that can be cut at each stroke. The hand axe, however, with its weight and bulk is easily held in the hand and requires less effort to use over a long working period (1–2 h).

Using basalt and phonolite tools of different designs for butchery gives us some practical reasons for designing a different type of tool in each of these materials. After extensive replication of WK type tools in basalt I found that making a hand axe from a flake would generally take less than 2 min; sometimes as little as 50 s. I also found that if I used a large flake as the tool blank it was possible to make a relatively thin, straight-edged hand axe, but then the manufacture time was increased to about 15 min and the result of this work was scarcely more useful, for butchery, than the 1 min product.

When working with phonolite it is not difficult to make a tool of the WK type, but we have already noted that the primary flake edges are quickly blunted when used for butchery and, if the tool has not been designed in the correct way, resharpening is not easily accomplished. It

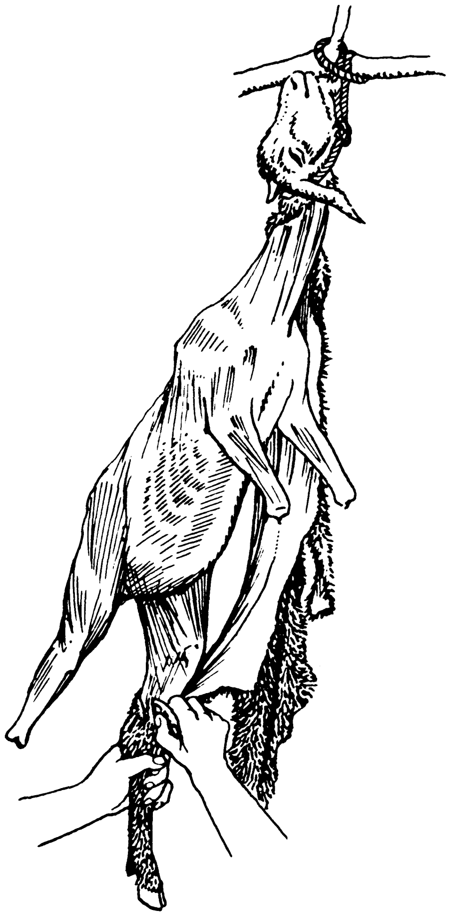

Figure 9

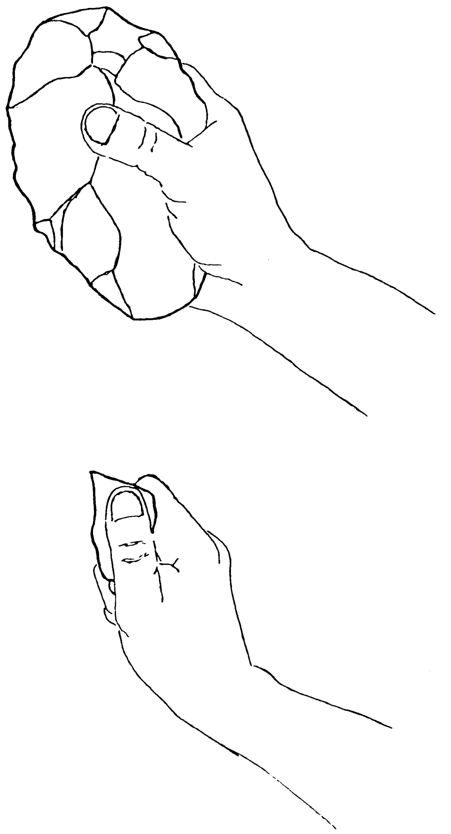

Figure 10

Figure 9. The skin is almost completely removed. Note how the lower parts of the limbs are removed with the skin.

Figure 10. Illustrating the ways in which a hand axe and a flake are held while being used for butchery. The hand axe has a longer edge and is more easily held than the flake.

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seems to me that a short manufacture time is being used at WK for the practical reason that tool efficiency can hardly be increased by spending more time on manufacture, the 'law of diminishing returns'. At HEB, where phonolite was used, the retouched edge is considerably more useful than the primary flake edge; resharpening is easily carried out, and it is therefore worth while to make a large tool of this design. In my experimental work, a tool of this type required about 5 min to make.

