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SHORT NOTE

Social Carrying and Defensive Behavior During Colony Emigration in the Leaf-cutting Ant *Atta sexdens*

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Abstract
In this work, we describe for the first time and under laboratory conditions, the behaviors related to social carrying and defensive strategies during colony emigration in the leaf-cutting ant *Atta sexdens*. Once colonies were laid on a tray under suboptimal conditions, groups of workers aggregated all over the body surface of the queen and brood, with mandibles half open and legs widely open in a 'entangle' formation. Queens were the first caste to be reallocated, followed respectively by the transportation of brood, newly-emerged workers, and pieces of fungus garden to the new nesting site. Contrary to what have been reported to the Myrmicinae species, adult transport followed a stereotyped sequence of acts involving approach, seize and transportation of newly-emerged workers to new target areas. Our results suggest that, in front of rapid unfavorable changes, leaf-cutting ants are capable of reorganize the nest in order to protect their members and resources.

Social carrying behavior is one of the most common behaviors performed by ants; workers constantly transport eggs, brood, and adults to target areas inside the nest (Moglich & Holldobler, 1974; Dahbi et al., 1997; Pie, 2002). Yet poorly investigated, social carrying seems to be primarily required in colony emigration, where it plays defensive roles as a response to the threats of the colony (Fowler, 1981; Nickele et al., 2012). Colony emigration occurs more frequently than previously thought (Hölldobler & Wilson, 1990). In *Acromyrmex* leaf-cutting ants, emigration process can take an entire week; they swiftly transport the symbiotic fungus, brood, males, gynes and queens to distances up to 100 meters (Nickele et al., 2012). In *Atta* species, emigration occurs subterraneously through underground galleries deeper than 1 meter that could reach distances up to 300 metres away from the original nest (Autuori, 1941; Fowler, 1981). According to Fowler (1981), in leaf-cutting ants, emigrations are generally induced by pesticide intoxication or intra- and interspecific competition.

In order to gain new insights into defensive strategies and social carrying behavior in leaf-cutting ants during colony emigration, in this work we adapted the methodology proposed by Möglich and Hölldobler (1974) where we stimulated emigration by keeping the population under suboptimal conditions and provided a new nesting site with optimal conditions. Such conditions were promoted by removing a portion of fungus garden with queen, brood, and workers from plastic containers of the original nest to an open tray where individuals were exposed to low humidity (approximately 30%). We then offered a new nesting site made up of a 2 L acrylic chamber with 1 cm of plaster in the bottom to keep the humidity high, according to the preference of the species for rearing site and fungus culturing (Araújo et al., 2011). The acrylic chamber was connected to the disturbed tray by a 45 cm plastic tube. The experiments were conducted with four mature colonies of *A. sexdens* collected in Ribeirão Preto, Brazil, and for each colony we stimulated emigration only once.

The observations were made with the aid of a digital video camera and the behavior acts were registered and described.

Once laid on the perturbed tray, workers displayed alarm behavior; they moved rapidly with open mandibles, while few others stayed motionless with mandibles widely open to upward position. Parallel to this immediate response, a group of workers, comprised mainly media workers (head width around 1.2 mm) and major workers (head width around 2.0 mm), aggregated all over the body surface of queen and brood, with mandibles half open and the pair of legs widely open in an 'entangle' formation (Fig 1 A-B). After approximately 5 minutes of exposure to the perturbed tray, workers started to reorganize themselves. First, a group of dozens of workers entered and explored the new optimal chamber, moving and touching the wall of the chamber with their antennae and the tips of the gaster. In all observed emigrations, the first caste to be transported was the queen, which happened after a soldier have returned from the new chamber, and induced the queen to move out from the disturbed tray by an attempt to grab her with the mandibles by the head or gaster (Fig 1B). We interpreted this behavior as a signalization to allow the queen to emigrate. Such behavior, only performed by soldiers, induced the workers, which were entangled onto the queen's body, to come down and rearrange themselves around the queen, sometimes pulling her by the legs, until the moment she arrived at the new nesting site. After the queen's reallocation, workers transported respectively to the new site: brood, newly-emerged workers (NEW) and pieces of fungus.

