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Laboratory observations of nuptial flights of the ant *Polyrhachis laboriosa*

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Short communication

Abstract. Ethology of *Polyrhachis laboriosa*, an ant species from equatorial Africa, is little known. No field observation of a nuptial flight of these ants was ever made. We describe two nuptial flights observed in a laboratory colony of *P. laboriosa* at a 3 days interval. They both occurred in the morning while the nest was kept in near darkness (less than 2 lux of daylight). Flying activity of the alates was suppressed within 1 h by their exposure to daylight of about 140 lux, and within several minutes by their exposure to a lamp emitting white light of 3,000 lux and acting as a source of heat. On the day following the first flight the alates and the workers showed exceptionally high level of mutual grooming. The alates, in particular the males, were transported by workers to the brood chambers whenever they strayed outside and after the nuptial flights.

Key words: *Polyrhachis laboriosa*, Formicidae, alates, nuptial flight, illumination

The ant genus *Polyrhachis* (subfamily Formicinae, tribe Camponotini) contains approximately 700 species and, thus, belongs to the largest ant genera (Bolton 1973, Dorow and Maschwitz 1990). The biology and the ethology of these ants remains still very little known (Dorow et al. 1990, Dejean et al. 1994). *Polyrhachis laboriosa* F. Smith is an arboreal species widespread in equatorial Africa. So far, only very few aspects of behaviour of these ants have been studied in more detail. Recently, the research on the ethology of these ants was focused mostly on various aspects of their foraging behaviour, on their ritualized inter-specific agonistic behaviour, and on the behaviour of foundress queens of that species (Dejean et al. 1994, Lenoir and Dejean 1994, Mercier and Dejean 1996).

No observation of a nuptial flight of *P. laboriosa* was ever made in the field (Lenoir and Dejean 1994, Mercier, personal communication). However, Lenoir and Dejean (1994) reported eleven cases of capture of alate females of *P. laboriosa* made at Yaoundé (Cameroon) in the years 1988-1990. All these females were captured during the morning in November or in December. According to Lenoir and Dejean, these data suggest that nuptial flights occurring in natural populations of *P. laboriosa* are nocturnal. However, that supposition remains still to be confirmed.

Presently, we describe two nuptial flights observed by us in a queenless colony of *P. laboriosa* kept in laboratory. All the ants came from a single nest collected in Ndupé (Cameroon; 125 km from Yaoundé in the direction of Douala) in December 1990.

The ants were housed first in a large artificial nest composed of a rectangular closed box made of transparent Plexiglas (28 cm x 28 cm x 9 cm). The nest contained six large test tubes acting as shelters for the ants and as brood chambers. Three of these tubes were empty, and three others were filled to about one-third of their length with water held in by means of a cotton plug. The ants were fed on honey mixed with crushed apples and sand (added to make the mixture less sticky) and on pieces of insects: houseflies and house crickets. Drinking water was provided in three large test tubes filled completely with water and plugged with cotton.

During the period 20th November - 15th December 1991 the ants were used in an experiment in which we observed their responses to prey items (dead house crickets). To that purpose, on 20th -24th November 1991, all workers were marked individually with small tags made of plastic foil glued to their thoraces. On 20th November 1991 we also enlarged the nest by connecting it with another closed box of the same size *via* a 15 cm long, 2.5 cm in diameter Plexiglas tube. From then on, that second box (the Box B) started to serve as the foraging area of our colony: we were no more putting any food in the box containing the test tubes with brood (called now the Box A). The Box B also contained two large empty test tubes (to serve as shelters for the ants) and two test tubes filled completely with water and plugged with cotton (to provide drinking water).

The whole nest was exposed to natural rhythm of daylight and darkness. Additionnally, on each day it was illuminated with a lamp providing white light illumination of 3,000 lux (as measured on the floor level of the nest) and acting as a source of heat (exposure to that lamp resulted in a 2-3°C rise of air temperature inside the nest within 20 min after its turning on). On each day, the nest was exposed to that lamp during in total approximately 6 h: the lamp was turned on and off in such a way that the temperature inside the nest was kept at 23-24°C. During the night (between 12.00 p.m. and 8.00 a.m.) the lamp was always switched off and the nest was placed close to a radiator. The temperature in the nest was kept at 20-21°C.

