THE FORMATION OF POLYETHIC STRUCTURES IN THE TERMITÉ MACROTERMES BELLICOSUS

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Macrotermes bellicosus, as all Macrotermes species, has two worker castes: major workers (20%) and minor workers (80%), the former being male, the latter female. Such a caste ratio is unique in this genus (Gerber et al., 1988) and may well be the expression of highly developed polyethic specialisation in this caste.

In contrast to other species, extranidal exploration and building activities on virgin ground are performed almost exclusively by minor workers and only 1 to 3% of strolling majors. Investigations made in experimental arenas have shown that only after food is discovered does the extranidal population undergo drastic transformation in caste ratio, major workers comprising up to 75% (Lys and Leuthold, 1987). Recent discoveries, however, have revealed that the development of castes involved in foraging depends on the consistency of food, the predominance of hard food leading to a significantly higher ratio of major workers. The major workers are indeed the specialists capable of biting off bits of hard food. How does the society regulate caste involvement according to this functional need? The consecutive steps of this integrative regulation process were analysed in a flat transparent chamber where the same food substance (lime wood) was offered either in a solid piece or in a piece of pressed sawdust. No soil was added to the arena. From a series of analyses of observations we propose a hypothetical model to explain social structuring in terms of a self-regulating mechanism. We are fully aware that our simple statements are valid only for this simplified experimental arrangement with no soil in the arena. Our 5 main statements are:

1) Both worker castes are recruited to food only by their own caste;
2) Only carriers of food are able to instigate recruitment in the nest;
3) Only 20% of the food collected is carried directly to the nest, the remaining food being transferred one or several times from one worker to another;
4) The minor workers accept food transfer better than the major workers;
5) Food is transferred more successfully to workers who are already carrying one or two food particles than to those carrying nothing. From this a hierarchical order of probability \( P \) of food transfer between the possible combinations of workers meeting is concluded:

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P (a:a) > P (A:A) > P (a:a) > P (a:A)
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where A and a are major and minor food-carrying workers, A and a are major and minor non-food-carrying workers.

The model of caste regulation in simple words works as follows: with hard food only the major workers (with more powerful mandibles) are able to bite off pieces. Therefore the majority of food transfers will take place within this same caste. Recruitment will result in an equilibrium of a majority of major workers according to the hierarchy of food transfer probability.

In the case of soft food the minor workers are also able to take pieces. Because of the higher probability of food transfer from A to a the major workers lose the majority of pieces by transferring them to minor workers which then carry them to the nest and recruit their own caste. In this situation an equilibrium with a majority of minor workers participating in foraging will be reached.

This model is surprising in its simplicity and represents a basis for explaining the social process of integration as seen in this particular situation. A mathematical formulation of this hypothetical model will be simulated on a computer. The value of such procedure is to provide a method guide for specific experiments in the future which will be aimed at quantifying missing parameters in order to understand the real biological process. The parameters used in the model are the number of major or minor workers able to be recruited, the rate of recruitment, which is partly controlled by the quality of food, and the different probability of food exchange between the termites (minor-major, loaded-unloaded, etc.).

REFERENCES
Polyethism in Macrotermes bellicosus (Isoptera).
Insectes Soc. 35, 226-240.

Caste polyethism during the process of food acquisition in the termite Macrotermes bellicosus.
In: Chemistry and Biology of Social Insects (eds. Eder and Rembold), Peperny, Munich, p. 116.