Palaeoanthropology

Stone legacy of skilled hands

James Steele

In 1964, Leakey, Tobias and Napier[1] added a newly discovered, smaller-brained, stone-tool-using hominid, now dated to 1.8-million years old (Myr), to the genus *Homo* (Fig. 1). They named the new species *Homo habilis*: 'handy man'. The stone tools of that earliest industry, the Oldowan (named after the Olduvai Gorge in Tanzania where *H. habilis* was found), were classified into distinct types that implied their makers had sophisticated technological know-how[2].

Subsequent work complicated this picture. Experiments in tool manufacture and use showed that the Oldowan tool kit was less organized than the original scheme implied[3]. There are now at least two other hominid species contending for the title of producers and users of the Oldowan tools, and the case has been made that none of these contenders currently assigned to the genus *Homo* is enough like us to merit the name[4]. However, new findings of very early stone tools west of Lake Turkana in Kenya, described by Roche *et al.*[5] on page 57 of this issue, show that their makers — whoever they were, and whatever name we give them — had surprisingly good control over their raw materials.

The archaeological site of Lokalalei 2C, close to the western margin of Lake Turkana, was excavated in 1997. It is dated to 2.34 ± 0.05 Myr, and consists of a dense concentration (about 10 m^2 in extent) of 2,067 fragments of worked stone, with smaller quantities of rather degraded animal remains. Another 516 artefact fragments were recovered by surface collection. Lokalalei 2C provides a high-resolution record of the activities of hominids who took stone cobbles, mostly of lava, and knapped them for sharp-edged flakes. By fitting the discarded pieces back together — up to 20 from a single cobble — Roche *et al.* show that these hominids had a high degree of control over the force, amplitude and precision of the hand movements required to detach flakes successfully and repeatedly from the parent core (Fig. 2). The knappers may also have appreciated the mechanical properties of their finer grained raw materials. No one has previously identified such skill so clearly in artefacts that are so old.

In 1991, the first late-Pliocene archaeological site at Lokalalei (Lokalalei 1), also dated to 2.34 ± 0.05 Myr, was excavated as part of the same programme[6]. Analysis of the stone tools found at Lokalalei 1 suggested they had been made by relatively unskilled hands. A plausible inference at the time was that these tools had been made at the very dawn of a tradition of flaked stone tool making[6], perhaps predating *H. habilis*[7].

Subsequent findings cast doubt on this view. By 1994, about 1,000 kilometres to the northeast in the Gona River drainage area in Ethiopia, stone tools had been excavated that could be dated to 2.5–2.6 Myr and that had clearly been made by hominids who had mastered the basic knapping skills[8]. Often several overlapping flakes had been removed in succession from the cores. Many flakes were well struck, showing that the makers understood the fracture mechanics of their materials. In 1994, in the adjacent Hadar drainage system, a jawbone similar to that of *H. habilis* associated with typical Oldowan stone flakes was recovered from a layer dated to 2.33 ± 0.07 Myr[9].

Roche and colleagues' findings[5] from Lokalalei 2C unequivocally show a good command of basic fracture mechanics, as applied to the raw materials used at this location. Let us not underestimate the difficulty of learning to execute rapid, precise, aimed movements of the arm and hand such as those needed for successful stone flaking. Wild chimpanzees in West African groups with cultural traditions of nut cracking using unmodified stone hammers take several years to become fully proficient at opening the nut without crushing its kernel. The effort is worthwhile: in the nut season, an adult female can obtain 3,800 calories per day this way[10]. Understanding, and exploiting, the fracture mechanics of stone itself to produce flaked stone tools adds a new level of complexity to such tasks.

So, which late-Pliocene hominid species could have made these early artefacts, and why? The answer must be found in the fossil traces of their hands and brains. Reconstructing what the tools from these very early sites were used for is frustratingly difficult. Roche *et al.*[5] found animal remains at Lokalalei 2C, including teeth and bones of grazing mammals, reptiles and fish. However, these remains are poorly preserved, show no tool marks, and may have accumulated at this stream-side location without hominid involvement. Tortoise bones and ostrich egg-shell fragments, found close to stone tools at Lokalalei 2C and 1, may be the remains of hominid meals, but this is an argument from association. We need infor-

