LETTERS TO THE EDITORS

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Organs of Equilibrium in Flying Insects

IN a recent unpublished lecture to the Cambridge Natural History Society on analogies between insects and aeroplanes, Mr. J. W. S. Pringle pointed out that many insects lack inherent stability; equilibrium during flight being maintained by appropriate displacements of the wings. Their difficulties are greatest when only a single pair of wings is present. It is in such insects (Diptera, in which the forewings alone are functional, and Strepsiptera with functional hindwings only) that the reduced appendages are transformed into halteres. According to the hypothesis of Fraenkel and Pringle¹, the knobbed haltere serves as an organ of equilibrium. Vibrating in one plane it acts as an alternating gyroscope. If the insect is rotated so that the plane of vibration is changed, lateral shearing forces will be set up in the cuticle of the base of the haltere and will be perceived by the campaniform sensilla.

Fig. 1. *Sisyphus* AT THE MOMENT OF TAKING FLIGHT (AFTER V. Lengerken)

Fig. 2. TIBIO-TARSAL ARTICULATION OF *Sisyphus*. a, DELICATE HAIRS FROM TIBIA OVER BASE OF TARSUS

Fig. 3. DETAIL OF THE ROW OF HAIRS. THE ARTICULATED BASES OF THESE ARE SEEN THROUGH THE OVERLAPPING MARGIN OF THE TIBIA

At the same meeting, the Rev. C. E. Tottenham raised the question of those beetles which extend the hindwings alone during flight and keep the forewings folded to the back. Now v. Lengerken² has described how the beetle *Sisyphus* (which flies in this way), immediately before flight and probably during flight, applies the tibia of the middle pair of legs to a groove in the side of the thorax, and upon this rigid base sets the tarsus into intensely rapid vibration (Fig. 1). v. Lengerken regarded these tarsal movements as having a 'stimulatory' function. But in view of the hypothesis of Fraenkel and Pringle, it was interesting to see whether the legs of these beetles are provided with sense organs which might enable them to function as organs of equilibrium.

Through the kindness of Mr. Tottenham, I have been able to examine the legs of *Sisyphus schaefferi* L. and of *Geotrupes sylvaticus* Panzer (as an example of a related beetle which extends its forewings during flight). In neither beetle are campaniform sensilla particularly numerous around the joint. But in *Sisyphus* there is a straight row of some eight or ten delicate articulated hairs, very slightly serrated, extending from the tibia over the base of the tarsus on its outer aspect (Figs. 2 and 3). Hairs of this type are absent from *Geotrupes*. If these are indeed innervated hairs sensitive to touch (and it has not been possible to prove that on dried material), they are ideally placed to detect deviations in the oscillating tarsi, and so enable these to serve as organs of equilibrium analogous to the halteres.

Tactile hairs in the neighbourhood of articulations are well recognized as proprioceptive organs in insects^{3,4,5}. Similar hairs are

present on the posterior limbs of *Sisyphus* which, so far as is known, are not vibrated during flight.

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March 11.

¹ Fraenkel, G., and Pringle, J. W. S., *Nature*, **141**, 919 (1938).

² v. Lengerken, H., *Biol. Zbl.*, **54**, 646 (1934).

³ Demoll, R., "Die Sinnesorgane der Arthropoden, ihr Bau und ihre Funktion (Braunschweig, 1917).

⁴ Diakonoff, A., *Arch. néerl. Physiol.*, **21**, 104 (1936).

⁵ Pringle, J. W. S., *J. Exp. Biol.*, **15**, 467 (1938).

Photoperiodism in Jute

JUTE is one of the most important fibre crops of Bengal, and two species—*Corchorus capsularis* L. and *C. olitorius* L.—are under cultivation. They are generally sown between March and May and harvested during September–October.

With the recommended varieties D.154 of *C. capsularis* and Chinsura green of *C. olitorius*, a few experiments on the influence of daily light period on the flowering of the plants were made by growing them in suitable pots, and the mean of the dates of the first initiation of visible flower buds of twenty plants being taken as the flowering date in every case.

(1) *Effect of short photoperiods.* (i) Plants sown on April 20 were exposed to short photoperiods of 3 hr. less than the normal light period (which in Calcutta is 12 hr. 20 min. in April, gradually increasing to 13 hr. 27 min. in June and then decreasing gradually to 11 hr. 50 min. in October), two types of treatments being given: in one set the exposure to short photoperiods commenced when the seedlings were 5 days old, and in the second set when they were one month old. The results are given in Table 1.

TABLE 1

April 20.

Species	Control	Vegetative period in days					
		Short photoperiod treatments					
		Treatment I from 5 days after sowing			Treatment II from 30 days after sowing		
		From commence- ment of treatment	From time of sowing	Earli- ness in days	From commence- ment of treatment	From time of sowing	Earli- ness in days
<i>C. capsularis</i>	114.1	27.6	32.6	81.5	17.4	47.4	66.7
<i>C. olitorius</i>	125.9	22.8	27.8	98.1	14.4	44.4	81.5

Apart from unusually great earliness of 81.5 and 98.1 days in the first set and 66.7 and 81.5 days for the second set for *C. capsularis* and *C. olitorius* respectively, a noteworthy developmental change associated with the flowering is a great development of a branch near the apex of the stem giving the appearance of an apical split. All the plants show the split at flowering, and the early flowering plants on exposure to short photoperiods show the split when the height of stem is about 60 cm. for *capsularis* and 35 cm. for *olitorius*, against the total height reached by normally grown plants of 250 cm. and 300 cm. respectively at flowering. The short photoperiod flowering plants, therefore, remain dwarf and become bushy due to the great development of lateral branches.

(ii) In a second set the plants sown on March 31, 1945, were exposed to 10-hr. and 11½-hr. light periods. There was scarcely any difference in the flowering time, as seen in Table 2.

TABLE 2

March 31.

Species	Vegetative period in days	
	10 hr. photoperiod	11½ hr. photoperiod
<i>C. capsularis</i>	38	39
<i>C. olitorius</i>	24	23

(2) *Effect of long photoperiods.* To investigate the effect of exposure to long photoperiods the plants were grown off-season in October and March, when the natural light period is short and the plants have comparatively short vegetative periods.

(i) Sown on September 28, the plants were exposed to long photoperiods of 16 hr., light for the additional period being supplied from 100 c.p. bulb at a distance of 1 m. The untreated plants of *C. capsularis* and *C. olitorius* exposed to natural light periods (12 hr. to 11 hr. 20 min.) flowered in 36.4 and 26.4 days respectively, while those exposed to long photoperiods did not flower up to the tenth week, when the experiment was discontinued (Table 3).