

Scientific Note

A new rescue behavior in the ant *Ectatomma muticum* Mayr, 1870 (Hymenoptera, Formicidae: Ectatomminae) captured by a trapdoor spider of the genus *Neodiplothele* Mello-Leitão, 1917 (Araneae: Barychelidae)

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Abstract. Rescue behavior among eusocial insects, particularly ants (Hymenoptera: Formicidae), is a remarkable cooperative interaction in which individuals risk their lives to save others without direct reward. This study reports the rescue behavior of the ant *Ectatomma muticum* Mayr, 1870 (Hymenoptera: Formicidae), which was freed from a trap set by a spider *Neodiplothele* Mello-Leitão, 1917 (Mygalomorphae: Barychelidae) in the paleodunes of the São Francisco River, in the Caatinga, northeastern Brazil. This is the first record of a rescue behavior in Ectatomminae and of a rescue involving an ant trapped in the silk of a trapdoor spider. *Ectatomma muticum* may represent a new model for the study of rescue behavior.

Keywords: Caatinga, Insecta, interspecific relations, sandy habitat.

Cooperation among colony members in eusocial insects like ants may manifest in various, including offspring care, defense against predators, and rescue of individuals at risk (Hölldobler & Wilson 1990; Hollis & Nowbahari 2022). Among these behaviors, the act of rescue stands out in several aspects, as the rescuers essentially expose themselves to danger to save another individual, and the act of rescue is not inherently rewarding or beneficial (Miller & Turza 2021; Hollis & Nowbahari 2022). Rescue behavior in ants was reported anecdotally until the study by Czechowski et al. (2002) on the rescue of an ant that fell into the trap and was captured by an antlion larva (Insecta: Neuroptera: Myrmeleontidae) and the experiment of Nowbahari et al. (2009) that simulate a natural situation in which an ant can be entrapped by collapsing sand and debris. Other dangers encountered by foraging ants are the trap webs made by spiders. A notable example of rescue behavior was observed in the species *Veromessor pergandei* (Mayr, 1886) (Hymenoptera: Formicidae), which consistently rescues colony members entangled in spider webs and subsequently destroys the webs themselves (Kwapich & Hölldobler 2019). This pattern of action suggests an adaptive strategy, possibly aimed at protecting the colony against external threats.

The understanding of ants' rescue behavior when captured by other predators is still limited, with records so far restricted to the subfamilies Formicinae (Czechowski et al. 2002; Uy et al. 2019), and Myrmicinae (Kwapich & Hölldobler 2019). This underscores the lack of knowledge across other ant lineages, regarding the evolutionary history of these interactions. Therefore, to contribute to filling this gap, the present study describes the first recorded rescue behavior for the Ectatomminae, involving the ant *Ectatomma muticum* Mayr, 1870 (Hymenoptera: Formicidae), which was freed from a trap set by a spider of the genus *Neodiplothele* Mello-Leitão, 1917 (Mygalomorphae: Barychelidae).

The rescue behavior was observed during a nocturnal expedition to collect ants (7–11 p.m.) on February 10, 2024, in a Caatinga area situated in the paleodunes of Casa Nova municipality, state of Bahia,

northeastern Brazil (9°23'43.6"S 41°21'35.3"W). The rescue event was directly observed by four researchers in the field. The paleodunes exhibit vegetation composed of small trees, shrubs, succulent and herbaceous plants that form, at their bases, leaf litter islands separated by large sandy areas, providing shelter and protection for various animals, especially against the high temperatures found in the sand exposed to the sun. We observed a worker of *E. muticum* partially buried in the sand. Since it is an unusual situation, we immediately decided to film the scene with a cell phone. Once the behavioral sequence had been completed, we collected the individuals and material involved in the scene we had filmed. All specimens collected were preserved in 70% alcohol. The ants and the spider were identified following the identification keys of Arias-Penna (2008) and Gonzalez-Filho et al. (2015), respectively. All individuals were deposited in the Laboratório de Mirmecologia do Sertão, Coleção Entomológica do Museu de Fauna da Caatinga, Universidade Federal do Vale do São Francisco, Petrolina, Pernambuco, Brazil (MFCE-LMS), the spider with the unique specimen identifier MFCE014613 and the ant with the code MFCE021593.

We observed a worker of *E. muticum* partially buried in the sand within a silk trap built by a spider, with only the head and the two anterior legs protruding from the ground (Fig. 1A; S1). Shortly afterwards, two other *E. muticum* workers approached the trapped ant. One began biting the silk structure adjacent to the ant, while the other started to dig the sand around the half-buried individual, which soon managed to escape from the trap with the assistance of its free legs (Fig. 1A–B; S1).

After being rescued, the ant performed autogrooming (Fig. 1C–D; S1), while the two other workers continued digging, biting, and stinging the silk structure until one of them managed to pull it out of the sand (Fig. 1C–F; S1). The rescue sequence lasted just over one minute. Immediately after the event, we collected a handful of sand from the excavation site and captured a spider of the genus *Neodiplothele*. Inside the silk structure, we found a dead worker of *E. muticum*.

In this study, we report and document for the first time a rescue

behavior involving an ant trapped in the silk-lined burrow of a trapdoor spider. Initially, it was thought that the ant was buried in the sand, but in fact it was captured and dragged into the burrow by a spider of the genus *Neodiplothele*. The observed behavior meets the four criteria that define rescue behavior proposed by Hollis & Nowbahari (2013): (1) the victim is in danger; (2) the rescuer puts themselves at risk by engaging in a rescue attempt; (3) the rescuer's behavior is appropriate

to the specific situation of danger or risk to the victim; and (4) the act of rescuing is not inherently rewarding or beneficial to the rescuer.