Evolution

Heard but not seen

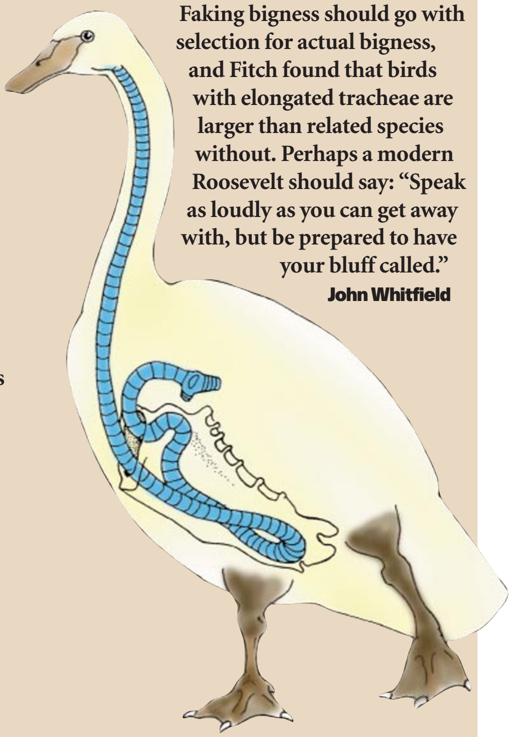
"Speak softly and carry a big stick", said Theodore Roosevelt. But a Darwinian might regard this as bad advice, as demonstrated by W. T. Fitch's explanation of the unusually long tracheae of some birds (*J. Zool. Lond.* 248, 31–49; 1999).

In at least 60 bird species — including the trumpeter swan shown here — the trachea is thrown into coils or loops instead of taking a direct route between the throat and the lungs. The trait shows a puzzling diversity: it is found in six avian orders, and has probably evolved several times. It occurs in migratory cranes and swans, and in large, sedentary rainforest dwellers such as currassows. Closely related species show large variation in trachea length. In some species, only the males possess elongated tracheae, whereas in others both sexes do.

Fitch argues that the best explanation is that a long trachea allows a calling bird to give an exaggerated impression of its size. This works through an acoustic process known as 'reduced formant dispersion': a call produced by an elongated trachea has more closely spaced resonant frequencies, producing a deeper, more baritone sound.

A common feature of birds with tracheal elongation is that they nest in dense vegetation, where visibility is poor, and where duplicating the call of a larger bird will be useful in defending a territory, or possibly attracting a mate. The lack of visual cues reduces the possibility that their trick will be discovered, but one would expect natural selection to promote scepticism in listeners. This might not happen, however, if honest calls remained in a sufficiently large majority. Faking bigness should go with selection for actual bigness, and Fitch found that birds with elongated tracheae are larger than related species without. Perhaps a modern Roosevelt should say: "Speak as loudly as you can get away with, but be prepared to have your bluff called."

