sensitivity are applicable. However, gas concentration detectors of a variety of types coupled to the recording and integrating machines gives the method tremendous sensitivity. In spite of all this the instrument has to be calibrated with known substances. If, however, records of a known substance are, in fact, obtained then the mass spectrometer may have to be brought in for the purposes of identification. One of the by-products of these developments has been the scaling up of the technique as a tool for the preparation of samples of compounds of quite exceptional purity. Any help in improving the effectiveness of separation procedures is a continuing requirement in chemistry.

The instruments briefly described here are of a complex character and even for laboratory use may range up to £25,000 each. Perhaps I should therefore direct attention to true chromatography, which makes use of the simpler materials, is of great elegance, and can be quantitative when necessary.

Here again it is a matter of partitioning a substance between the stationary solid phase—a piece of filter paper—and a moving liquid phase in which the substance is dissolved. By virtue of the movement of the liquid across the paper, substances distribute themselves on the paper depending on the magnitude of the partition coefficient between the two phases. Even greater separation can be achieved by afterwards running another liquid at right angles to the motion of the first. If the substances are coloured the process can be followed visually, hence the name chromatography. If not, they can be made to react with reagents to develop colour, and thus can be observed easily. What is more, it is possible to label some of these substances with radioactive atoms and to scan a chromatogram by suitable radioactive counters to identify the positions of the materials used. Thus, we almost come back to sealing wax and string, for paper chromatography is not much removed from this in its basic simplicity. However, the signs are that although these extraordinary methods are basically simple it is not long before detecting tools are devised to make them more sensitive and more reliable.

In this short space I have tried very briefly to scan a vast field of chemistry and applied physics. There has been no opportunity to indicate the quantitative aspects of the situation and therefore to demonstrate just how much is now possible with these numerous advances. There is much talk about interdisciplinary research these days. There could not be a better demonstration of it than in this field. The advances made are due to real collaboration. The physicists have certainly invented the basic tools—it has been the groups of far-sighted chemists who have seized them with enthusiasm and explored them to the full.

FOSSIL HAND BONES FROM OLDUVAI GORGE

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In *Nature* of December 17, 1960, Dr. L. S. B. Leakey reported on the discovery of a number of fossil bones of the hand and the foot on a living floor some 20 ft. below the uppermost limit of Bed I, Olduvai. Later (*Nature* of February 25, 1961), Dr. Leakey reported the discovery of a mandible and two parietal fragments of a juvenile from the same site and associated with a well-defined living floor of an Oldowan culture.

Fifteen of the hand bones pertaining to at least two individuals, an adult and a juvenile, have been identified and examined, and are described here. Their allocation is given in Table 1.

Table 1

Juvenile		Uncertain age		Adult	
4 Middle phalanges	*I.U.*	1 Trapezium	*I.U.*	2 Proximal phalanges	*C.D.*
		1 Scaphoid	*I.U.*		
2 Terminal phalanges (fingers)	*C.U.*	1 Capitate	*C.D.*		
		1 Base of 2nd metacarpal	*I.D.*		
1 Terminal phalanx (thumb)	*C.U.*	2 Fragments of middle phalanges	*I.D.*		

C, complete; *I*, incomplete, *D*, damaged; *U*, undamaged.

The middle phalanges (Fig. 1, second row) from the juvenile hand, lacking only their epiphyses, constitute a series II–V from the right hand. They are robust bones, rather more so than phalanges of comparable length of juvenile *Gorilla* and adult *Homo sapiens*. They are strongly curved and, palmad, bear well-defined grooves which are situated in the distal half of the bone for the insertion of flexor digitorum superficialis.

The adult proximal phalanges (Fig. 1, third row) are also more robust than bones of comparable length in modern man; they are strongly curved both longitudinally and transversely, fusiform in shape and deeply hollowed out on the palmar aspect; sharply defined fibrous flexor sheath ridges extend from the base of the bones to their necks.

The terminal phalanges (Fig. 1, top row) which are juvenile, having incompletely fused epiphyses, are characteristically *sapiens* in form. The terminal phalanx of the thumb is of particular interest; it is stout and broad and bears a deep impression for the insertion of flexor pollicis longus.