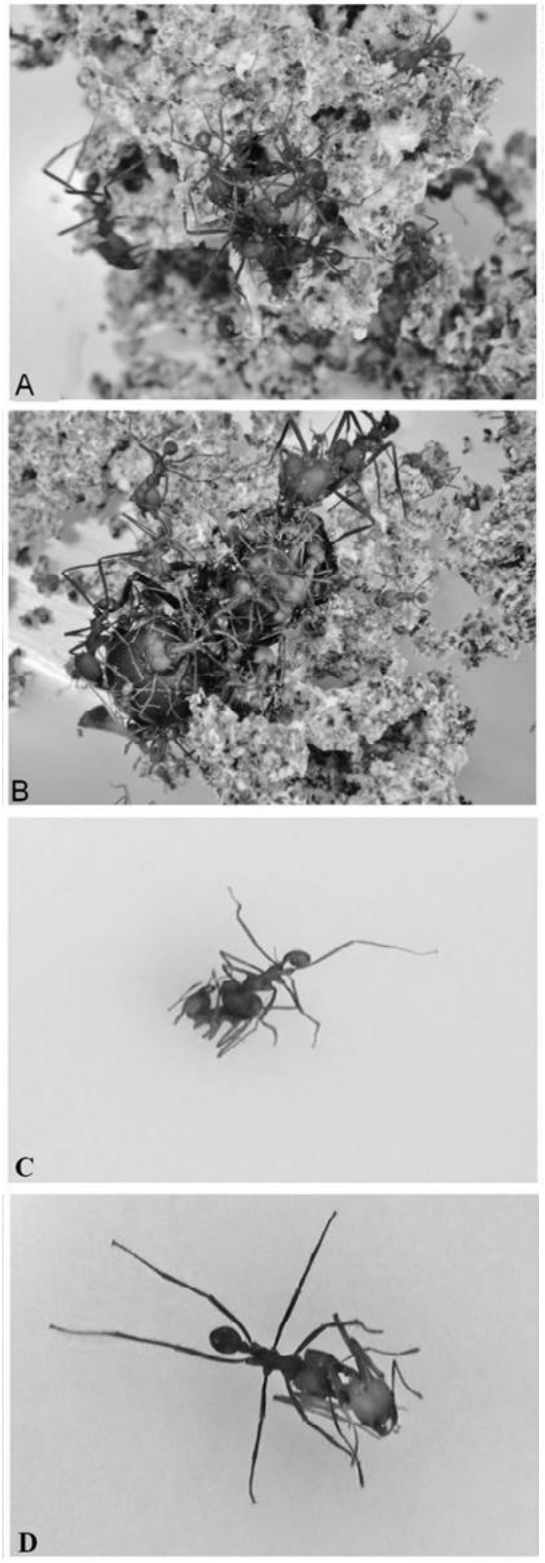

Fig 1. Behaviors associated to colony defense and social carrying during colony emigration, in *A. sexdens*. **A, B**: Aggregation of median and major workers around the body surface of larvae (A), and queen (B). **C, D**: Social carrying behavior of a newly-emerged worker during colony emigration.

Contrary to what have been reported to the Myrmicinae species (Moglich & Holldobler, 1974), adult transport in *A. sexdens* followed a stereotyped sequence of acts separated into three categories: approach, seize and transportation. 1) Approach, when the transporter worker approached the NEW by touching her with the antenna or legs, sometimes performing front leg boxing; 2) seize, when the transporter pulled the NEW by the legs, petiole or gaster; 3) after being seized, NEW assumed the 'pupae' position (Fig 1C), by contracting the pair of legs close to the body, allowing the transporter to grab her by the petiole or gaster and reallocate them together with queen and brood items (Fig 1D). Our results suggest that, in front of adversities, leaf-cutting ants are capable of promptly reorganize the nest in order to protect their members and resources.

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