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Trail communication in two *Paratrechina* species *Paratrechina longicornis* (Latreille) and *Paratrechina vividula* (Nylander, 1846) (Hymenoptera: Formicidae)

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Abstract

The hind gut of the worker of the two *Paratrechina* species is the source of the trail pheromone. In *P. vividula*, the poison gland secretion has an inhibitory effect but in *P. longicornis* it hasn't. In *P. lon gicornis* and *P. vividula*, the optimum dose of the trail- following was found to be 1 gaster equivalent / 30 cm trail. The optimum dose lasting time could last for 105 minutes in both the two species.

Key words: ants – *Paratrechina longicornis* - *Paratrechina vividula* – trail pheromone – concentration – optimum dose lasting time

Introduction

The genus *Paratrechina* comprises about 118 described species, some of which have been spread throughout the world by commerce, becoming invasive pest ants in the buildings of many countries (Fox et al., 2007).

P. longicornis, native of West Africa, is one of the 'crazy ant' species, so-called because foraging workers move quickly along erratic paths. It is considered as one of the most frequent 'tramp species'. Although moist conditions are preferable for reproduction, small and ephemeral *P. longicornis* nests can be found in plantations, gardens, and buildings where colonies occupy all available cavities in the ground, live or dead plants and walls (Banks & Williams, 1989; McGlynn, 1999 and Dejean et al., 2000). Like most invasive ants *P. longicornis* has a monomorphic worker caste and is omnivorous, feeding on live and dead insects, seeds, honeydew, fruit, plant exudates, and many household foods. Nevertheless, unlike other invasive ant species, *P. longicornis* is neither territorial nor aggressive toward other ants and its foraging strategy mostly depends on the rapidity of the foragers and their ability to immediately recruit nestmates at short or long range when they find a food source (Banks & Williams, 1989; Wetterer et al., 1999 and Holway et al., 2002).

P. vividula (Nylander) is common in many urban locations, and behaves like an introduced species, although it is assumed to be native to Mexico (Trager, 1984).

In general the trail pheromone is employed by some workers to recruit other workers of the same species to a food source (Bonnet, 1779). Trail pheromones may help ants chose the more rewarding branch at a trail bifurcation, and may also allow more rapid changes in directing foragers to particular locations (Jackson et al., 2006).

The present study is aimed to investigate the source of the trail pheromone, optimum dose response and optimum dose lasting time in *Paratrechina longicornis* and *Paratrechina vividula*.

Materials and Methods

Source of the ant species

A colony of each *P. longicornis* was collected inside a kitchen of a house at El Borgaya village 6 kilometers north to EL-Minia city. A colony of *P. vividula* was collected from a moisture soil of a field in the district of El-Minia University. Each colony contained a few queens with brood, workers and males.

The ants were kept in a plastic bottle filled partly with some soil granules. The bottle was placed in a plastic bowl with (25 cm internal diameter and 60 cm vertical wall) to serve as a foraging area. The ants were fed with tiny drops of honey placed on a sheet of paper. At least once a week, ants were offered fresh dead insects; as well as 10% sugar solution in a glass test tube. To compensate moisture loss of the soil granules, few drops of water were added at different periods whenever needed.

Trail following bioassay

To investigate the source of the trail pheromone, the poison gland, Dufour's gland and the hind gut were tested. Each gland was dissected in distilled water under the Cambridge instruments binocular dissecting microscope (Model Z30E) using two fine tweezers. A circle of 5cm radius was drawn on a sheet of white paper with a lead pencil using a geometric compass. The circumference of the circle was divided into arcs of 1cm each. The extract of gland being studied was transferred in to the reservoir of a standard graph pen by using a 100µl mircosyring (Pasteels & Verhaeghe, 1974). The paper containing the solution was allowed to dry for 2 min before bioassay. Then the paper was placed in the foraging area of the ant nest to observe whether workers could follow the trail or not during twenty minutes. The number of arcs run by each ant along the circular trail was counted and compared with hexane alone (control).

Optimum dose of the trail pheromones

To determine the lower optimum and upper optimum dose of the trail pheromone, different concentration ranging used from 0.01, 0.1, 1.5, 10, 20 and 40 glands of each test gland of each species were prepared. Each concentration in 100 µl hexane was allowed for workers for twenty minutes. The applied trail was introduced into foraging area of workers and the mean number of arcs run by individuals was calculated and was used as a measure of activity.

Optimum dose lasting time

The optimum dose of the trail pheromone obtained from the previous experiment for each ant species was allowed for workers after different period of time from its initial application (15, 30, 45, 60, 75, 90, 105, 120 min).

