LETTERS TO THE EDITORS

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Temperature Acclimatization in Insects

AMONG the voluminous literature on temperature and poikilothermal activity, an occasional paper is found dealing with temperature acclimatization. The majority of work has been carried out with fish.

With respect to insects, Mellanby^{1,2} showed for a number of species that their activity at low temperatures was modified by their previous thermal history, thus indicating that insects became acclimatized to temperature. Thermal acclimatization experiments have been carried out with the German cockroach, *Blattella germanica* L. and some of the experimental evidence is presented below.

The relation between acclimatization temperatures and activity at low temperatures above freezing is shown in Fig. 1. It is evident that insects kept at 15° C. are able to remain active at temperatures at which others from 25° C. and 35° C. are immobilized by cold. Acclimatization to cold is not an unlimited process, which is illustrated in Fig. 2, where cold immobilization or 'chill-coma' temperatures are plotted against their corresponding acclimatization temperatures. The 'chill-coma' temperature of *B. germanica* acclimatized at 10° C. is the same as for those acclimatized at 15° C. This suggests that acclimatization is only possible within a certain temperature-range.

Fig. 1. Relation between acclimatization temperatures and activity at low temperatures for males of *B. germanica*

Fig. 2. Relation between 'chill-coma' temperatures and acclimatization temperatures for males of *B. germanica*

Experiments have also been carried out on survival at 7° C. of *B. germanica* acclimatized at 35° C., 25° C. and 15° C. Insects from 15° C. lived longer than those from either 25° C. or 35° C.; the 35° C. group died most quickly. This implies that much of the previous work on cold-death points at temperatures above freezing is invalidated. The cause of death at low temperatures is unknown, but insects immobilized by cold for a given period showed signs of a nervous disturbance which was not reversible.

This and other phases of the work will be published more fully elsewhere.

E. H. COLHOUN

Sub-department of Entomology,
Department of Zoology,
University of Cambridge.

¹ Mellanby, K., *Proc. Roy. Soc., B*, 127, 473 (1939).

² Mellanby, K., *J. Animal Ecol.*, 9, 296 (1940).

Acclimatization and the Thermal Death Point in Insects

INSECTS, like other cold-blooded animals, are active over a range of temperature, limited below by the chill coma point, and above by the heat coma point (closely related to the thermal death point, that is, the upper lethal temperature, for they cannot recover from long periods of heat coma). On the whole, the heat coma point is higher for insects from warm regions, and the chill coma point is lower in those from cool regions.

The chill coma temperature can be readily altered. I showed some years ago that in a number of species exposure for as short a period as 24 hr. to warmer or cooler conditions within the normal range will modify the chill coma point substantially, in some species by as much as 7.5° C.^{1,2}

I now find that the heat coma point and the thermal death point can similarly be rapidly changed by keeping insects at different temperatures for periods of only 20 hr.; longer exposure gives no further adaptation. Thus, in the mealworm, *Tenebrio molitor*, larvae from cultures kept at 37° C. for 24 hr. have a thermal death point, for a one-hour exposure, of 44° C.; those kept at 30° C. or below have a thermal death point of 42° C. The results for larvae of the mosquito *Aedes aegypti* are very similar. Two facts are apparent when these results are compared with the low-temperature experiments: (a) the range over which the thermal death point can move is much smaller than that over which the chill coma temperature can be changed; (b) substantial changes in the thermal death point are caused only by previous exposures to temperatures towards the top of the range over which the insects can survive, whereas low-temperature adaptation occurs over the whole range.

Insects acclimatized to high temperatures thus survived exposures which killed unacclimatized insects. It was noticed, however, that they did not continue their development and moult or pupate at the same time as unheated controls. It seems that sublethal exposures to heat may destroy the internal secretions which control these processes. I showed³ that if the blow-fly larva *Lucilia sericata* is kept at a high temperature for several days it goes into diapause, while controls pupate. Wigglesworth⁴ has similarly shown that at temperatures above the optimum the bug *Rhodnius prolixus* does not moult.