



SHORT NOTE

Ant Rafting in an Extreme Ecosystem

GERALDO W. FERNANDES, FLÁVIO S. DE CASTRO, FLÁVIO CAMAROTA, JESSICA C BLUM, RENATA MAIA

Universidade Federal de Minas Gerais, Departamento de Genética, Ecologia e Evolução, Belo Horizonte, Brazil

Article History

Edited by

Evandro Nascimento Silva, UEFS, Brazil
 Received 24 September 2021
 Initial acceptance 27 September 2021
 Final acceptance 06 October 2021
 Publication date 19 November 2021

Keywords

Campo rupestre, *Linepthea micans*,
 Mountaintop grassland, Rupestrian
 grassland, Serra do Cipó.

Corresponding author

Flávio Camarota
 Universidade Federal de Minas Gerais
 CEP: 31270-901, Belo Horizonte, Brasil.
 E-Mail: camarotaflavio@gmail.com

Abstract

Ants are among the most abundant organisms on Earth, being adapted for living on different solid surfaces. However, in some habitats, like riparian forests and flooded plains, water can be a constant obstacle, and overcoming this obstacle can be essential to determine the persistence of ants in such habitats. While most ant species avoid the water during a flood by foraging at higher elevations or climbing on trees, a few species developed ways to overcome this obstacle by swimming. Here, we report, for the first time, ants of the species *Linepthea micans* (Forel 1908) performing rafts. We observed 14 rafts in three consecutive days at approximately 1400 meters a.s.l. in Serra do Cipó, Brazil. Notably, this is the first record of ant rafting in tropical mountaintop grasslands, extreme habitats with shallow and sandy soils, where small temporary water pools are extremely common in the wet season.

Introduction

Ants are among the most ubiquitous organisms in terrestrial habitats, being highly diverse and comprising a significant part of the terrestrial arthropods' biomass (Holldöbler & Wilson, 1990; Lach et al., 2010). Ants are terrestrial and cursorial organisms adapted for living on different solid surfaces, from the soil underground to the canopies of tropical rain forests. Although water is present in 70% of the planet, interactions with water represent a formidable obstacle for such terrestrial organisms. Successfully overcoming this obstacle can be essential to determine their persistence in some specific habitats. Among these habitats are those constantly flooded, such as the intertidal zone and seasonally flooded areas, like floodplains and riparian forests. While some species avoid the water by constraining their foraging activities to drier habitats or climbing taller objects (Adis, 1997), others developed ways to overcome this obstacle by swimming.

While ant swimming is not usual, it has been known for over a century that ants have some swimming ability (Field, 1903; Wheeler, 1910). The swimming behavior occurs in multiple ant genera distributed in different clades, and there is often considerable variation across different ant groups and even among species within genera (Yanoviak & Frederick, 2014). Usually, larger ant species, like *Pachycondyla* spp. and *Odontomachus bauri*, are efficient swimmers, using their long legs to provide propulsion (Yanoviak & Frederick, 2014). Perhaps, the most extreme cases involve ant species inhabiting mangroves (Nielsen, 1997; Robson, 2010). The Australian ant *Polyhachis sokolova* can have their colonies submerged for 3.5 hours during a normal tide cycle and covered by two meters of water under extreme tides (Shuetrim, 2001). Another interesting adaptation is related to ant species associated with pitcher plants and other epiphytes, such as *Camponotus schmitzi* ants that live in symbiosis with the pitcher plant *Nepenthes bicalcarata*,



in Bornean rain forests (Clarke & Kitching, 1995; Merbach et al., 2007). This interaction is unique because the ants actively forage on the water to prey on the insects captured by the pitcher plant (Bohn et al., 2012). In the ground of tropical forests, some large-bodied ants, such as *Ectatomma ruidum* and *Acromyrmex lundii*, can walk to overcome small pools of water (Adis, 1982; Yanoviak & Frederick, 2014). While most of the mentioned taxa are from tropical habitats, some cases were also reported for temperate forest ants, including the genera *Camponotus* and *Formica* (DuBois & Jander, 1985; Yanoviak & Frederick, 2014).

Some ant species, usually small-bodied, can overcome the lack of morphological adaptations for swimming by linking their body together in a kind of self-assembly, the ant rafting, consisting of floating conglomerations of ants (Purcell et al., 2014; Avril et al., 2016). Rafting is extremely important in habitats where colonies are often exposed to floods, and these floating masses can persist from some hours to even a few weeks (Adams et al., 2011). The rafts comprise interconnected workers connected mainly by their tarsi and curling their appendages, forming Velcro-like connections in the structure (Adams et al., 2011). The rafting behavior gained much attention since it is used by one of the most prominent invasive ant species, *Solenopsis invicta*, which can form rafts of thousands of individuals (Mlot et al., 2011; 2012). The native habitats of *S. invicta* are mostly comprised of seasonally flooded plains, like the Brazilian Pantanal. This adaptation could have been extremely important in defining *S. invicta* as one of the numerically dominant ant species (Adams et al., 2011). While rafting appears to be a formidable adaptation for those species living in constantly flooding habitats, only a few species have been recorded performing rafting. One common feature is that they were all found in habitats prone to inundation.