The dose of each trail was allowed for worker for 10 mins, and the mean number of arcs run by workers was calculated using the circular trail technique, and was used as a measure of activity at each time and compared with zero time of application.

Statistical analysis

Analysis of variance using one-way ANOVAF (DSL) test was used for the obtained data.

Results and Discussion

Source of the trail pheromones

In *P. longicornis*, the hexane extract of the poison gland did not elicit any activity where as the hexane extract of the Dufour's gland elicited a little activity, where the mean number of arcs run by workers was 1.033±0.2165 with a range of 0-4. On the other hand the hind gut is the source of trail pheromone where the mean number of arcs run by individuals along the trail was 9.11±0.7 with a range of 1-28 (Fig. 1).

In P. vividula, the hexane extract of each of poison gland and Dufour's gland eleicited an activity where the mean number of arcs run by individuals was 4.371±0.4 and 7.919±0.97 with a range of 0-15 arcs and 0-28, respectively. The activity was significantly (P> 0.01) different from that evoked by the hind gut (Fig. 2).

It is evident that the hind gut is the source of trail pheromone in many genera belonging to the subfamily Formicinae as *Oecophylla longioda* Latreille (Hölldobler & Wilson, 1978). *Camponotus socius* (Hölldobler, 1971), *Camponotus sericeus* Fabricius (Hölldobler et al., 1974), *Camponotus pennsylvanicus* (Traniello, 1977), *Camponotus atriceps* and *C. floridanus* (Haak *et al.*, 1996) and *Formica polyctena* (Horstmann *et al.*,1982). *Lasius neoniger* (Traniello, 1989), and *Polyrhachis* species (Hölldobler & Wilson, 1990).

In a trail to find whether or not the poison gland and the Dufour's gland secretion of P. longicornis has an effect as a synergizer for the hind gut secretion, a mixture of the hind gut and the poison gland or a mixture of the hind gut and the Dufour's gland was tested against workers. It was found that the poison gland or the Dufour`s gland has no effect (Fig. 1). This result is in agreement with that obtained by Ali and Mashaly, (1997a), who found that the Dufour's gland secretion had no effect in the activity of workers of *Pheidole jordanica*, *Pheidole sinaitica* and *Pheidole sp.*

In *P. vividula*, a hexane extract of a mixture of both the hind gut and poison gland or a mixture of the hind gut and Dufour's gland was tested. It was found that the Dufour's gland secretion has no effect on the trail-following activity. The poison gland content showed an inhibitory effect where the activity was significantly (P> 0.01) decreased (a mean 21.23±0.86 arcs with a range of 3-95 arcs) being less than that of the hind gut extract alone (Fig. 2). The decrease of activity in this case is probably due to the presence of certain substance (s) in the poison gland which acts

as an inhibitor. The inhibitory effect was also observed with *Tetramorium simillimum* Smith, where the poison gland secretion , the source of the trail pheromone was inhibited with the Dufour`s gland secretion (Ali and Mashaly, 1997b). Cammaerts (1992) working with *Myrmica rubra* L., found a different result where the poison gland, the source of the trail pheromone, was enhanced with the Dufour`s gland secretion.

Optimum dose of the trail pheromones

A certain concentration of a trail pheromone appears important, since a too high or too low, concentration of trail pheromone elicited either no response or repellency (Barlin et al., 1976). Also ants are able to optimize their foraging behavior by selecting the most rewarding source, due merely to a modulation of the quantity of pheromone laid on a trail (Hangartner, 1969; Hölldobler & Wilson, 1990; Traniello & Robson, 1995). Therefore, different concentrations of the trail pheromone were tested against each of the ant species under investigation.

Data were presented in Fig. 3 indicate that workers of *P. longicornis* and *P. vividula* utilize a concentration of 1 gaster extract to evoke their highest activity. Activity significantly decreased at concentration below and above 1 gaster ($P < 0.01$) at the highest and lowest concentration of 40 gasters and 0.01 gaster, the recorded activity was nearly similar to the control bioassay.

