LETTERS TO THE EDITORS

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A Photographic Method for the Study of Insect Migration

THE study of the migration of swarms of the desert locust (*Schistocerca gregaria* Forsk.) has involved the detailed analysis of the flight behaviour of the individual locusts constituting a swarm. Following Gunn *et al.*¹, it has been shown that by placing a camera on the ground with the lens pointing upwards, it is possible to obtain photographs of locusts flying in a swarm which are 'readable' up to the limits set by the lens, the shutter-speed in relation to the ground-speed of the locust, and the emulsion used. These photographs have been useful for determining the orientation of individuals and also, from the size of the images and of a sample of the locusts under observation, the area-density and volume-density of the flying locusts in the layer of the swarm resolvable by the camera.

A further development of this technique, using a camera modified to give two images of each locust on each negative separated by a known interval of time, has made it possible to record also the track and ground-speed of the individual locusts. By including in the field of view of the lens a wind vane, and also recording the corresponding wind-speed, the air-speed of the flying locusts can be estimated. An F.24 aerial survey camera was used, with a focal-plane shutter and a control unit (type 35) which can be set to give exposures automatically at any time interval between 3 and 50 sec. on a 100-exposure film in an interchangeable magazine. A modified shutter-blind was made with two $\frac{1}{8}$ -in. slits instead of one, at a distance of $1\frac{1}{4}$ in. from each other, giving at the appropriate tension the sequence 1/500 sec. exposure - 1/50 sec. interval - 1/500 sec. exposure. The interval of 1/50 sec. between exposures gave locust images usually separated clearly but not by too great a distance for the pairing of corresponding images. An electric counter of post-office type, recording the revolutions of an electric anemometer, was fitted to the camera in place of the usual clock recording system. With the automatic control taking photographs at known time-intervals, each photograph thus recorded the speed and direction of the wind as well as the course and track of each locust, for which both ground-speed and air-speed could be estimated. The material is still in course of analysis;

it has been found to provide evidence not only of the behaviour of the locusts but also of the fine structure of turbulent air.

I wish to thank Mr. L. Jackson, of the Williamson Manufacturing Co., Ltd., Willesden, for his co-operation in the manufacture of the shutters.

H. J. SAYER

Desert Locust Survey,
Nairobi, Kenya. Nov. 10.

¹ Gunn, D. L., Lea, H. A. F., *et al.*, "Locust Control by Aircraft in Tanganyika", Anti-Locust Research Centre, London, 1948.
Gunn, D. L., Perry, F. C., *et al.*, *Anti-Locust Bull.*, No. 3 (1948).

Genetical Effects of Radiations from Products of Nuclear Explosions

PROF. J. B. S. HALDANE's letter¹ on the genetical effects of radiation resulting from nuclear explosions raises the question of the relative dose-rates to man and to *Drosophila melanogaster* arising from natural sources of ionizing radiations. It appears to have been generally assumed that the background dose-rates to the gonads of all species are identical, whereas they are likely to differ considerably. The gonads of the *Drosophila*, for example, are exposed to both environmental β - and γ -rays, but those in most mammals are screened entirely from external β -rays and partly even from γ -rays. In Haldane's argument, deductions about radiation effects in *Drosophila* appear to have been carried over to the human case without allowing for this difference.

The suggestion that the radiation dose needed to double the human mutation-rate is a little more than 3 r. per generation is based by Haldane on the following arguments, set out in his Croonian Lecture²:

(1) "... it follows that human mutation rates are about twice those of *Drosophila* per nuclear division and about one two-hundredth of those of *Drosophila* per day."

(2) "It has been calculated that natural radiations and particles of high energy will account for only 0.001 of the mutations in *Drosophila*."

(3) "It is clear that if so they may account for about a fifth of those in man, and in view of the uncertainty of our knowledge as to the efficiency of particles from K40 and cosmic rays in producing mutations, and the different radiosensitivity of different genes, it is quite possible that radiation may account for most human mutation."

No reference is given for statement (2), but the result quoted is that given by Lea³, where the fraction 0.001 is deduced on the basis of the known number of mutations produced per unit dose in *Drosophila* and an estimated background dose-rate of 50 ionizations per c.c. per sec., or 2.2 mr. per day, giving 0.05 r. in the life-span of the fly. This dose-rate, given by Lea³ as a "generous estimate" based on the measurement of the natural leak of ionization chambers, must by its magnitude include ionization due to external β -radiation. By comparison, the background dose-rate which affects human soft tissues, including the gonads, is about 0.26 mr. per day⁴, amounting to the value usually quoted of 3 r. in thirty years. This is only one-eighth of the dose-rate used

Fig. 1. Part of double-exposure vertical photograph of desert locusts, mainly flying up-wind; wind-direction indicated by arrow on wind-vane; Feb. 15, 1955, Mito Andei, Kenya