On three consecutive days in April 2021, we observed the formation of 14 rafts at a small first order wash at approximately 1400 meters a.s.l. in Serra do Cipó, Brazil (19°10'19,7" S 043° 60' 49,2" W) (Fig 1). On the first day, nine rafts were observed. These varied from 3 to 10 cm in diameter and were composed of a single ant species, *Linepithema micans* (Fig 2 a, b). The form of the rafts was mostly a circle, with a very large number of ants. Only workers were observed in the rafting. Curiously, ants swam actively towards the rafting, even against the wash's weak but constant water flow. Yet another interesting behavior was the jumping of many individuals into the water from some grass stems. This jumping behavior was observed in the morning (9:00 – 11:00) and lasted for ca. 15 minutes. On the following day, six rafts were observed; they had similar sizes. After the raft observations, we collected ant individuals to assure their species-level identification. The ants were stored in vials with 70% ethanol and brought to the laboratory. The ant identification was performed by Flávio Siqueira de Castro, by comparisons with the extensive collection of Formicidae from campo rupestre of the Laboratory of Insect Ecology at the Universidade Federal de Minas Gerais, Brazil. All ants collected are held at this referred collection of Formicidae, which consists mostly of specimens from the PELD/CRSC Project (Silveira et al., 2019).

Here, we show, for the first time, ants of the species *Linepithema micans* (Forel, 1908) performing rafts. While this is not the first record for rafting on the genus *Linepithema* (see Nondillo et al., 2013), it is the first record of such complex social behavior in a tropical mountaintop grassland. *L. micans* is very common in the study area (Costa et al., 2016; Monteiro et al., 2020; Calazans et al., 2020; Castro et al., 2020) and generally exhibit high recruitment rates with many individuals



Fig 1. Ant raft in a small water pool in Serra do Cipó, Minas Gerais, Brazil.

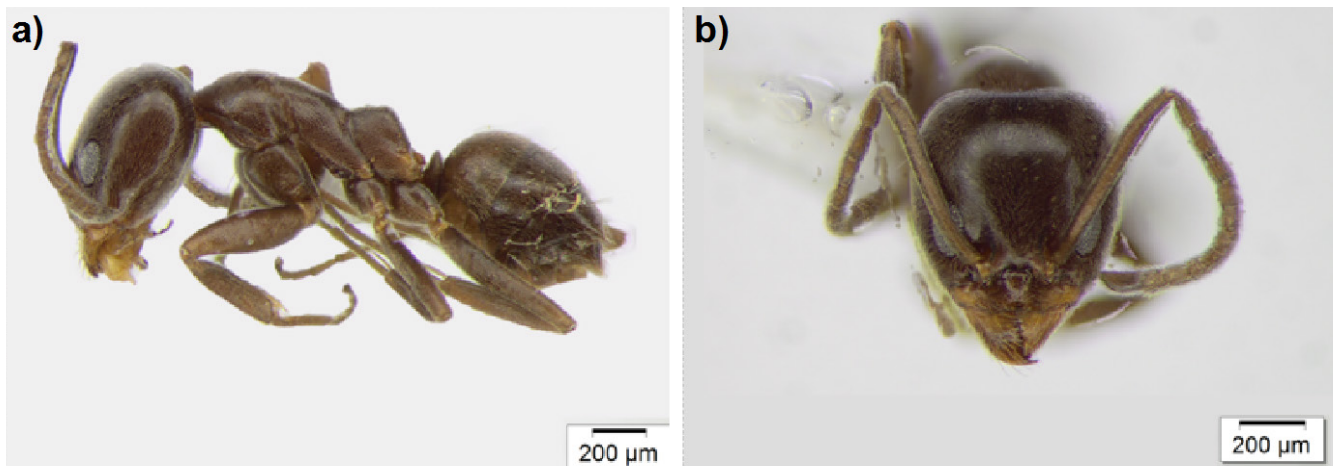


Fig 2. Lateral (a) and frontal (b) view of a *Linepithema micans* worker.

foraging on the ground (Nondillo et al., 2013). The formation of rafts by *L. micans* has purposes similar to other species with this behavior. That essentially means the ants gather a significant part of the colony to find drier places to forage. The soils in the harsh and nutritionally poor habitats at high elevation in the Espinhaço mountains are mostly shallow and sandy. During the wet season, the formation of small temporary water pools is extremely common (see reviews in Fernandes, 2016). Thus, while rafting is relatively uncommon among ant species, our observation suggests that this behavior may be more widespread than previously thought.

Although no specific swimming adaptation has been reported for this species, this is the first record of such a phenomenon. The region where the observations were taken is known for its high precipitation and rapid flood events due to the orographic rains and strong winds. During the winter, the moisture-laden clouds may bring important water and humidity to the region, representing another stressing variable among the others known for this mountaintop area (see Fernandes, 2016). While we do not know the relevance of this behavior to colony success, it may represent an important observation on the plasticity of ants to deal with abrupt changes in extreme tropical environments.

Acknowledgements

We thank the support provided by the Brazilian National Research Council – CNPq, Minas Gerais Foundation for Science (Fapemig), Anglo American, and the Project Peld-CRSC-17 (CNPq-MCTI).

Author contributions

All authors contributed to the study's conception and design. All authors performed data collection and analysis.

Conflicts of Interest/Competing Interests

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

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