Tumlinson *et al.* (1972) found that the ant *Atta texana* Buckley ants showed actively trail-following response at 0.8 ng per cm trail, but showed no trail –following response when the concentration exceeded 2.7 ng per cm trail. Morgan *et al.* (1990) reported that in *Tetramorium impurum* Foerster, the highest activity was reported at a concentration of 0.1 poison gland equivalent / 30 cm trail. The activity decreased at a concentration of one and 0.01 poison gland / 30 cm trail, then totally disappeared at the concentration 0.001 gland. Ali (1996) found that the optimum dose of trail following activity of *Pheidole teneriffana* which induced the highest activity was only one gaster equivalent /30cm. *Pheidole Jordanica, Ph. sinatica and Ph. sp.*, induced the highest activity between one and 5 gasters equivalent / 30 cm trail (Ali & Mashaly, 1997a). *Crematogaster inermis* Mayr, utilizes an optimal dose concentration ranging from one to 5 glands equivalent / 30 cm trail, while *Leptothorax angulatus* mayr and *Titramorium simillimum* Smith, the optimum dose was found to be 5 gasters (Ali & Mashaly, 1997b).

Optimum dose lasting time

A parameter critical to the function of a trail is its persistence, and trail longevity must be matched to the foraging ecology of a particular species. Indeed, in ants trail longevity varies from minutes (Hölldobler *et al.* 1995) to several weeks (Torgerson & Akre 1970). Short-lived trails can rapidly modulate recruitment to ephemeral food sources, whereas long-lived trails will be more suited to persistent, or recurrent, food sources.

In the present study as indicated previously, the Optimum dose of the trail pheromone of both *Paratrechina* species is one gaster equivalent / 30cm trail. At this concentration the activity of workers decreased to its lowest level after 105 minutes in the two species (Fig. 4).

In other studies with other different species, the persistence of the trail was nearly the same as it was obtained in the present study where the optimum dose lasting time recorded few hours. In *Pheidole Jordanica, Ph. sinatica and Ph.* sp., the initial application at a concentration of two gasters, the activity recorded just a trace after 105-120 minutes at a concentration of 5 gasters, the activity increased gradually after its initial application where it recorded the highest value around 60 minutes then it decreased after 165-180 minutes (Ali & Mashaly, 1997a). Ali and Mashaly (1997b) found that in *Leptothorax angulatus*, activity in workers towards 5 gasters equivalent/ trail could last for 75 mins. At concentrations of one gaster, activity lasted for only 15 mins. *Tetramorium simillimum* recorded 75 mins for a concentration of 5 gasters and 30 mins for one gaster equivalent / trail. In case of *Crematogater inermis*, activity in workers recorded just a trace after 120, 196 and 270 mins at concentrations of 1, 2 and 5 glands equivalent / trail, respectively. *M. minimium* Buckle, were hardly active after 2.5 hr (Blum, 1966). In *Camponotus pennsylvanicus* De Geer the trails remained active for about 2 hr; but with presence of visual information, the trails remained active for 24 hr (Hartwick et al., 1977). Van Vorhis et al. (1981) found that the trail pheromone of the dolichoderine ant, *Iridomyrmex humilis*, remained active for 4 hr; when deposited on filter paper, and then the activity in workers completely disappeared after 8 hr. But in the other studies the persistence of the trail remains for a days as the artificial trails in *Tetramorium guineense* F. was not volatile; as the trail kept their activities for at least 168 hr at 28 ˚C (Blum & Ross, 1965). The trail of *Monomorium pharaonis* Linnaeus remained active for about a day. Cammaerts *et al.* (1994) found that the trail pheromone in *Tetramorium aculeatum* may act for days on a dry substrate.

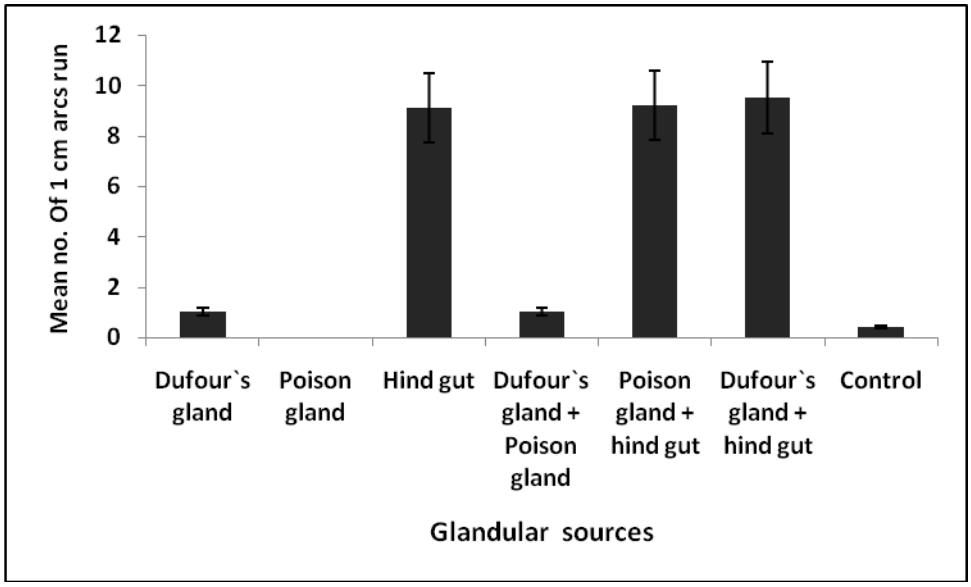

Fig. 1: Trail following activity evoked by glandular source of workers of *P. longicornis* using the circular trail following test.