Thus we have two different raw materials with different mechanical flaking properties, different edge strengths, and that function differently when used. It seems that the early tool makers were making their tools accordingly.

The third major raw material that was used for hand axe manufacture at Olduvai was quartzite. At Naibor Soit (figure 6) this material occurs in slabs from which tools can easily be made. Fine retouch is not easy and flakes often shatter when struck. Quartzite is a versatile material and takes different stone-working techniques without difficulty. It is interesting to note that, whereas bifaces occur in many different raw materials in bed IV assemblages, small tools such as scrapers always occur in either quartzite or chert. The chert is strong, fine-grained and flint-like, but was of limited use to early tool makers because it occurs in small (10–15 cm diameter), irregularly shaped nodules (Hay 1976, p. 184). Simple scraping experiments involving scrapers of phonolite, basalt and quartzite show that, no matter what material is being scraped (bone, wood, or hide), the edge on the quartzite tool will last more than twice as long as edges on the other two. Here it was apparently not a matter of changing the tool design in materials other than quartzite; there was no point in making them at all.

Summary

The experimental manufacture of bifaces of the types found at WK and HEB has shown that the mechanical properties of the materials and the sizes and shapes in which they occur at their sources influence tool manufacture. The experimental use of these bifaces shows their efficiency for butchery and indicates practical reasons for the biface morphology in each material. Not only has it been found that hand axes are efficient butchery tools, but also that they are altogether better for this activity than other stone tools occurring within the same assemblages (Jones 1980). (See Clarke & Haynes 1970.)

Archaeological evidence from Olduvai bed IV shows that, though several materials were available for scraper manufacture, quartzite and chert were regularly and consistently used. Experimental manufacture and use show that edges in these materials last a great deal longer than those in any other material. Raw material appears not to have been so critical a factor where hand axes were concerned, since they are found in several raw materials at virtually every Acheulean site in bed IV.

It is clear that early tool makers were carefully considering the properties of the raw materials available to them.

Discussion: implications for Olduvai

It is now possible to examine the archaeological material at Olduvai in the light of these practical experiments. The developed Oldowan and Acheulean industrial complexes are seen to coexist at Olduvai for some 0.75 Ma. Various interpretations have been made: it has been suggested that the industries represent various seasonal activities of one cultural group in which different activities required different tool kits (Isaac 1976). Another view is that they represent two totally distinct cultural groups (Leakey 1975). In either case, I would suggest, on the basis of my experiments, that the assemblages classed as Acheulean are better equipped to carry out fast, efficient butchery of large animals. Indeed, on the understanding that these bifaces, made on large flakes, mark the most significant difference between the two industries (Leakey 1975), the activity that they seem to represent, heavy-duty butchery, may be suggested as the main activity difference. In Olduvai bed II the stratigraphy is sufficiently clear to enable R. L. Hay to observe: 'the known Acheulean and Developed Oldowan B sites appear to differ in their palaeogeographic distribution. Sites of the Acheulean industry, as defined by the percentage of bifaces, lie more than 1 km inland from the margin of the lake, whereas contemporaneous Developed Oldowan B sites tend to lie within 1 km. of the lake margin' (Hay 1976, p. 181). This could represent the different seasonal activities of one cultural group moving close to and then away from the lake at different times of the year. There are modern ethnographic examples of just this kind of seasonal movement, for example the Hadza, who live east of Lake Eyasi in Tanzania, generally remain within one small drainage basin but live in dispersed groups during the rainy season and regroup to live near the few water holes during the dry season (L. Smith, personal communication).

The evidence is also consistent with the two culture groups theory, each of them exploiting different parts of their environment. The 'Acheulean' groups, staying by rivers leading into the lake where shelter, water and associated vegetable foods are available, would also be near what were presumably open plains where large animal carcasses could be sighted and scavenged.

The geographical area with which we are dealing is small (a few kilometres squared) and presumably well within the daily range of early hominids. My experimental tool manufacture provides some other interesting information that helps to put the archaeological material into perspective: an Acheulean site such as WK with 146 bifaces (hand axes and cleavers) could easily represent the products of three tool makers working for a day.

