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Food transport in ants: Do *Lasius niger* foragers maximize their individual load?

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Abstract

The decision for a *Lasius niger* forager to lay a chemical trail and launch recruitment to a food source is governed by an internal individual threshold. The value of this threshold triggering chemical communication is not set by the maximal capacity of the crop. Actually, trail-laying ants are still able to drink additional food encountered on their homeward journey. The partial filling of the crop by trail-laying ants may be a means for the ants to shorten foraging trips and to speed up the information updating within the nest. Moreover, by partially filling their crop, foragers keep a potential for sampling resources and for tasting other encountered food sources. ***To cite this article: A.-C. Mailleux et al., C. R. Biologies 332 (2009).***
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Résumé

Transport de nourriture chez les fourmis : Les fourrageuses de *Lasius niger* maximisent-elles leur charge individuelle ? Chez la fourmi *Lasius niger*, la décision de tracer une piste chimique et de lancer un recrutement vers une source de nourriture repose sur un seuil de réponse interne et propre à chaque individu. La valeur de ce seuil déclenchant la communication chimique n'est pas déterminée par la capacité maximale du jabot (estomac social) de la fourmi. En effet, les fourmis recruteuses déposant une piste chimique de recrutement sont encore capables de boire à une source découverte lors de leur retour vers le nid. Ce remplissage partiel du jabot des recruteuses leur permettrait de gagner du temps afin d'accélérer le transfert d'informations actualisées vers le nid. De plus, en se remplissant partiellement, les fourmis gardent la possibilité d'échantillonner d'autres sources nouvellement rencontrées qui pourraient s'avérer plus profitables. ***Pour citer cet article : A.-C. Mailleux et al., C. R. Biologies 332 (2009).***
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Keywords: Recruitment; *Lasius niger*; Threshold; Crop load

Mots-clés : Recrutement ; *Lasius niger* ; Seuil de réponse ; Chargement

1. Introduction

The whole organisation of insect societies relies on the variability of individuals in their propensity to carry out some tasks and to respond to internal and external stimuli. In ants, individuals are characterised by their

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own response threshold to a given stimulus [1–4], this response threshold being determined by several internal factors such as genetic predisposition [5,6], the age [7], the physiology [8], the caste belonging [9–11] or the individual experience [12,13]. In the case of foraging, such thresholds can also vary in relation to other factors such as demand for food [14–17], distance from nest to food patches [18], or presence of amino acids in honeydew [19].

In previous papers, we have shown that, in *Lasius niger*, an internal response threshold governs the decision of an ant forager to launch recruitment to a newly discovered food source [20–23]. Indeed, when a scout finds a sucrose solution droplet, the decision to inform nestmates by the laying of a recruitment trail is an all-or-nothing response, based on the ability of this scout to ingest a food volume acting as a threshold. If the scout cannot obtain this volume, it goes back to the nest without recruiting. Information about the food volume is thus conveyed to the society through the percentage of trail-laying individual among returning ants.

The threshold determining the trail-laying response of foragers is not a fixed value shared by all members of the colony, but varied from one individual to another. However, we do not know whether this critical response threshold is determined by physiological constraints such as the maximal capacity of the crop. Therefore, in the present article, we investigate through an experimental approach, and with the help of a model, whether the rule of thumb evidenced for a single food source remains valid when a scout has to collect two droplets to reach its threshold volume, the first droplet on the foraging area and the second one placed on their way back to the nest. To this end, we extend the one-source experiment initially developed by Mailleux [20, 21] to a double source set-up.

The present article raises the following questions: Are the foraging activities of ants modified as they encounter a new source on their way back to the nest? Do they retrieve this additional food load? Is the value of the threshold volume triggering chemical recruitment set by the maximal capacity of the crop? We studied the ingested volume, the intensity and frequency of the trail laying behaviour, and the time spent foraging before, between and after ants found the two sources.

2. Material and methods

2.1. The experiment

Experiments were carried out on the black garden ant, *Lasius niger*, a common Palaearctic species, which feeds on the honeydew of aphids like *Tuberolachnus salignus*, *Aphis fabae* or *Metopeurum fuscoviride* [24–31]. We dug colonies of 1000–2000 workers out of earth slopes in Brussels and reared them in the laboratory in plaster nests at a room temperature of $22 \pm 3\,^{\circ}C$. These colonies were queenless. Each nest ($20 \times 25 \times 0.5$ cm) was divided in four interconnected sections ($16 \times 4 \times 0.5$ cm) covered by a red glass plate. Nests were regularly moistened and were fed three times a week with brown sugar solution (0.6 M) and dead cockroaches (*Periplaneta americana*). We carried out assays on four colonies that were starved for four days.

In mass-recruiting ant species such as *Lasius niger*, the first scouts that lay a trail back to the nest play a key role in the triggering and the building-up of collective foraging patterns [21,32–34]. Consequently, we focused our observations on the foraging behaviour of these individuals. We choose to deliver a 0.7 µl droplet at each food source as this volume was comparable to the maximal amount of honeydew actually produced per aphid individual [24–26]. This volume was also lower than the average desired volume and it compelled most foragers to search for additional sources to reach their desired volume [20]. Drinking at the first droplet is then expected to satisfy only a small fraction of the ants that will lay a trail as they leave the area.

One hour before each experiment, the nest was connected by a bridge to a small foraging area. A scout was allowed to drink a first droplet of sucrose solution (0.7 µl, 0.6 M) at a single micropipette hanging in the centre of the square foraging area (6 cm × 6 cm). The concentration of the sucrose solution was close to the total concentration of sugars occurring in droplets emitted by *Lasius*-attended aphids [24–26]. Once the scout had ingested the first droplet, the scout could either return to the nest or keep on searching for additional food droplets (see Fig. 1). On its homeward journey, a second droplet (0.7 µl, 0.6 M) was delivered by another micropipette hanging in the middle of the bridge, 9 cm from the first one. The second source was introduced after the first one. It was out of reach of the scout when it was walking on the bridge in the direction of the foraging area. More than 95% of the foragers found the second micropipette on their way back to the nest, and thus, had the opportunity to drink, or not, at this second food droplet. We analyzed only the behaviour of those foragers that had found the two food sources. Each of the 63 observed scouts was tested only once. After the passage of one scout, the bridge was renewed.

We studied the ingested volume, the intensity and frequency of the trail laying behaviour and, the foraging time of ants before, between and after that ants found

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