thoroughly with water. The filtrate was slightly acidified with sulphuric acid and concentrated under reduced pressure.

After the removal of inorganic salts and acid-insoluble organic acids by filtration, the reddish-brown solution, adjusted to contain about 4 N sulphuric acid, was subjected to ether extraction for many days. The extract, composed mainly of polycarboxylic acids, was freed from ether by evaporating to dryness, and the reddish-brown solid was obtained, which was decarboxylated by the copper-quinoline method of Montgomery and Holly[3].

The distillate during decarboxylation was collected in ethyl alcohol, in which the presence of benzene was confirmed by its ultra-violet spectrum ; pyridine was also detected.

The dark-coloured residue from the decarboxylation was mixed with ether, filtered through a filter paper to remove insoluble materials, and washed with hydrochloric acid (1 : 1) and 5 per cent sodium hydroxide successively to remove basic and acid fractions, respectively. The neutral fraction was then freed from ether by evaporating to dryness, and after drying in a desiccator containing silica gel, dissolved in small quantities of carbon tetrachloride.

The carbon tetrachloride solution was chromatographed through an alumina column. By developing it with carbon tetrachloride, a yellow band moved down, giving at first colourless, then yellow filtrates. Development was continued until the yellow band passed through the column and the filtrate became nearly colourless. This filtrate was passed through a silica gel column. The top of the silica gel column (fraction 3) was stained strongly reddish-brown, the other part of the column (fraction 2) colourless, and a colourless filtrate was obtained (fraction 1). Fractions 3 and 2 were scraped separately, and eluted with ether.

Three fractions could be distinguished under ultra-violet light on the alumina column after development ; the upper layer (fraction 6) being dark brown in appearance and showing no fluorescence, the middle layer (fraction 5) yellowish brown and yellowish green fluorescence, and the under layer (fraction 4) grey and partly red fluorescence. These fractions were scraped out separately, and eluted with acetone. Fractions 5 and 6 were reserved for further investigation.

Fractions 1–4 were tested for aromatic compounds by examination of infra-red and ultra-violet spectra, besides routine organic analysis. The results obtained so far may be summarized as follows :

First it must be mentioned that yellow crystals were readily obtained from fractions 3 and 4 by evaporating the eluates. Needle-shaped crystals obtained by recrystallization from ethyl alcohol followed by sublimation were identified as anthraquinone, because its melting point was 285° C. and this was not depressed by mixing with authentic specimen, and the infra-red spectrum was identical with that of anthraquinone.

Fraction 1 was considered to be mainly composed of paraffins, but the ultra-violet spectrum showed small quantities of naphthalene derivatives to be present. In the case of Fuji humic acid, 2-methyl-naphthalene was confirmed by its ultra-violet spectrum and the melting point of its picrate (115–116° C.). The presence of naphthalene derivatives in fraction 2 was also presumed.

From these results, though very qualitative, it is reasonable to suppose that humic acids showing a higher degree of humification contain not only a benzene ring but also anthracene, probably in the form of anthraquinone and naphthalene rings.

Differences in the nature and properties of humic acids obtained from various soils may be explainable by the composition of their aromatic nuclei. Further investigations are proceeding.

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PSYCHOLOGY

Measuring Visual Constancy for Stationary or Moving Objects

If two objects of the same size are viewed so that one is twice as far from the eyes as the other, the retinal image of the farther object will be one-half the size of the image of the nearer object, but it does not appear half the size to the observer. They both appear almost the same size and the effect, which is due to perceptual interpretation of the retinal image, is known as size constancy[1,2].

In this method of measuring constancy of size, the eye is placed close to a small light-source which casts the shadow of an object (such as a flat disk) on a vertical screen. The angle subtended at the eye by the shadow will remain constant for any distance of the screen, but the shadow appears to expand as the screen on which it is projected is moved away from the observer. Other positions of the eye in relation to the source will produce size changes in the retinal image when the screen is moved. With the eye nearer the screen, the retinal image will contract (Fig. 1) ; with the eye behind the source it will expand. The degree of size constancy may be described in terms of the Thouless ratio, which is given by :

$$\log \frac{d_2 l_1}{d_1 l_2} \Big/ \log \frac{d_2}{d_1}$$

where d_1 and d_2 are distances of the screen from the eye when the shadow measures l_1 and l_2 respectively, the position of the eye being such that no size change is observed.

One can also measure constancy of shape, this being the tendency for a flat object to have a perceived

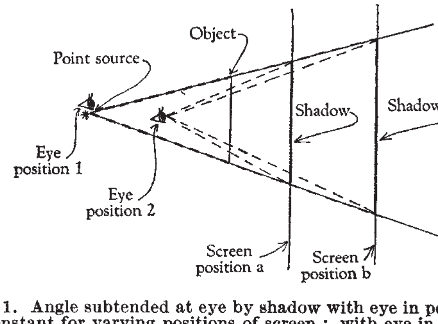

Fig. 1. Angle subtended at eye by shadow with eye in position 1 is constant for varying positions of screen ; with eye in position 2, angle subtended decreases as screen moves from position a to position b

shape corresponding very nearly to its normal projection ('normal' in the geometrical sense). If the screen is rotated around its vertical axis while the shadow-casting object remains stationary, the shadow appears to enlarge horizontally. Although the shadow on the screen changes shape, the retinal image is unaltered. The shape perceived is nearly that of the shadow viewed normally.

