

somewhat in their spectroscopic properties. It may be found that the same statement is true of the visual pigments. If these pigments resemble haemoglobin in having protein prosthetic groups, it may be differences in the latter which bring about the changes in wave-lengths.

Here then are data obtained several years ago, by two methods on animals' retinas<sup>2</sup> and by two methods on humans' retinas<sup>3</sup>, which are in agreement, within experimental error, with this modern scheme suggested by Dartnall of an equal frequency difference series. That this could not possibly happen by chance is quickly proved by applying the same criterion to random wave-lengths, because when this is done no agreement is found to occur (see Fig. 4). When, therefore, Collins and Morton write "It follows that the evidence for a constant frequency difference is quite inadequate", the weight of evidence seems to be definitely against their view.

Now, if the facts presented in this and previous communications were the only evidence available, it would still appear to be sufficient to substantiate all the above statements; but, in fact, three additional pieces of evidence are available which have not so far been mentioned.

(a) It is possible in other ways to determine approximately the crest wave-lengths of the human receptors. Moreover, these wave-lengths are found to be in good agreement (1) with those quoted above which are given by the fixation point and the subjective colour methods, (2) with those found in animals, (3) with the retinal pigments as determined by Dartnall, and (4) with the constant frequency difference series.

(b) The shapes of the response curves both of human and of animal receptors resemble one another in being single hump curves. They also resemble the wave-length - optical density curves of the retinal pigments in the same respect.

(c) The spans (half-height widths) of the response curves both of human and of animal receptors do not differ much from one another. Nor do they differ much from the spans of the wave-length - optical density curves of the retinal pigments. It seems likely that further research will demonstrate conformity between the spans of the receptors of different wave-length and of the corresponding pigments.

Several other physiological points might be raised with regard to Collins and Morton's letter, but three only will be referred to here.

(1) They write, "As cattle are believed to have only rods in their retinas . . .". This belief is not supported by Sir Herbert Parsons in his book on "Colour Vision"<sup>4</sup>. He writes: "Greeff<sup>5</sup> says that there are rods and cones in the retinae of most mammals, . . . There are vertebrates possessing only rods . . . amongst mammals, hedgehog, bat, mole and nightape . . .". Thus cattle would have both rods and cones.

(2) Later on, Collins and Morton write: "as Hart-ridge mixes up eyes using vitamin A<sub>1</sub> and vitamin A<sub>2</sub> . . .". They are presumably referring to the fact that Dartnall worked on tench, whereas Granit worked on various animals—cats, rats, guinea pigs, snakes, frogs and tortoises—and I myself worked on human retinas, and that it seems likely that whereas some of these retinas contain vitamin A<sub>1</sub>, others contain vitamin A<sub>2</sub>. If that is their point, may I put the following questions to them? Is it true that the two types of vitamin A are mutually exclusive? Is it not a fact that both types have been found

side by side in the liver? If they can exist side by side in the liver, why can they not do so in the retina?

(3) Collins and Morton write: "Hartridge also states that the yellow pigment . . .". Now if my letter is read again it will be found that it does not contain this statement. What will be found is: "Evidence is to be presented elsewhere for the hypothesis that the yellow pigment . . .".

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<sup>1</sup> Dartnall, H. J. A., *Nature*, **166**, 207 (1950).

<sup>2</sup> Granit, R., "Sensory Mechanisms of the Retina" (1947).

<sup>3</sup> Hartridge, H., *Phil. Trans.*, B, **232**, 519 (1947).

<sup>4</sup> Parsons, J. H., "An Introduction to the Study of Colour Vision", 14 (1924).

<sup>5</sup> Greeff, "Graefe-Saemisch Handb. d. ges. Augenheilkunde", 1, 1, V (1900).

THE points raised by Dr. Collins and Prof. Morton and others will be discussed in a forthcoming paper.

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## TEETH OF FOSSIL PRIMATES AND MODERN APES

ONE of the major obstacles to the development of comparative odontology, especially so far as it bears on the problem of man's origin, has been the lack of objective criteria at the disposal of workers in the field of primate evolution. When in the early 'twenties a single fossil tooth from Nebraska, identified as that of an ape with certain human affinities, *Hesperopithecus haroldcookei*, was shown later to belong to a peccary, more than one notable anthropologist had reason to hang his head. Since then, the instructed public has been treated to a wide divergence of opinion among other specialists over the human versus ape-like qualitative features of the teeth of Peking man.

In such an impasse, the provision of material which enables less subjective comparisons to be made between the teeth of living anthropomorphous apes and contentious primate fossils is most welcome. Two joint studies by E. H. Ashton and Prof. S. Zuckerman, "Some Quantitative Dental Characteristics of the Chimpanzee, Gorilla and Orang-Outang" and "Some Quantitative Dental Characters of Fossil Anthropoids"\*, in turn furnish, according to a rigorously defined technique of measurement, the main absolute and relative dimensions of larger samples of the teeth of modern great apes than have hitherto been available, and then compare statistically the results obtained with the values published by the describers of some extinct primate forms.

Owing to the dubious validity of the sex that has been assigned (all too often with alarming unconcern) to individual, and particularly young, fossil specimens, their dental characters are in each case compared with those of both male and female contem-

\* *Phil. Trans. Roy. Soc.*, B, **234**: No. 616, "Some Quantitative Dental Characteristics of the Chimpanzee, Gorilla and Orang-Outang" (pp. 471-484, 5s.); No. 617, "Some Quantitative Dental Characters of Fossil Anthropoids" (pp. 484-520, 9s.). By E. H. Ashton and S. Zuckerman. (London: Cambridge University Press, 1950.)