was unable to discover whether these two hormones were separate in their mode of action or whether they formed parts of an integrated system which resulted in the visible coloration. Evidence from the albino strain shows that, despite the absence of black pattern, the background colour shows the same phase changes as in the normal strain. This supports the two-hormone hypothesis and appears to indicate that the two factors can be separated. It is hoped that the albino strain can be used for clarifying further the physiology of phase coloration; living material would be willingly supplied to research workers who may be interested.

The albino strain has now been bred to the *F*₇ generation without the appearance of any individuals of the normal type and without any loss of vigour. Crosses between albino and normal adults show a Mendelian pattern of inheritance, in which albinism is recessive.

I wish to thank Mr. R. D. MacCuaig for his kindness in sending me the twelve original albino hoppers.

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Sclerotization and Melanization: Two Independent Processes in the Cuticle of the Desert Locust

CONSIDERABLE advances in our knowledge of sclerotin formation in the insect integument have been accompanied by little progress in our understanding of melanin formation. This seems to be due to confusion between the two processes of sclerotization and melanization.

The cuticle of the last nymphal instar of the desert locust, *Schistocerca gregaria* (Forskål), is pale and not amber-coloured, although, like that of the cockroach *Periplaneta*¹, it appears to be phenolically tanned. It contains melanin only in well-defined patches. A critical study of melanin formation in this cuticle has led to two important conclusions. First, melanization and sclerotization are two independent processes, as was suggested by Goodwin². Each appears to involve its own copper-protein phenolase. Secondly, the two processes are consecutive in the melanized areas, sclerotization being delayed until melanin formation has been completed. Hitherto it does not seem to have been unequivocally shown that darkening of an insect exoskeleton may not be accompanied by tanning.

In the soft cuticle newly exposed on moulting, a copper-protein phenolase occupies the entire thickness of the presumptive exocuticle (*A*, Fig. 1). This enzyme appears to be identical with that responsible

Fig. 2. Albino nymph

for hardening in the cockroach ootheca³, in the puparium of *Sarcophaga*⁴ and in the cuticle of *Periplaneta*⁵. That it is indeed concerned with hardening is indicated by its absence from the arthrodial membranes, which remain soft throughout the instar. A similar, but more highly reactive, phenolase (*B*, Fig. 1) occupies only those regions of the exocuticle in which melanin is destined to be formed. Attempts to distinguish critically between the two enzymes have been only partly successful. Both activate the same substrates, but differ in the intensity of their action and in the extent to which they are inhibited by the usual phenolase inhibitors.

Closely correlated with this difference in enzyme activity is the distribution of phenolic material in the epidermis at the onset of the hardening process. In unpigmented areas, strongly reducing material (*C*, Fig. 1) accumulates in the epidermal cells and may represent diphenolic compounds. In pigmented areas, on the other hand, no such material is apparent in the epidermal cells. It is remarkable that the cuticle, at the same developmental stage, is itself slightly argentaffin only in the unpigmented areas. Elsewhere it is not argentaffin, but becomes so after melanin formation has been completed.

The reason why melanin is not formed in the cuticle of the albino strain of the same species of locust⁶ may now be referred to. Surprisingly, the highly active phenolase concerned in melanin formation is not lacking (*B*, Fig. 2), but is uniformly distributed throughout the outer zone of the presumptive exocuticle. Nor are diphenols absent from the cuticle, for I have extracted from the exuviae of albino nymphs the same diphenols (including protocatechuic acid and dihydroxyphenylacetic acid) as from the cuticles of the normal strain. But reducing substances accumulate at the onset of hardening throughout the whole epidermis of the albino locusts (*C*, Fig. 2), just as they do in non-melanized areas of the normal strain, and it may be suggested that failure to form melanin, whether in the pale areas of the cuticle of normal nymphs or in the whole cuticle of albinos, may be due to the withholding by the epidermis of the necessary chromogen.

These observations were made during an investigation into the cuticle of the desert locust carried out at the University of Manchester and supported by the Anti-Locust Research Centre. A full report is being prepared.

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Fig. 1. Normal nymph