THE THERMAL DIFFUSIVITY OF THE ORGANIC MATERIAL OF A MOUND OF FORMICA POLYCTENA FOERST. IN RELATION TO THE THERMOREGULATION OF THE BROOD (HYMENOPTERA, FORMICIDAE)

by

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SUMMARY

The thermal diffusivity of the organic material of a mound of the red wood ant (Formica polyctena Foerst.) in its early stage of development is estimated and compared with the thermal diffusivity of the surrounding sand.

It is shown that it is the structuring activity of the ants that gives the mound its typical thermal property. By the construction of the mound the ants primarily generate a temperature-gradient during the day that provides them with better opportunities for the selection of the optimum temperatures of the various developmental stages of the brood, especially the pupae, than by nesting in the sand.

The importance of the position of the mound in relation to the surrounding vegetation is discussed in view of the shading effect.

INTRODUCTION

The constant and high (25–30°C) temperature of the nests of the red wood ant is already known for a long time (cf. the compilations of the literature by KNEITZ, 1964 and WILSON, 1971). During a student course of the ecology department I started measurements of the temperature in a nest of Formica polyctena with the intention to demonstrate this constancy. We did not succeed however: the temperatures inside the mound were fluctuating with even greater amplitudes than we measured in the surrounding sand at the same depths.

From these variations of the temperature we were able, by the application of physics with certain simplifications, to determine and compare the thermal diffusivities of the mound and of the surrounding sand, which implies a tremendous reduction of the many measurements. This can be seen as the physical interpretation of the construction of the mound.

It will be shown that from our observations of the circadian temperature rhythm we come to the same biological conclusions as those

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that are derived from the seasonal variations of the temperatures inside the mounds of *Formica ulkei* observed by Scherba (1962): “The mound temperatures not only average higher than those in the surrounding soil, they also vary with depth, providing a gradient along which the ants distribute the various developmental stages according to their particular temperature preferendum.” (Wilson, 1971).

Since at the time of our observations the mound was only two years old and since later measurements done in larger and older nests did show the well-known regulation of the temperature, the conclusions presented here must have only a limited period of validity during the development of the mound at least in the case of *Formica polyctena*.

**MATERIALS AND MEASURING PROCEDURES**

In the dune area of Meijendel, north of The Hague, many mounds of *Formica polyctena* can be found, though these mounds are far from being as extensive as those in pine woods.

The temperature measurements were concentrated on one nest in a dry area with sparse vegetation. The nest was situated in the sand on the upper part of a one-metre-high slope of approximately 20 degrees, facing to the south. The slope was partly overgrown with shrubs (*Euonymus europaeus, Salix repens, Ligustrum vulgare* and a small *Crataegus monogyna*), of which the spindle trees overshadowed part of the mound and its environment from time to time during the days of the measurements.

The mound had a flat surface on equal level with the surrounding sand. We therefore can hardly speak of a proper mound, but with this term I want to indicate the organic material of the nest. The mound had a diameter of 40 cm and reached, mixed with an increasing amount of sand, to a depth of approximately 30 cm, while passages extended into the sand both at the sides and beneath the mound down to a depth of approximately 50 cm.

Many properties of the nest became known incidentally, as the temperature measurements were initially started as part of a larger research programme. A capture-recapture and counting procedure revealed a grand total of 28,000 inhabitants, of which 15,000 were active on the various tracks (Krük-de Bruin et al., 1977). The counting procedure implied the digging out of the nest which was carried out carefully. The ants were kept alive in the organic material and after three days of counting the nest material was dumped again at the original nest-site, the sand first (by inattention to a depth of 25 cm instead of the original 30 cm), the organic material plus the ants on top. A few handfuls of extra organic material provided the replenish-