The carpal bones (Fig. 1, 4th row) are all damaged, but sufficient of their original form remains to determine their structural and functional affinities. The lunate surface of the scaphoid has a rectangular outline; and the tubercle, which is broken off at its root, was probably somewhat elongated, though not as long as in the anthropoid apes. The trapezium has a well-defined saddle-surface but the evidence provided by the other articular surfaces indicates that its 'set' in the carpus was unlike that found in modern man and similar to the condition in *Gorilla*.

The capitate, though badly eroded, is generally more *sapiens* than ape-like.

Morphologically, the Olduvai hand bones cannot be closely matched with any known hominoid species living to-day. They bear, however, a greater similarity to juvenile *Gorilla* and adult *H.s. sapiens* than to adult *Gorilla*, *Pan* or *Pongo*. This is due largely to the absence in the fossil bones of any features peculiarly characteristic of brachiators. The adult

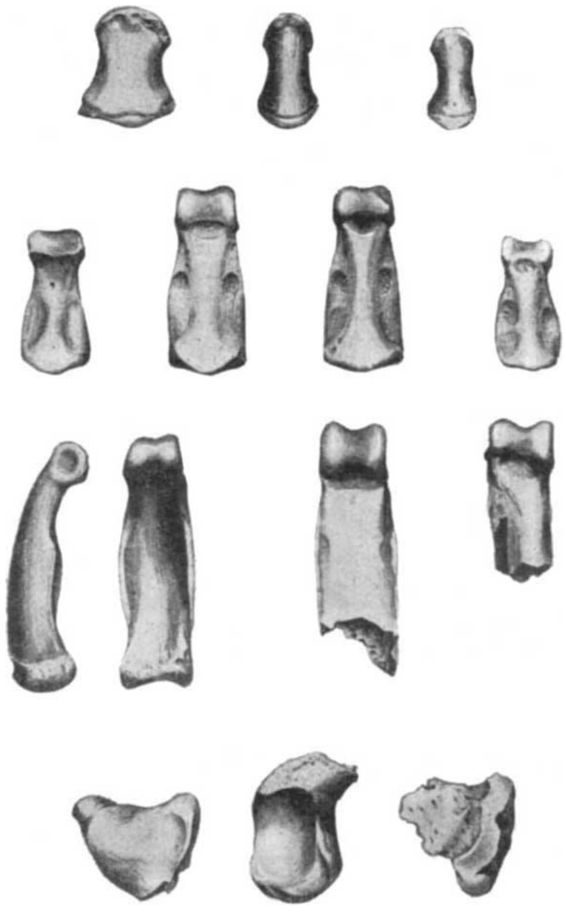

Fig. 1. Hand bone assemblage (drawings by Audrey Besterman). Top row. Juvenile. L. to R., terminal phalanx (thumb); 2 terminal phalanges (fingers). Second row. Juvenile. Middle phalanges, I–V. Third row. L. to R., proximal phalanx (adult), lateral and A.-P. views. 2 proximal phalanges (juvenile). Fourth row. Indeterminate age. L. to R. L. trapezium, L. scaphoid, L. capitate

gorilla hand has a number of specializations that are presumably related to its secondarily terrestrial mode of life and its great body-weight; these features, again, are absent from the fossil bone. The juvenile gorilla hand lacks the secondary specializations of the adult, and it is possibly for this reason alone that its bones have affinities with those of the fossil. The fossil bones differ from those of modern man in a number of features: (1) robustness; (2) dorsal curvature of the shafts of the phalanges; (3) distal insertion of the flexor digitorum superficialis; (4) strength of fibro-tendinous markings; (5) 'set' of trapezium in the carpus; (6) the form of the scaphoid; (7) the depth of the carpal tunnel. The fossil bones resemble modern man in the following features: (1) presence of broad, stout terminal phalanges on fingers and thumb; (2) form of the distal articular surface of the capitate; (3) ellipsoidal form of metacarpo-phalangeal joint surfaces.