John Whitfield



W. TECUMSEH FITCH

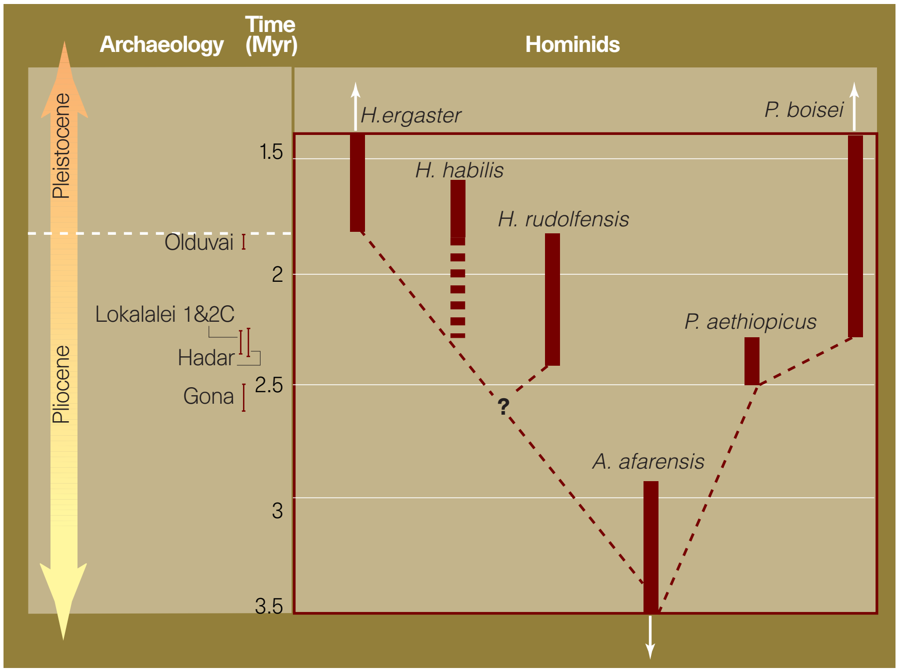


Figure 1 **Absolute ages of the archaeological sites described in the text, and of the hominid species extant in East Africa 3.5–1.5 million years ago (Myr). Dashed lines show probable evolutionary relationships. Olduvai, site FLKNN1; Hadar, site AL666. (Modified from ref. 16). New fossils from Ethiopia[17] may provide the missing link at the roots of the genus *Homo*, and date from 2.5 Myr.**

H. ROCHE/MPK

Figure 2 **'Refit' from Lokalalei 2C. Roche *et al.*[5] reconstructed the arrangement of sharp-edged flakes, used as tools, that were struck from a core stone. Scale bar is 10 cm long.**

mation from other sites, predating the two-million year mark, that have both stone tools and tool-marked bones, before reaching any firmer conclusions.

Meanwhile, no one is certain who wielded these tools. Using electromyography, Marzke and colleagues[11] identified the hand muscles crucial in the experimental manufacture of Oldowan tools. Habitual tool making would be reflected in the bones of the hand regions stressed by these muscles, and in joints whose configurations affect these muscles' biomechanical efficiency. The findings of Roche *et al.*[5] will prompt a renewed examination of fossil evidence for the evolution of hominid hands.

Manual dexterity in primates is also correlated with specific aspects of brain organization[12,13]. So far, the best quantitative measures of early-hominid brain organization relate to cranial capacity. This is a crude measure, but not useless[13]. The average cranial capacities of adult great apes range from 393 to 465 cm^3 (ref. 14). Hominid species living 2.5–2.3 Myr ago included early robust australopithecines (*Paranthropus aethiopicus*, cranial capacity about 410 cm^3), and the earliest *Homo* (with affinities to *H. habilis*, 500–650 cm^3, and/or *H. rudolfensis*, 600–800 cm^3; ref. 15). Thirty-five years on, can we emulate Leakey *et al.*[1], and place the tools at Lokalalei into the hand of *Homo*, using an argument from design?

The new findings[5] will not resolve this issue. But they bring such a resolution closer with hard evidence of the considerable technical skill of at least some late-Pliocene hominids. □

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Daedalus

Adhesive antibodies

Many alternative medicines are said to 'boost the immune system'. Few orthodox drugs can make this claim. (One possible exception, the veterinary anti-helminthic Livanisole, has discouraging side-effects). Daedalus has been pondering the matter.

Our immune system responds to an invading antigen by raising antibodies, which bind selectively to the antigen molecules. The bound molecules usually couple together in their turn to give a big, stable immunocomplex particle, easily recognized and swallowed by the body's scavenging macrophage cells. By contrast, the antibodies of a poor immune system may bind only loosely to the antigen, or fail to couple further. The resulting small or fragile agglomerations are far harder to mop up, and may cause trouble of their own. So Daedalus aims to tighten the binding, with some sort of selective molecular glue.

Chemists will immediately recognize this concept. Many substances crystallize only with 'water of crystallization'. The water molecules fill awkward gaps in the crystal lattice, giving a tightly packed and stable solid. Other small molecules can also work. With the aid of the right glue molecule, even the feeblest antibody might bind firmly to an invading antigen.

DREADCO's biochemists are finding this idea rather a challenge. Antibody–antigen binding is almost impossible to predict; furthermore, different species, or even different strains of the same species, can raise quite different antibodies to a given antigen. Indeed, says Daedalus, many quirky nostrums or remedies may occasionally work only because they contain some small glue-molecule that happens to fit the patient's individual antibodies. So his team is devising a 'cocktail' of small, polar molecules, to be injected into the body like a charge of shotgun pellets. With luck, one or more of them will act as glue molecules for the current antibodies.

Urea, DMSO, alcohol and acetone are obvious candidates, as are the more polar fluorohydrocarbons. Heavy water can influence protein folding; it, and deutero-versions of the other molecules, will also be included. In particular, Daedalus has high hopes of deuterohydrogen, HD. Its small size will let it sneak into tiny gaps in the binding, and its asymmetry will give it a bit of useful polarity. A deuterohydrogen breathing chamber could do wonders for an overburdened immune system. Sadly, the mixture with oxygen will be devastatingly explosive.

David Jones