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Light-on and Light-off Effects on the Circadian Flight Activity in the Mosquito *Anopheles gambiae*

A PRELIMINARY investigation of the flight activity of female *Anopheles* (*Cellia*) *gambiae* Giles (Lagos strain) fed on sugar has been undertaken using a modification of the recording technique described by Jones[1]. Groups of five or ten recently emerged adults were placed in a 'Perspex' walled chamber (*c.* 1·5 l.). This was placed in a sound-proof box in a constant temperature room, maintained at 24°–26° C. The mosquitoes were supplied with a small quantity of 15 per cent glucose solution with a cotton wool "wick", which also served to maintain a relative humidity in the chamber of 65–85 per cent. Artificial lighting (150–200 lux) was used during both the rearing and experimental periods, and the light régimes were controlled with a simple time switch. Flight activity was recorded acoustically for periods of up to 1 week, and a direct record of the activity was made with a pen marker on a kymograph with a continuous paper roll attachment. A similar recording "channel", without mosquitoes, was used to record any unwanted acoustic or electronic interference which was loud enough to operate the pen markers.

Groups of females subjected to alternating periods of 12 h light and 12 h dark had periods of intense activity lasting about 20–30 min following both the light-on and the light-off signals. They were inactive during the remainder of the light period, but were usually active in 'bursts' throughout the dark period. A 2 h dark period included in the first 9 h of a 12 h light period produced no response. If the light was switched off 3 h early, there was no immediate increase in activity, but the insects became active 1–2 h earlier than usual. If the light was switched off 6 h late, the onset of activity was delayed until the light was switched off.

There was no obvious cyclical pattern of activity in mosquitoes kept in constant light throughout their life, but cyclical activity with a period of about 23 h followed a change to constant dark. The active part of the cycle lasted about 12 h and the first period of activity started with the light-off signal. It is not clear from these findings whether the change resulted from the synchronization of the individual cycles which were previously out of phase, or whether the cycle was started by the change from light to dark.

The light-on and light-off responses differed in their respective latencies. Light-on activity usually started within a few seconds of the signal, whereas the onset of light-off activity was delayed usually for 1–5 min.

It would seem from these results that the pattern of flight activity is controlled by an endogenous rhythm similar to that which controls oviposition and sugar feeding in other mosquitoes[2–4]. The cycle has a free-running period in the dark of less than 24 h and light appears to have an inhibitory effect on activity. Thus, in alternating light and dark, activity is synchronized with the external régime by the delaying effect of light. Eyles and Bishop[5] have observed that egress of *Anopheles quadrimaculatus* from their resting places at sunset can be prevented by artificial illumination. The cycle is not immediately responsive to light-off signals given 3 h or more earlier than usual. The latency of the light-off response and the similarity with the results of other work[6] suggest that a hormonal mechanism is involved[7] and that light acts by inhibiting secretion. The speed of the light-on response suggests that it is mediated directly by the nervous system and may be a "startle" reaction to the sudden switching on of the light. Pre-adaptation of the insect to the dark may be an important constituent of this reaction.

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M. D. R. JONES
M. G. FORD
J. D. GILLETT

Department of Biology,
Brunel University,
London, W.3.

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