Nest-moving and food location in *Tapinoma erraticum* (Hymenoptera, Formicidae)

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Abstract - *Tapinoma erraticum* is a highly opportunistic ant species well-known for its tendency to emigrate. The authors speculate whether these frequent nest-movings are a part of its foraging strategy. In the laboratory, there is a clear preference for the ants to emigrate towards a nest located near a food source. In the field, however, interspecific competition seems to be the limiting factor.

Keywords: *Tapinoma erraticum*, food recruitment, nest-moving, competition.

Introduction

*T. erraticum* is well-known for its tendency to emigrate. Sometimes, it is possible to identify the cause of this behaviour: we have personally observed such a nest-moving caused by an evident flood in the nest. Other explanations can be settled such as the competition of other species, a food shortage or both. However, in many cases, the emigration occurs with no obvious change in the suitability of the nest site. This species is indeed a highly opportunistic one. When confronted to another ant species around a food source, either it leaves the place or it repels its competitor. This latter case seems to occur only if it has already built a sufficient recruitment force. Either way, *T. erraticum* is unable to displace another ant species if this one is well established on the food source.

In the ant species so far studied the recruitment for a new nest and the food recruitment share the same basic mechanisms, i.e. if the species uses group recruitment, it is essentially the same for both uses (e.g. *Camponotus*, Hölldobler, 1971). The only differences observed are at the level of the invitation behaviour. By this
mechanisms sharing, it seems that the ants gain the economy of a behavioural program.

To the best of our knowledge, _T. erraticum_ uses mass-recruitment for both nest-moving and food recruitment. In addition of the functional link previously described, it is tempting to speculate whether the frequent nest-moving in this species are a part of its foraging strategy.

This work intends to test if food location has an influence on the choice of potential nest sites. Accordingly, the dynamics of food and nest-moving recruitments will also be described.

**Material and Methods**

1. **Food recruitment**

   Colonies of _T. erraticum_ were kept in artificial plaster nests in the laboratory. The colonies had a water distributor at their disposal and except in the experimentation periods, they were fed with sugar solution and pieces of _Tenebrio molitor_ larvae.

   The experimental device used to measure the incoming and outgoing flux of ants is shown in Fig. 1A. Two days before the experiment, the experimental apparatus was settled and food distributors removed. At the beginning of the experiment, the food source was offered 35 cm from the nest. As soon as a scout discovered the food source and began to drink, the number of ants at the food source and on the foraging area were counted each minute.

2. **Recruitment to a new nest site**

   The nest used in this experiment had a 1,000 workers force. In order to observe the nest-moving dynamics, the old nest condition was altered and a more favourable new nest presented (Abraham and Pasteris, 1980). In the case of _T. erraticum_, which is a dry-zone species, the factors inducing nest-moving are (1) an increase of the old nest humidity that induces itself a decrease of the temperature, and (2) an increase of the temperature in the dry new nest.

   The experimental device we used is shown in Fig. 1B. One hour before the beginning of the experiment, we increased the humidity of the plaster nest and the distributors of food and water were removed. When the apparatus was settled, the number of ants in the old arena was counted. From this moment, the number of worker ants, of queens and of larvae which went out and into the new nest was counted at intervals of 2 minutes.

3. **Nest-moving : choice experiments in the laboratory**

   The experimental apparatus is described in Fig. 1C. This device allowed us to test two hypotheses about the frequent nest-moving of _T. erraticum_ : (1) whether nest-moving is spontaneous, and (2) whether the position of a food source can influence the choice of the nest site.

   In order to test the first hypothesis, a food source was located near the old nest N1 (first series of experiments), to test the second hypothesis, the food source was randomly located near one of the two new nest sites (second series of experiments). Except con-
Nest-moving and food location in *Tapinoma erraticum*

cerning the food location, the three nest sites were identical. They were left undisturbed during the whole experiment. From the beginning of the experiment, the number of ants in each artificial nest and arena was counted every day at 13:00 (moment where the activity of these ants is maximum in laboratory conditions). This measurement was continued for 5 days after the nest-moving of the colony in one of the proposed sites. The size of the tested colonies ranged from 50 to 200 workers for the first series of experiments and from 70 to 600 for the second one.