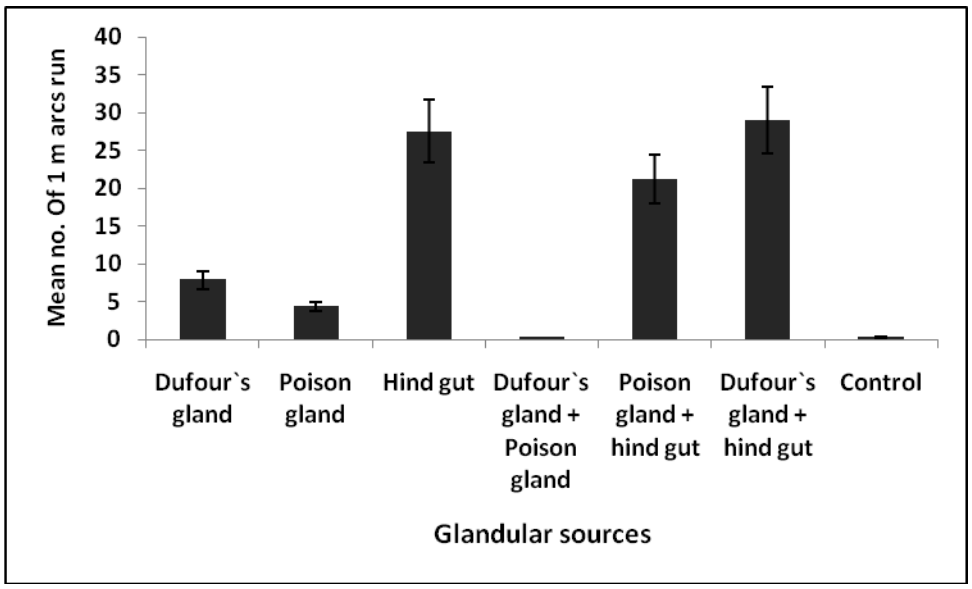

Fig.2: Trail following activity evoked by the glandular source of workers of *P. vividula* using the circular trail following test.

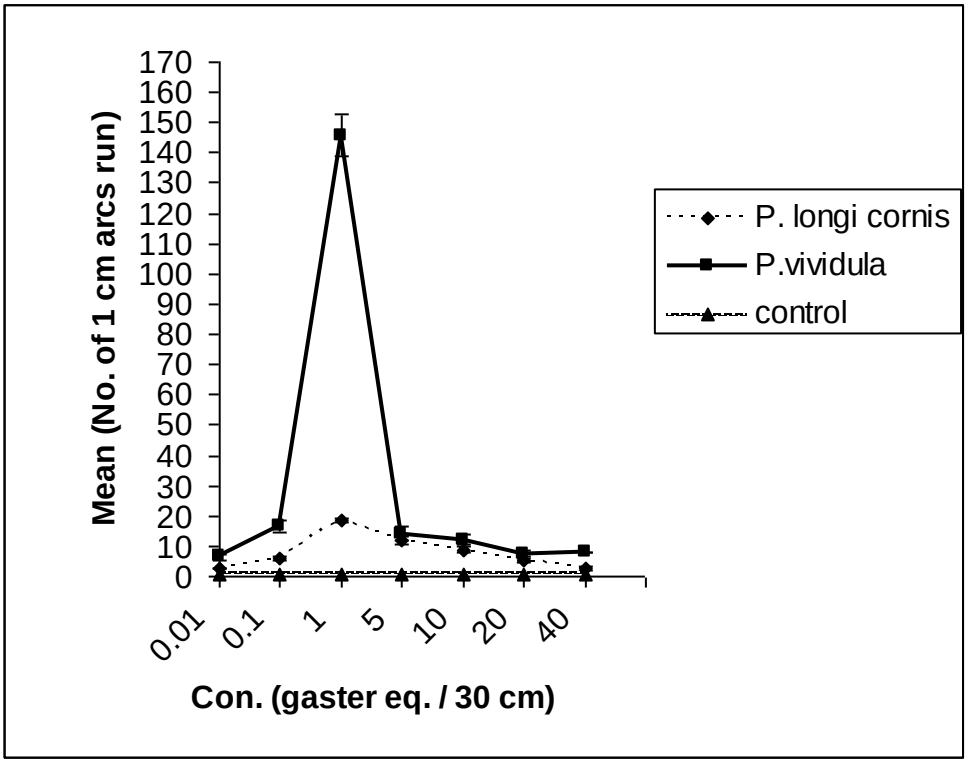

Fig.3: Response of *P. longicornis* and *P. vividula* workers to different concentration of gaster extract using the circular trail-following test.