During the period 26th November 1991 - 15th December 1991, the colony was composed of 50 workers, 17 alate females, 1 female possessing still 1 wing, 11 males and 20 small (less than 2 mm long) larvae. No ant died during that period. The alate females and males as a rule stayed within the test tubes placed in the Box A. In particular, the males were guarded by the workers and not allowed to depart. Initially, when the nest was composed of a single box, the males were not allowed to stay outside of the test tubes serving as brood chambers: if any of them strayed outside, it was promptly transported back by one of the workers. Often the workers did not even wait until the male assumes a typical transport posture, but dragged it to the brood chamber by a leg or by a wing. After the enlargement of the nest by adding the Box B, the workers allowed the males to stay outside the test tubes within the Box A, but any male which strayed into the Box B was quickly transported back into the Box A.

On 6th -7th December 1991 the lamp illuminating and heating the colony during the daytime was exceptionally not turned on; instead, the nest was kept close to a radiator both during the night and during the daytime. On 8th December in the morning, while the nest continued to be kept close to the radiator in near darkness (less than 2 lux of daylight), we observed the first of the two nuptial

TABLE I

Main events recorded during two nuptial flights observed in a captive queenless colony of *Polyrhachis laboriosa* in December 1991. At the start of each observation the nest was exposed to less than 2 lux of daylight. For further explanations see the text

Time	Observations
	8th December 1991
10.00	In the Box A, 10 alate females and 5 males are flying. No other ant is present outside the test tubes containing brood. In the Box B, 3 alate females and 2 males are flying; 3 workers also present there are motionless. The nest is moved to a place where it is exposed to about 140 lux of daylight.
10.20	5 alate females and 5 males continue to fly uninterruptedly in the Box A. 1 alate female and 2 males continue to fly in the Box B. The remaining alates which were present in the Box B at the start of the observation already re-entered the Box A. 3 workers present in the Box B continue to be motionless, with their bodies pressed tightly against the ground.
10.30	In the Box A, 3 alate females are reentering the test tubes containing brood. Workers are starting to issue out of these tubes.
10.45	In the Box A, 2 workers belonging to the inner service (never observed in the Box B) are transporting 2 males into the test tubes containing brood.
10.50	In the Box A, 2 alate females are flying, 7 other alate females are walking on the ground. In the Box B, only 1 alate female is still present, but she is no more flying.
11.00	In the Box A, the last alate female stops flying and the last male is being transported by a worker into the test tube containing brood.
	11th December 1991
8.00	3 alate females and 2 males are flying in the Box A; in the Box B, no ant is present. The nest is exposed to a heating lamp producing white light of about 3,000 lux (as measured on the level of the floor of the nest). Immediately afterwards the workers start to issue out of the test tubes containing brood.
8.03	Flying activity of the alate females starts to be interrupted (the bouts of about 10 s of flying become interspersed with the bouts of about 20-30 s each of walking on the ground). The males continue to fly uninterruptedly.
8.10	All males are already dragged back by workers into the test tubes containing brood. 2 alate females are still staying outside of these tubes, but they are no more flying.
10.00	2 alate females continue to walk outside of the test tubes containing brood. They were not showing any flying activity since it stopped a few minutes after the exposure of the nest to the heating lamp.

flights reported in the present paper. Main observations recorded during that flight are summarized in Table I.

During the whole day which followed that flight, both the alates and the workers of *P. laboriosa* were unusually active. Up to 8th December, all the males and the majority of the alate females usually stayed motionless inside the tubes in the Box A; only two alate females were sometimes observed to walk outside of these tubes. On 8th December after the nuptial flight the males also stayed in the test tubes in the Box A, but they showed an unusually high level of non-locomotory activity. The alate females were exceptionally active, too, and they were very frequently walking out of the test tubes. The workers showed a very high level of allogrooming behaviour which involved antennal contacts with the nestmates, licking their bodies, and scraping their bodies with the mandibles. Allogrooming behaviour of the workers was directed to males, alate females, and to other workers. As a consequence of that intense allogrooming, ten workers lost their tags, while no tag was lost during the preceding two weeks since the day when all workers were marked. In contrast, on the next day (9th December 1991) the ants were very little active: no ant was present in the Box B during the whole day up to 23.00 in the evening. Only then, while the nest was already kept in darkness, 3 workers were observed to forage in the Box B.

The second nuptial flight was observed on 11th December 1991. Main observations recorded during that flight are summarized in Table I. As can be seen, this time the exposure of the flying alates to the lamp producing approximately 3,000 lux of artificial white light and acting as a source of heat suppressed their flight activity almost instantaneously, much quicker than in the previous case when the flying alates were exposed to 140 lux of daylight. The second flight was not followed by an increased activity level of the ants, nor by intense allogrooming activity of the workers.