There seems little doubt that this assemblage of fossil hand bones all belong to the same species. The difference between the juvenile and adult hand bones are no greater than the differences between the bones of an adult and a juvenile gorilla. In view of this conclusion that the two individuals on the *F.L.K. NN* 1 site are co-specific, all the hand bones are taken into account in the discussion of the functional and systematic implications of the hand as a whole.

While morphologically the precise affinities of the Olduvai hand are indistinct, functionally there seems little reason to doubt that the hand is that of a hominid.

The hand of modern man is capable of two basic prehensile movements that have been termed precision grip and power grip[1]. The power grip is used by man when a secure and strong grip is required for performing an activity in which the elements of delicacy and precision are of secondary importance. In the power grip the object is held as in a clamp between the flexed fingers and the palm, reinforcement and counter-pressure being supported by the adducted thumb. The precision grip, nevertheless, is used by man where a delicate touch and a precise control of movement is required and is achieved by means of a grip between the palmar aspect of the terminal phalanx of the fully opposed thumb and the terminal phalanges of the fingers. The essential osteological correlates of the precision grip are: (1) a fully opposable thumb with a broad spatulate terminal phalanx; (2) broad terminal phalanges on the other digits; (3) a proportion in length between thumb and digits that would permit a full pulp-to-pulp contact between them when they are approximated. While there appears to be little or no doubt that the Olduvai hand fulfils the first two requirements of the precision

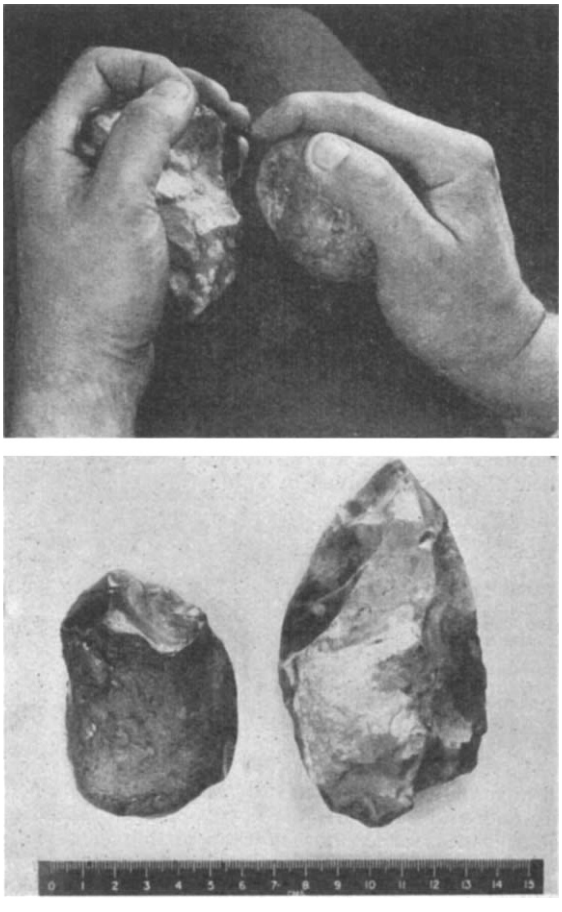

Fig. 2. Top, stone-on-stone technique of hand-axe construction using a power grip only. The flint core is being supported on the knee; bottom left, 'Oldowan' pebble-tool; right, 'Chellean' hand-axe made by me using the above technique

grip, there is no way to be certain about the last in the absence of the thumb metacarpal. While the saddle-surface of the trapezium leaves no doubt that the thumb could be rotated medially about its own axis to face towards the other digits, there is no reason for supposing that the proportions between the thumb and index finger of the fossil form are exactly as in modern man; indeed, the 'set' of the trapezium in the carpus suggests that this is not so. The question therefore is whether the thumb, having undergone rotation, is capable of pulp-to-pulp contact with the remaining digits. In the anthropoid apes while the thumb is opposable *per se*, pulp-to-pulp contact cannot be made owing to the marked disproportion of the length of fingers and thumb. It would seem, therefore, that the Olduvai hand was capable of power grip equal in performance, but, in view of the evidence of the attachment of the flexor tendons, comparatively greater in strength than in modern man. There is less certainty with regard to precision grip, which, while undoubtedly possible, may not have been as effective as in modern man. The overall picture presented by this assemblage is of a short powerful hand with strong, curved digits, surmounted by broad, flat nails and held in marked flexion. The thumb is strong and opposable, though possibly rather short.

