THE INFLUENCE OF THE COMPOSITION OF EXPERIMENTAL GROUPS ON CASTE DEVELOPMENT IN ZOOTERMOPSIS (ISOPTERA)

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Springhetti (1969, 1970, 1971) has produced evidence that the presence or absence of certain castes in homogeneous groups of Kalotermes flavicollis has a marked influence on the development of the larvae, pseudergates or nymphs. Besides the well-known inhibitory influence of reproductives on the development of replacement reproductives it was found that reproductives also inhibit alate development and that they stimulate presoldier differentiation. Soldiers, on the other hand, stimulate replacement reproductive development, but inhibit the formation of presoldiers. Based on these findings and on our histological and experimental evidence we have suggested that reproductives might produce and give off juvenile hormone and that soldiers then possibly give off an anti-juvenile substance (Lüscher 1972). In connection with the recent data on the action of juvenile hormone analogues in Zootermopsis (see Wanyonyi and Lüscher, this volume) it was of interest to study the effect of soldiers and reproductives in the two species Z. angusticollis and Z. nevadensis. Moreover it seemed of interest to study the effect of group size, which in Kalotermes is negatively correlated with regressive development (Lüscher 1952). In Z. angusticollis broad headed larvae occur which are much larger than the nymphs with wing pads and which probably develop into soldiers and replacement reproductives only. It was to be expected that these forms could also influence the development of larvae and nymphs. They will be referred to here as pseudergates, although they do not entirely fit into the definition of this term.

The experimental colonies were set up during a collecting trip to Pacific Grove, California. By using termites collected directly in the field at the end of March 1972 we had the best chance of setting up really homogeneous groups, in which the last instar nymphs were the same in respect of age in relation to moulting. The most important results were obtained with last instar nymphs. We shall therefore only report these experiments in this paper.

The experimental groups were observed daily and the moulted individuals were marked with spots of nitrocellulose paint. Newly produced alates and replacement reproductives were removed so that they could not themselves influence the further development of the nymphs. The experiment was continued until all nymphs had moulted.

The comparison of the development of nymphs in colonies of 120 and groups of 30 individuals revealed a striking difference in the rate of imaginal and stationary or regressive development. In the large groups a high proportion of the nymphs developed into alates, while in small groups more stationary and regressive moults occurred and in some cases there was a striking retardation of the moults, especially in Z. nevadensis.

All other groups were set up with 30 nymphs. Added to these were 4 replacement reproductives, 3-5 soldiers, 4 reproductives together with 3 soldiers and finally, in Z. angusticollis only, 10 pseudergates.

Replacement reproductives had, in both species, an inhibiting effect on alate production, while soldiers stimulated alate production. If reproductives and soldiers were present together, no effect could be observed. Pseudergates had the same effect as soldiers in respect to alate development.

Replacement reproductive development was observed only in Z. angusticollis. Soldiers did not seem to have an influence on this development, but it was inhibited as expected by reproductives. It was also inhibited by pseudergates, but this may have been due to the fact that an average of 7 out of 10 pseudergates moulted into replacement reproductives and may, as such, have exerted an influence before they were removed.

Since juvenile hormone may also have a moult-inhibiting or moult-retarding effect (Wanyonyi and Lüscher, this volume), it was of interest to see where such moult-retarding effects could be observed. In Z. nevadensis a significant retarding effect was exerted by reproductives. Soldiers showed in both species a moult-accelerating effect, but the influences were nil when both soldiers and reproductives were present.

Our results confirm the findings of Springhetti in respect to the inhibitory action of reproductives on alate and on replacement reproductive development. The action of reproductives in promoting soldier development could not be demonstrated in Zootermopsis, probably because, in our species, the rate of soldier production is generally very low and especially so in nymphs of the last instar. Rare presoldier moults were however observed, so that this developmental step can now be added to the developmental scheme given by Miller (1969).

The actions of soldiers on replacement reproductive and on soldier development, which Springhetti has demonstrated in Kalotermes, could not be confirmed for Zootermopsis.

Our results seem to indicate that in Zootermopsis the reproductives have in several ways the same effect as juvenile hormone and that soldiers have an opposite effect. The following table summarises our results and those of Springhetti in respect to juvenile hormone (+) and anti-juvenile hormone (-) effects.

Juvenile hormone effect	Caste	Z. angusticollis	Z. nevadensis	Kalotermes
Moult inhibition or retardation	reproductives	+	+	
	soldiers	-	-	
Inhibition of replacement reproductive production	reproductives	+		+
	soldiers			-
Inhibition of alate production and induction of regressive moults	reproductives	+	+	+
	soldiers	-	-	-
	pseudergates	-		
Stimulation of presoldier production	reproductives			+
	soldiers			-

It can now be stated, that all effects of juvenile hormone with the exception of the prothoracic gland degeneration effect, can be mimicked in some or in all species of termites which have been investigated, and that generally the soldiers have an opposite action to the reproductives.

Our results therefore offer new evidence for our earlier postulate that reproductives may give off juvenile hormone and that soldiers and possibly the large pseudergates of Z. angusticollis have the opposite effect. This antagonistic effect could be explained by the production of an anti-juvenile hormone or by the possibility that these castes take up and metabolize juvenile hormone more rapidly than larvae and nymphs.

It remains now to be demonstrated that juvenile hormone is in fact given off by reproductives.

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