I would like to thank Dr Mary Leakey for her encouragement and support while I was at Olduvai, Paul Sila, Kavevo Kimeu and Mwongela Mwoka for their assistance with my butchery experiments, D. Bygott for the drawings of goat skinning, and the Boise Fund of Oxford for financial assistance. The photographs in figures 1–4 were taken by J. Reader.

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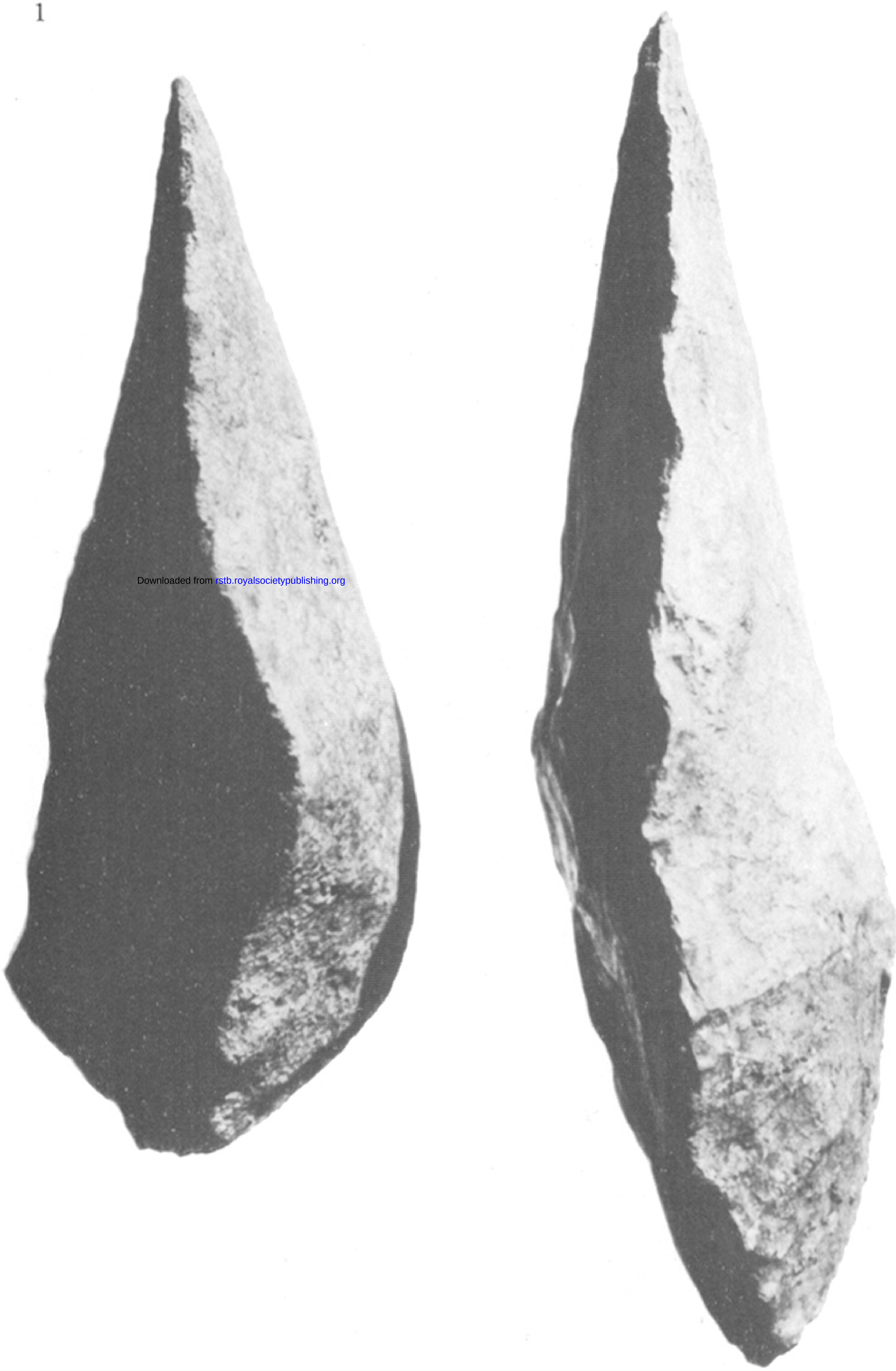

