INEFFICIENCY IN BROOD-REARING
IN THE ANT MYRMICA RUBRA L.

by

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Efficiency is a measure of the degree of realisation in practice of a theoretically derived work-output expectation. It has long been realised as being of great importance in the struggle for existence between living aggregates, but few measurements have been made on insect societies. These usually exist and function in the nest at densities so high, that from knowledge of non-social insects bred at such densities (Drosophila, Triboliium) one would expect gross inefficiency. As the principal occupation at these densities is brood-rearing this process has been chosen as a starting point for investigations, part of which have been published (BRIAN, 1953) and parts of which are in the press. Here only a brief account of one aspect of the subject can be considered.

By taking the reasonable theoretical system in which \( nx \) workers give \( n \) times the work output of \( x \) workers, that is in which the output is strictly proportional to the worker number, it is easily shown by measuring the gain in weight of equal groups of larvae that individual inefficiency exists and that it increases with the number of workers in the team (BRIAN, 1953). The causes of inefficiency have been sought, and appear to be at least three: the shape of the working group, the attitude of the nurses towards small larvae in the presence of large ones, and the method of feeding. Of these only the first appears superficially group-size dependent, but further thought shows that in fact all three are.

GROUP SHAPE

In both plane nests and in nests composed of cells arranged on a square lattice in plaster of Paris (each cell large enough to hold many ants and larvae) the larvae are placed in a central pile and covered and surrounded by workers. By measuring the area of the larval pile, the area of the whole group of workers and counting the number of workers over the larvae, it has been possible to show that when a fixed number of larvae is used,
and various numbers of workers added, the group shapes are different. Although the more workers there are the greater the worker area, the larvae are not spread out commensurately. Yet the proportion of the worker population in contact with the larvae is the same for all; with the result that the density of workers on the larvae in the larger groups far exceeds that in the smaller ones, a condition which through sheer mechanical interference might cause inefficiency with the group-size differential looked for (it should be emphasised that the nests themselves cause no constraint). It is interesting that in the cellular nests this is only true of the largest culture-groups; for the smaller worker teams the density of those in contact with the larvae is the same, a fact which suggests that if the ants were allowed to build their own nests they might produce a design conferring even greater efficiency.

The constant proportion of workers in contact endured (subject to sampling variations) when groups of different sizes were used in any one nest type, when groups of different sizes were placed in different nest types, and even after larval growth greater in those groups with many workers than in those with few. This all indicates that there are two types of worker at least, nurses and non-nurses and the work of EHRHARD (1931) which showed age-labour-differentiation in this species should be recalled.

Similar results to the above may be obtained using groups of fixed worker/larva composition but of varying actual sizes.

**LARVAL SIZE**

A second cause is the low stimulatory power that the small larvae have over workers. Whilst food is distributed nearly randomly to individuals in groups in which all larvae are the same size, in groups of two sizes mixed, the large larvae dominate, and may if numerous enough and if workers are in short supply "inhibit" all growth of the small ones. A curious result is obtained on the other hand if workers are more than sufficient to satisfy larval demand. If one takes a fixed number of small larvae and sets up groups with 0, 1, 2, 3, etc., large ones, one finds as would be expected that the more of the latter sort there are the greater the gain in weight (in a certain period) of the whole group. Yet at the same time the gain in weight of the small larvae is less the more large ones there are present; that is the total output can be increased by giving more large larvae, but a smaller proportion of this goes to the small larvae. In other words, worker effort is sub-maximal and the system is inefficient. If one considers such a mixed population of larvae of fixed numbers and composition, then the more workers there are, the more small larvae will receive attention, but it will not be the enthusiastic attention given to large ones, and the average individual worker output measured as larval gain in weight will decline as their number increases.