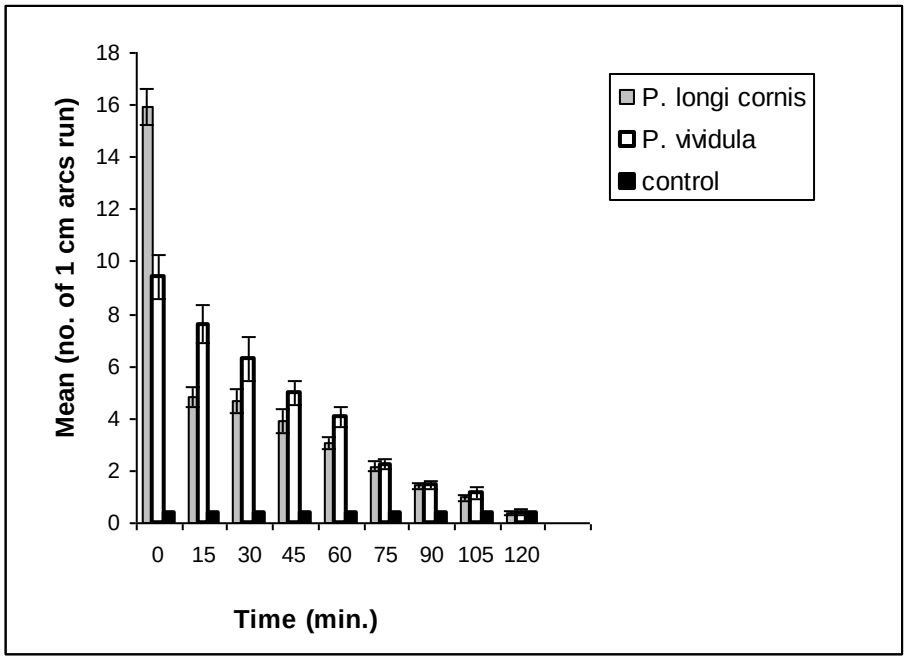

Fig 4: Optimum dose lasting time of trail pheromone of the ant *P. longicornis* and *P. vividula* (1 gaster equivalent /30 cm trail)

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المجلة المصرية لعلم الحيوان
المجلد 51 (ديسمبر 2008)

دراسة فيرمون الأثر فى نوعين من النمل من تحت فصيلة فورميسيني، باراتريكينا لونقيكورنس و باراتريكينا فيفيديولا

أشرف محمد على مشالى، أسماء صابر على و محمود فضل على
قسم علم الحيوان – كلية العلوم – جامعة المنيا

استهدف البحث الحالى دراسة بعض خصائص فيرومونات الأثر فى نوعين من النمل من تحت فصيلة فورميسيني هما باراتريكينا لونقيكورنس و باراتريكينا فيفيديولا.
اشتملت الدراسة على النقاط التالية:
1- معرفة مصدر فيرومون الأثر.
2- إيجاد الجرعة المثلى لإحداث أكبر اقتفاء للأثر فى الشغالات.
3- معرفة زمن بقاء الجرعة المثلى من الفيرومون.

وفيما يلى ما أوضحته نتائج الدراسة:

- أن المعى الخلفى هو مصدر الفيرومون فى كل من النوعيين، ولم يكم لمستخلص الغدة السامة وغدة دوفور تأثير على مستخلص المعى الخلفى فى نشاط الشغالات فى حالة باراتريكينا لونقيكورنس، أما فى حالة باراتريكينا فيفيديولا فكان للغدة السامة تأثير تثبيطى لمستخلص المعى الخلفى ولم يكن لمستخلص غدة دوفور تأثير.
- أن الجرعة المثلى لحدوث أكبر نشاط اقتفائى فى النوعين كانت عند تركيز مكافىء لواحد معى خلفى لكل 30 سم أثر.
- عند استخدام تركيز مستخلص الجرعة المثلى (واحد معى خلفى) قل النشاط فى النوعين مع مرور الوقت حتى سجل أقل قيمة له بعد مرور 105 دقيقة.