The magnitude of this effect can be measured, again using a null method, by arranging for a compensatory change of shape of the retinal image. This may be done by rotating the (flat) object. The screen and object may be linked to provide simultaneous rotations, their relative angles of rotation being adjustable. The magnitude of the effect may again be stated in terms of the Thouless ratio, which is given by:

$$\frac{\log P - \log S}{\log R - \log S}$$

where R is the ratio of the width of the shadow on the screen to its height, P the ratio of perceived width to perceived height (arranged to be constant and measured when the screen is normal to the observer), and S the ratio of the retinal width of the shadow to the retinal width when the screen is normal. If the angles subtended at the eye are small, the Thouless ratio is given by $\frac{\log \cos p}{\log \cos q}$, where p is an angle turned through by the object and q the corresponding angle turned through by the screen (Fig. 2), the relative angles of rotation being such that no change of shape is observed.

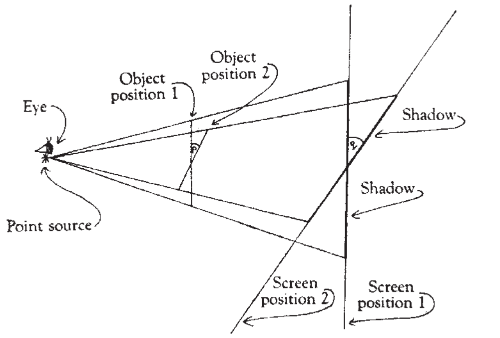

Fig. 2. With eye as close as possible to source, relative angles of rotation are adjusted until no change in shape observed

We are using this shadow method to investigate constancy during movement, which should be important in considering perceptual judgments involved in flying or driving. In particular we have tried to discover whether apparent movement due to constancy can be adapted. It is known that continuous presentation of real movement gives rise to an after-effect of apparent movement in the opposite direction[3]. The question here is: Can apparent expansion or contraction of the shadow produce an after-effect ? By projecting the shadow on a series of screens which move continuously away from the observer and are stopped after 1 min., we find that an after-effect does take place, though the retinal image of the shadow remains unchanged during the movement of the screens. During the movement the shadow appears to expand ; in the after-effect, it appears to contract. An after-effect of movement can thus be produced without shift of the image across the retina. Observation of the moving screens without the shadow does not produce the same after-effect of contraction of the shadow thrown on the screen now stationary, so the after-effect is not merely an induced movement, as described by Duncker[4].

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ANTHROPOLOGY

The Juvenile Mandible from Olduvai

Further to my report in *Nature* on February 25, p. 649, about the new discoveries of hominid remains in Bed I and Bed II at Olduvai Gorge, additional information can be given on the mandible of the juvenile from the site *FLK.NN*.I, at a horizon older than that of *Zinjanthropus*.

The third lower premolar (often called the first lower premolar by anatomists) is, in all the published Australopithecines, markedly shorter mesio-distally than wide bucco-lingually. The published figures for fully erupted lower third premolars of Australopithecines in South Africa include 14 from Swartkrans with indices ($100 \times L)/B$ ranging from 76·00 to 91·9 and a mean of 83·2. Kromdrai has only one reasonably preserved third lower premolar with an index of 83·2. Sterkfontein has only two good measurable examples published, which give indices of 77·8 and 76·8 respectively. Makapan has two measurable teeth, and the indices are said to be identical, at 88·4.

It is thus clear that, on the basis of the available published data (which are confirmed by my own observations on the original material at Pretoria and Johannesburg, which Prof. R. A. Dart, Prof. P. V. Tobias and Dr. J. T. Robinson kindly allowed me to examine), the third lower premolars of all known Australopithecine specimens are broader bucco-lingually than they are long mesio-distally. The index ($100 \times L)/B$ gives a range of 76·00–91·9.

In the juvenile hominid from the level below *Zinjanthropus* of site *FLK.NN*.I the measurements of the third lower premolars are as follows:

	Length	Breadth	Index
Left	11.00	9·5	115·8
Right	11·00	9·5	115·8

Thus, while all the published length–breadth indices of fully erupted lower third premolars of all *Australopithecus* and *Paranthropus* specimens are much less than 100 (that is, broader than long) and have a range of 76·00–91·9, the indices of the tooth in the juvenile hominid from the pre-*Zinjanthropus* level are greater than 100, being in fact 115·8.

Quite apart from this very clear measurable difference which puts the third lower premolar completely out of the known range of measurable