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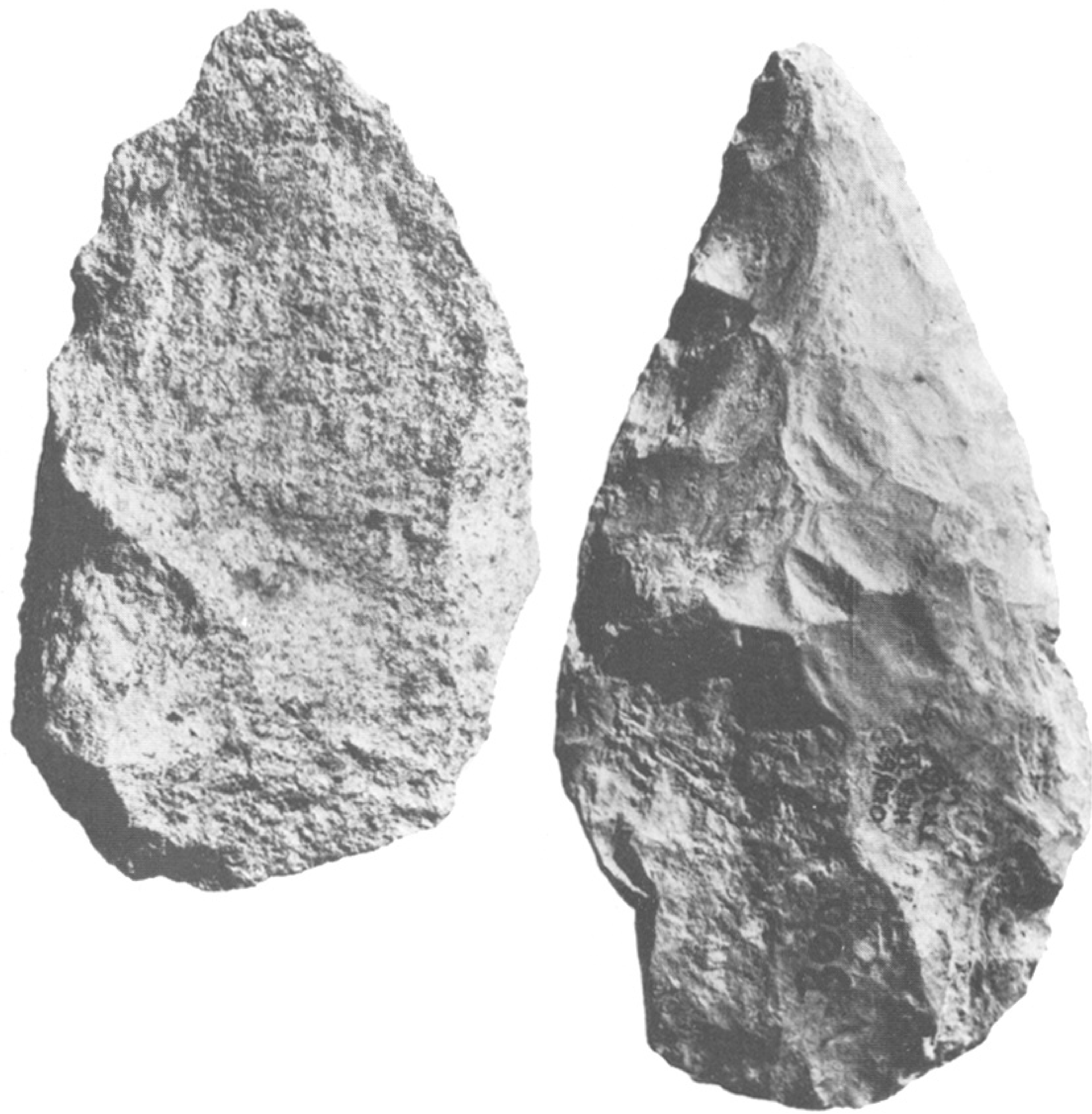

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