At a recent conference at Burg Wartenstein, Austria, organized by the Wenner-Gren Foundation for Anthropological Research, an attempt was made to produce a diagnosis for the genus *Homo*. It was agreed that such a diagnosis could not be made unless certain characters and character complexes were present in combination. Included in these characters, which are referable to the skull, the brain and the post-cranial skeleton, was the criterion that 'the hand is capable of making tools of a recognizable culture'. If one assumes that the artefacts of an early Oldowan culture found on the living floor were the work of the species the remains of which are found there, then this criterion is fulfilled and, in addition, an interesting conclusion is possible: that toolmaking was established in the human lineage long before the hand had assumed its modern human form.

If, on the other hand, one bears the possibility in mind that some other, more advanced form was the toolmaker and the known incumbents of the floor were its victims, then it is in the functional morphology of the hand itself that one must look for evidence of toolmaking. On anatomical grounds there is no doubt that the Olduvai hand was sufficiently advanced in terms of the basic power and precision grips to have used naturally occurring objects as tools to good advantage. There is less certainty about toolmaking, which involves not only a peripheral but also a central intellectual factor as Oakley[2] has long insisted. The report on the Bed I juvenile skull fragments, soon to be published, may throw some light on this question by indicating the approximate cranial capacity of the juvenile skull.

Given the intellectual ability, the construction of the crude, rather small pebble-tools of the type found on the living floor, is well within the physical capacity of the Olduvai hand. Precision grip, which is imperfectly evolved in the fossil hand, is not an essential requisite at this level of craftsmanship as personal experiments in the construction of 'Oldowan' pebble-tools and 'Chellean' hand-axes have shown (Fig. 2).

[1] Napier, J. R., *J. Bone and Joint Surg.*, **38**, B, 902 (1956).
[2] Oakley, K. P., *Man the Toolmaker*, Fourth ed. (Brit. Mus. (N.H.) 1949).

THE BRITISH MUSEUM (NATURAL HISTORY)

NEW BOTANICAL EXHIBITION GALLERY

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THE title of Prof. L. Hogben's familiar book, *Science for the Citizen*, acts as a challenge to anyone concerned with the planning and execution of a museum gallery concerned with some branch of science. The purpose of this article is to place on record the basic considerations and intentions that have guided us in the preparation of the new Botanical Exhibition Gallery which is at least the third in line of succession in the British Museum. Very little seems to be known of the exhibition at Bloomsbury, where all the departments of the British Museum were originally concentrated. A photograph shows it to have been in keeping with the austere traditions of adult education that the more enlightened and liberal Victorians were encouraging. Learning was not to be taken lightly, or perhaps only by those fortunate enough to enjoy a university education. Its successor, which was established after the move of the scientific departments to South Kensington in 1881, came to a violent end on the night of September 9–10, 1940, when, during the course of an air raid, an oil bomb was dropped on the east wing of the Museum. Although disastrous damage occurred and many valuable scientific specimens were destroyed some good resulted as it initiated a replanning of the accommodation so that additional storage space for the scientific collections, together with a fine new exhibition gallery, were made available within the existing shell of the building. The old gallery was stacked with valuable information, but made few concessions to the lay visitor drifting rather aimlessly around the Museum on a wet afternoon. In addition, the passage of time left some exhibits misleading and incomplete, while some major aspects of modern botany remained unmentioned.

It is now our duty to present the credentials of our new venture. First, for whom is it intended ? The obvious answer is that for a national museum the whole population must be the target. This, however, is a drastic over-simplification; to attempt to make a uniform appeal to all grades of intelligence and education over the population would in our opinion be disastrous. Some selection must be made to direct the main impact of the Gallery on to a particular target. Rightly or wrongly we have chosen those taking Ordinary or Advanced Level Certificate of