The trapped ant may have emitted signals that attracted the other two workers. Although this was not directly observed, recruitment could plausibly involve chemical cues (Crewe & Fletcher 1973; Kwapich & Hölldobler 2019; Hollis & Nowbahari 2022; but see Miler & Kuszewska 2017) or vibrational signals produced through stridulation (Golden &



Figure 1. Rescue behavior of a worker of the ant *Ectatomma muticum* Mayr, 1870 (Hymenoptera: Formicidae) trapped by a trapdoor spider. A) Partially buried worker rescue by one worker that dig and another that bit an adjacent structure; B) The trapped worker almost out of the trap; C and D) The rescued worker grooms itself while the other two continue to attack the trap; E and F) a worker bite and sting the buried structure until managing to pull it out of the sand. A-D) the red arrow indicates the trapped worker. E) the green arrow indicates the worker that bit and stung the silky structure. F) The blue arrow indicates the silky structure that has been unearthed.

Hill 2016; Masoni et al. 2021; Santos Junior et al. 2021). Some species of the genus *Ectatomma* Smith, 1858 (Hymenoptera: Formicidae), are known to use stridulatory signals in distress or rescue contexts (Pavan et al. 1997; Peña Carrillo et al. 2021), making this a biologically plausible, albeit untested, explanation for the observed behavior.

The rescue behavior of ants captured by spiders is still poorly documented (Kwapich & Hölldobler 2019; Uy et al. 2019) and corresponded to spiders building webs until our observation. We report a novel case of rescue behavior for an ant caught in a predator's trap that falls between the case of spiders and their webs and the case of the ambush antlions and their conical pitfall traps on sand and loose soil. The rescue ants attacked the silk structure and dug into the sand until the trap was inactivated. Destroying the trap into which the rescued ant had fallen allows the foraging area to be "demined," and Kwapich & Hölldobler (2019) proposed that an important driver for the evolution of systematic trap destruction could be the foraging strategy of the ant species.

The trapped ant was probably rescued by conspecifics from the same colony, as an individual of another colony or species is not usually rescued or must be attacked after being rescued (Nowbahari et al. 2009; Hollis & Nowbahari 2013; 2022; Taylor et al. 2013). Rescue behavior was especially documented in species of the subfamilies Myrmicinae and Formicinae, known for their large colonies (Czechowski et al. 2002; Nowbahari et al. 2009; Hollis & Nowbahari 2013; Taylor et al. 2013; Kwapich & Hölldobler 2019; Uy et al. 2019). However, representatives of the subfamily Ectatomminae typically maintain smaller colonies (Dornhaus et al. 2012). For ant species with smaller colonies, the loss of an individual may significantly impact colony size, needing greater energy expenditure to produce another individual, while rescuing can facilitate the maintenance of larger colony size which could be a factor influencing the evolution of rescue behavior in social species even in species forming large colonies (Frank et al. 2017; and see Hollis & Nowbahari 2022). This may be particularly true for the ant *E. muticum* inhabiting the Caatinga, a highly seasonal environment (Albuquerque & Melo 2018) where the availability of resources is lower at a certain time of year.

In the paleodunes of the São Francisco River, the ants *E. muticum* face multiple risks both inside and outside the nest, particularly during foraging. Although such risks are not exclusive to this environment, they may be especially pronounced in paleodune systems. In some cases, ants in danger can still be rescued, particularly because nestmate foragers may be present within the same foraging area and therefore within range of potential rescue signals emitted by the victim. Among the potential threats observed in the paleodunes are burial in loose sand and encounters with predator-built traps, especially those of antlions and spiders, which are abundant in this environment. It is not surprising, then, to have observed the presence of rescue behavior in this ant species. In addition to the destruction of the trapdoor spider trap, it would be interesting to know whether *E. muticum* foragers are able to avoid the traps of their predators, as it has been demonstrated experimentally in another ant species of the genus *Cataglyphis* Foerster, 1850 (Hymenoptera: Formicidae) (Bar et al. 2022). The presence of rescue behavior in *E. muticum* must be an adaptation to the dangers present in the habitat where populations of this species live, as suggested by Hollis & Nowbahari (2022). Field observations and additional studies on other species of the Ectatomminae, particularly on populations or species with different ecological contexts, are still needed, as is the case for many ant groups.

Here, we expand current knowledge on rescue behavior in ants by reporting a field-based observation involving a subfamily for which this behavior had not yet been documented. Moreover, direct observations in the natural habitat are also important for understanding the ecological significance of such behavior. This species, *E. muticum*, appears to form relatively small colonies, often with no more than a few hundred workers (BJB, pers. obs.), and some populations of which live in a sandy habitat full of trap-building predators, could certainly be a new model for studying rescue behavior.

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Authors' Contributions

AOS-J: investigation, writing - original draft, writing - review & editing; GLC: investigation, resources, data curation, writing - original draft, writing - review & editing, visualization; AGC: investigation, writing - review & editing, visualization; AFAL: validation, writing - review & editing, supervision, project administration, funding acquisition; BJB: validation, investigation, data curation, writing - original draft, writing - review & editing, visualization, supervision, project administration, funding acquisition.

Conflict of Interest Statement

The authors declare that there is no conflict of interest.

Ethical Approval

This study did not involve human participants or vertebrate animals and, therefore, did not require approval from an ethics committee under applicable institutional and national guidelines.

Supplementary Material

Supplementary data for this article be accessed at doi: <https://doi.org/10.5281/zenodo.19020121>

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Generative AI Statement

Generative AI (ChatGPT) was used exclusively to assist with English language editing and grammar improvement. The AI tool did not contribute to the study design, data analysis, interpretation of results, or scientific conclusions. All content was reviewed and approved by the authors, who take full responsibility for the manuscript.

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