Fig. 1. - A. Experimental device used in the food recruitment experiments. FS : food source, A : nest, DW : water distributor, distance N-FS : 35 cm, B : bridge, A1, A2, A3 : arenas. B. Experimental device used to observe the nest-moving dynamics. L : 40W lamp, A1, A2 : arenas, NO : old nest (without red cover), N1 : new nest (with red cover). C. General experimental device used for the nest-moving choice experiments in the laboratory. A1, A2, A3 : arenas, N1, N2, N3 : nests. N1 is the original nest, N2 and N3 are the potential nest sites.

4. Nest-moving : choice experiments in the field

The field work was conducted in Vaucelles, Belgium, in an open calcareous quarry facing south. Experiments were conducted on two 3m x 3m experimental sites.

The first site was used to observe the space distribution of the colonies of *T. erraticum* without perturbation. The experiment was carried out during the period May to July 1990. The distribution of the nests was noted one or two times per week by placing baits (sugar solution and biscuits crumbs). This experiment allowed us to determine the nest-moving frequency of *T. erraticum* in natural condition.

On the second site, we offered 20 artificial nest sites with half of them close to a permanent food source (solution of sucrose). The distribution of the nest sites with a food distributor was random. The artificial nest sites were composed of a pane covered by a slate. Each week, the nest sites were examined and the eventual presence of a colony and its species noted.
Results

1. Food recruitment

The curve showing the recruitment at a 1M sucrose food source performed by a 1,000 ants society, has a characteristic bell-shape (Fig. 2). The food recruitment begins very quickly in an explosive way and the curve never passes through a phases of plateau. The results obtained in the lab are consistent with our field observations.

Two sources experiments were also performed but these results will be exposed elsewhere. There is, however, a result which is of interest here. If two sources of different quality are sequentially offered and if the difference of concentrations is high (case of 0.1M versus 1M saccharose sources), the colony can shift its recruitment activity from the "poor" source to the "rich" source. For instance, in an experiment with a 1,000 ants society, a 1M source was offered 30 min. after a recruitment began on a 0.1M source. At this time, the first recruitment involved 10 ants feeding at the 0.1M food source; 50 min. later, there were no more ants around the poor source and 12 ants feeding at the rich one.

![Graph of food recruitment](image)

**Fig. 2.** - Food recruitment : time evolution of the number of ants feeding at a 1M food source or present in the foraging area. The experimental device is described in Fig. 1A. The Tapinoma erraticum society had a 1,000 workers force.

2. Recruitment to a new nest site

The recruitment can be divided in three phases (Fig. 3): (a) the exploration phase, (b) the recruitment and transport phase, and (c) the final phase. These phases are similar to those observed by Abraham and Pasteels (1980) in the nest-moving in Myrmica rubra.
3. Nest-moving: choice experiments in the laboratory

3.1. Food source located near the old nest

We observed 17 nest-moving: 10 colonies moved on the N2 side and 7 on the N3 side. The time lapse between two nest-moving varied from 2 to 27 days. These results suggest that the frequent nest-moving in *T. erraticum* are spontaneous; there is no need for any external factor to force a *Tapinoma* colony to move. Interestingly enough, once installed in the new nest, all the societies moved again after some days towards the original nest N1 where the permanent food source was located. This return sign a certain instability in the system. This instability could be explained by the presence of the permanent food source near the original nest N1.

3.2. Food source located near one of the new nests

In this experiment we intended to test whether or not the choice of a potential nest site is influenced by the presence of a permanent food source in its vicinity. We observed 14 nest-moving: 11 towards the nests with a food distributor in the vicinity, and 3 towards the nests without a food source near them.

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**Fig. 3.** Dynamics of nest-moving: time evolution of the number of workers, queens and larvae in the new nest. Thick line: number of worker ants in the new nest N1, thin line: number of larvae in the new nest N1, dotted line: number of queens in the new nest N1, a: exploration phase, b: recruitment and transport phase, c: final phase (the line is broken because this phase was not completed 270 min. after the beginning of the nest-moving). The experimental device is described in Fig. 1B. The *Tapinoma erraticum* society had a 1,000 workers force.
So the nest-movings towards new nest sites with a food source in the vicinity are more numerous than those towards nests without food source. This difference is statistically significant (binomial test, p < 0.05).

