Polyethism and feeding ecology among ant workers of *Formica rufa* and *Formica polyctena*: a case study at "de Rijksbossen, De Haan"

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Task partitioning or polyethism among ant workers is assumed to be a key factor behind the evolutionary success of social insects. Workers specialize on tasks such as brood tending, foraging, colony defense... Task partitioning increases colony productivity and reproductive success if workers tend to engage in tasks at which they are more efficient than their nest mates.

A striking feature of some ant species is the variation in size and / or shape of the worker caste within a colony. This phenomenon is also known as worker polymorphism and can take on different forms and gradations. Some species have discrete worker subcastes with an enormous variation between the subcastes and have no intermediary forms. Other species have workers that range along a continuum in size and shape. Task preference is correlated with the phenotype of the worker in many species. This task-phenotype matching increases colony efficiency.

The aim of this thesis was to unravel the relation between phenotype and task in two related red wood ant species (*Formica rufa* s. str.). Both mound-building ants are conspicuous members of temporal and boreal forests and their huge colonies play a key role in forest ecosystems. Workers have no distinct castes but a continuous size distribution. They are highly variable in size (max. head width 1.00 mm – 2.05 mm) but not in shape. Maximal head width captures almost all morphometric variation and was therefore used as a proxy for size.

The study was conducted in "de Duinbossen van De Haan" from July until October 2009. This study area is a highly fragmented dune forest with a strong recreation pressure. The forest hosts two sympatric red wood ant species, *Formica rufa* and *Formica polyctena*. Except from the often reported difference in pilosity, no additional morphological difference between those species could be detected. There were also no indications for different ecological preferences or different social life strategies.

Workers performing different tasks (nest builders, nest material collectors, honeydew tenders, prey capturers, scouts, idle workers, carriers of empty cocoons, carriers of dead ants, social carriers and reference ants on the mounds) were sampled at five different time periods (beginning of July; end of July, middle of August, beginning of September and beginning of October).

Additionally, we integrated some task-related relationships in our study:

* Size-distance relationship, wherein we tested the effect of distance to the nest on the size of honeydew tenders, prey capturers and scouts.

* Size-load relationship, wherein we studied the correlation between the size of the worker and her load (prey and nest material)

* Ortstreue: By marking honeydew tenders with enamel paint, we investigated site fidelity of workers visiting trees with aphids.

In accordance with other studies on wood ants, we found a strong correlation between task and size of the workers. The smallest workers primarily stay in the nest and help with nest construction. The largest workers performed tasks such as capturing prey, collecting nest material, scouting, carrying both dead and living ants (social carrying). Carriers of empty cocoons, idle workers and workers on the mound were of intermediate size. Honeydew tenders varied

Fig 1. Polymorhic workers of *Formica polyctena* feeding on a drop of sugar water.

significantly in size across a distance gradient and ranged from a small size similar to nest builders close to the mound to a size as large as the largest workers at further distances. Such size-distance relationship was not observed in prey capturers and scouts. In contrast with honeydew tenders, prey capturers cannot estimate the distance to the prey.

We found a temporal pattern in the size-task relation at the end of the season. There was an overall decrease in size of the ants on the mounds and of the nest material collectors. On the contrary, the size of the honeydew tenders increased towards the end of the season.

We explain for every task how a particular size-cohort can increase the efficiency of a task.

Additionally we demonstrate that social carrying involves a size-based division of labor with large workers carrying smaller workers to new nest sites.

Prey capturers had a weak size-load relationship. The largest workers carried the whole range of prey sizes. The smallest workers carried only small prey, despite the fact that they are able to transport heavier loads. Nest material collectors did not seem to have a preference for a particular load mass. Based on the different characteristics of the two tasks, we propose three hypotheses to explain the dissimilar relation: Distance (i), distance and stimulation (ii), risk management (iii).

Additionally, we also determined prey and nest material composition during five sample periods. As expected wood ants are highly polyphagous. The main prey were Diptera and Isopoda, but the diet changed over time with an increasing importance of Oligochaeta.

Workers brought mainly thatch and resin to the nest. There is a clear temporal variation in the composition.

Site fidelity of the honeydew tenders was very high and they preferred to return to particular branches and leaves on the trees. Experimental exchange of workers between trees did not influence their fidelity. Over time, site fidelity or Ortstreue tend to decrease.

The modest polymorphism found in these wood ant species allows a flexible division of labor. Workers are hardly limited by their size to perform all tasks in the colony. Only prey capturing and nest material collecting requires workers with a head width larger than 1.20 mm.

We conclude that the size-based division of labor together with the size-distance relationship, size-load relationship, the site fidelity and worker flexibility enhances colony efficiency.

Source:

PARMENTIER T., 2010. - Taakverdeling en voedselecologie bij de werksters van *Formica rufa* en *Formica polyctena*. Unpublished Master thesis, TEREC, University of Ghent, 128 pp.