Our present observations are among the first data providing information about the nuptial flights of *P. laboriosa* and about the factors influencing nuptial flight activity of alates of that ant species. The only other observation of a nuptial flight in of *P. laboriosa* made so far - a flight of 6 females and 5 males observed in June 1990 at midnight - was also made in laboratory (Lenoir and Dejean 1994).

Our present data also demonstrate that flying activity of alates of *P. laboriosa* is suppressed by their exposure to light (alone or coupled with the rise in temperature). Hence, they support the supposition of Lenoir and Dejean (1994) that nuptial flights of that species are nocturnal or occur during the early morning, although that supposition remains still to be verified by field observations.

Laboratory studies of ant nuptial flights and mating behaviour are already fairly numerous (among others, Chauvin 1947, Gösswald and Schmidt 1960, Passera 1963, Plateaux 1970, 1978, Gösswald 1978, Woyciechowski 1990, Yamauchi et al. 1994). These studies demonstrated, among others, that ants may carry out nuptial flight activities and/or mate successfully even if confined to relatively small containers (Plateaux 1970, Woyciechowski 1990, Yamauchi et al. 1994).

Numerous authors reported the data demonstrating that nuptial flights of various ant species occur at a species-characteristic time of the day (Kannowski 1959, Talbot 1965; for the reviews, see also McCluskey 1973, 1974, Hölldobler and Bartz 1985, Hölldobler and Wilson 1990). Nocturnal flight activity of alates was reported, among others, in the ants of the genus *Lasius* (Forel 1920), in *Atta texana* Buckley (Moser 1967), *Paraponera clavata* Fab. (McCluskey and Brown 1972), *Myrmecocystus mexicanus* Wesmael (Conway 1980), and in males of numerous species of army ants (Schneirla 1948, Raignier and van Bowen 1955, Haddow et al. 1966, Kannowski 1969, Baldridge et al. 1980).

Nuptial flight timing is, at least partly, controlled by endogenous clocks: ant alates (males and virgin winged females) kept in laboratory under constant illumination conditions as a rule show peaks of activity at the hours at which nuptial flights of a given species occurr in the field (McCluskey 1963, 1965, 1967, McCluskey and Brown 1972). In addition to that endogenous control, daily activity patterns of the alates and/or their nuptial flight activities can be modulated and fine tuned by environmental cues, in particular, by temperature and illumination (McCluskey 1963, 1965, Hölldobler and Maschwitz 1965, Boomsma and Leusink 1981, Hölldobler and Bartz 1985). In the field, exposure to sunlight results usually in joint increase of the illumination level, air temperature, and the temperature of the upper layer of soil and it is often difficult to discriminate between the effects of these factors (Kannowski 1959, Boomsma and Leusink 1981).

During nuptial flights and prenuptial and postnuptial activities the ants often respond to change in illumination rather than to its level (Kannowski 1959, Talbot 1959, 1964, 1966, Plateaux 1978). A suppressing effect of the increase in illumination on nuptial flight activities similar to that observed by us in *P. laboriosa* was reported in the ant species *Lasius minutus* Emery (Kannowski 1959, Talbot 1965), *Lasius speculiventris* Emery (Kannowski 1959a, Talbot 1965), *Aphaenogaster treatae* Forel (Talbot 1966), *Leptothorax unifasciatus* Latreille (Plateaux 1978), and *Atta texana* Buckley (Moser 1967). In *A. texana* the alates are photonegative only at the beginning of the nuptial flight: before midnight light makes them retreat to the nest, but thereafter they become progressively photopositive (Moser 1967). Talbot (1945) also reported a suppressing effect of exposure to sunlight on nuptial flight activities of *Myrmica emeryana* Forel, but she attributed it to an abrupt rise in temperature.

Our observations also demonstrated that workers of *P. laboriosa* control the depart of the alates, in particular the males, by transporting them back to the brood chambers whenever they stray outside and after nuptial flights. Such worker control of nuptial flight activities of the alates was described in numerous ant species. In the ants of the subfamily Formicinae, it was reported in the genus *Formica* (Talbot and Kennedy 1940, Kannowski 1959, Talbot 1959, 1964, 1966, 1971, Marikovsky 1961, Rosengren and Fortelius 1986), *Prenolepis* (Talbot 1945), *Lasius* (Kannowski 1959a), *Acanthomyops* (Talbot 1963), *Camponotus* (Hölldobler and Maschwitz 1965, Talbot 1965) and *Myrmecocystus* (Conway 1980).

On the other hand, workers of some ant species were also observed to prompt the alates to depart (Kannowski 1959a, Talbot 1956, 1966, Marikovsky 1961, Conway 1980), or to remain totally passive (Talbot 1945, 1968, Kannowski 1959, Moser 1967).

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