In these experimental conditions, selected site is thus clearly influenced by trophic factors. The time lapse between two nest-movings varied from 2 to 55 days.

4. Nest-moving : choice experiments in the field

4.1 Observation of nest-movings in undisturbed sites

The only reliable information extracted from this experiment is the frequency of the nest-movings. All the nests observed since their installation moved after 1 to 5 weeks. These values are thus in the same range as in the laboratory conditions.

4.2 Influence of a permanent food source near a potential nest site.

Of the 20 proposed sites, 8 were occupied by colonies of ants of different species and two exhibited exit holes of Tetramorium (Table 1). We can see that all the colonies of T. erraticum, except one, settled in the sites unprovided with a close permanent food distributor. We also noted foragers of T. erraticum at all the distributors except during the period when these were monopolized by another species such as Myrmica sabuleti, for instance. The food distributors monopolized by Tetramorium sp. were blocked to their profit by recovering them with gravel.

Table 1. Choice experiments in the field, installation of colonies of ants in the 20 artificial nest sites.

<table>
<thead>
<tr>
<th>sites with a food source</th>
<th>sites without a food source</th>
</tr>
</thead>
<tbody>
<tr>
<td>one colony of Myrmica sabuleti</td>
<td></td>
</tr>
<tr>
<td>one colony of Leptothorax sp.</td>
<td></td>
</tr>
<tr>
<td>one colony of Tapinoma erraticum</td>
<td></td>
</tr>
<tr>
<td>two sites with exit holes of Tetramorium species</td>
<td></td>
</tr>
<tr>
<td>five colonies of Tapinoma erraticum</td>
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</tbody>
</table>

Discussion

T. erraticum is a species which practices a mass-recruitment to collect food (Verhaeghe et al., 1980). This type of recruitment allows a very fast transmission of the information but confronted with multiple sources, mass-recruiting species like Lasius niger always stay prisoners with their first choice (Beckers et al., 1990). On the contrary, T. erraticum has retained a high degree of flexibility.
Nest-moving and food location in *Topinoma erraticum*

The origin of such a flexibility is discussed elsewhere (de Biseau et al., 1992). Either way, this flexibility undoubtedly allows *T. erraticum* to redirect quickly its foraging activity, especially when confronted with competitors.

Concerning the nest-moving, the recruitment dynamics is similar to the one described by Abraham and Pasteels (1980) in the case of *Myrmica rubra*. The only difference between these two species lies in the time scale of the different phases. In the case of *T. erraticum* each stage is linked to the other at an elevated speed. On the other hand, the nest-moving in *Myrmica rubra* is very slow.

This difference in the nest-moving duration can be explained by the fact that *T. erraticum* is a species which moves frequently and that *Myrmica rubra* is a species which moves only if the conditions of the environment become unfavorable, which is a rare event. The type of recruitment used by *T. erraticum* for nest-moving is the same as for food exploitation: a mass-recruitment (Meudec, 1979). Our experiments showed that the nest-moving in *T. erraticum* is spontaneous but unstable.

In the laboratory, we proved that an exogenous factor like a food source near the potential nest site can orientate and stabilize the installation. This hypothesis has been already explored by Dubuc and Meudec (1984). They concluded that the nests located next to a food source were not systematically chosen when the ants emigrated although they were more frequented before the emigration. However, their experiments were conducted on only two nests.

When we tested the same trophic factor in the field, we noticed that the colony of *T. erraticum* avoided to nidificate in the offered site with a permanent food source at proximity. In fact, in the field, there are other factors which can interfere in the choice of a new nest site such as competition. This factor seems to be a very important limiting factor. Indeed, a potential nest site with a proximate food source is prone to attract competitors!

These laboratory and field results allow us to propose an eco-ethological scenario which can account for the frequent nest-movings in *T. erraticum*. The foraging strategy used by *Topinoma* is typically opportunistic (Wilson, 1971). This strategy consists in foraging in the areas which are deserted by the other ants to decrease the risk of competition. While exploring these areas, foragers could discover potential nest sites. Those with abundant resources in the vicinity are preferred but only if there is no competition. However the zones where the competition is weak are supposed to persist only for short periods and therefore can be invaded by other species at every moment. This possible event could explain the spontaneity of the nest-moving (endogenous cycle) towards one of the deserted sites which were previously inspected.

References


