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SHORT NOTE

A Day in the Life of the Giant Ant *Dinoponera lucida* Emery, 1901 (Hymenoptera, Formicidae): Records of Activities and Intraspecific Interactions

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Abstract

Ants present a wide variety of nesting sites, feeding habits, and trophic interactions, but the biology of most species remains unknown. *Dinoponera lucida* is a poneromorph ant forest-specialist and solitary forager, endemic to the Brazil's Atlantic Forest. Herein we describe foraging activities, guard and maintenance of the nests, orientation mode, and intraspecific interactions performed by *D. lucida*. We found three nests distant from each other at least 8.5 m, and the mean reached distance by a worker was 3.8 m. The workers showed colony fidelity and random forage in their territory. We observed two non-agonistic interactions between workers from the same nest, and two agonistic interactions between foraging workers from different nests. The low frequency of agonistic interactions suggests that workers from different nests are unlikely to forage in the same area. Our results expand the knowledge on ants' natural history through data on foraging activities, guard and maintenance of the nests, orientation mode and intraspecific interactions.

Ants are among the most abundant groups of terrestrial invertebrates. Ants have a wide variety of nesting sites, feeding habits, and trophic interactions (Kaspari, 2000), and are the subject of basic and applied research. However, the biology of most species remains unknown, urging descriptive studies (Krell, 2004; Greene, 2005).

Dinoponera lucida Emery, 1901 is a poneromorph ant endemic to the Atlantic Forest (Peixoto et al., 2010; Simon et al., 2020), endangered (EN) according to the Brazilian Red List (MMA, 2014; ICMBio, 2018). *Dinoponera lucida* is a forest-specialist solitary forager with no recruitment, a typical behavior of *Dinoponera* species (Planqué et al., 2010; Araujo et al., 2015; Curbani et al., 2021). Few ecological studies are available (see Peixoto et al., 2008, 2010), but, as a threatened species, nesting and foraging data are crucial for conservation plans. Herein, we add further information on intraspecific non-agonistic and interspecific agonistic interactions, guarding, and maintenance of the nests, foraging activities and orientation mode performed by *D. lucida*.

We carried out observations from September 29th to October 2nd, 2017, in the Reserva Natural Vale (22.711 ha), municipality of Linhares, northern of Espírito Santo

state, southeastern of Brazil. We observed *D. lucida* workers in foraging activity for 48 hours (cumulative sampling), continuously from 6 AM to 6 PM for four days, from three distinct nests in a 30 m x 30 m plot in a lowland coastal forest (19º 09' 14.5" S, 40º 04' 14.0" W).

The solitary workers of *D. lucida* foraged for food around the nests, covering an estimated area of 11 m^2 (based on mean radius reached by workers). Workers do not appear to have specific pattern displacement or preference for any area. They randomly forage in their territory making a sinuous route while touching the leaf litter with antennae. We did not observe workers entering in nests other than their own nests, nor aggressive interactions between nestmates. *Dinoponera lucida* had colony fidelity throughout sampling. Workers returned straight to their original nests after capturing prey. *Dinoponera gigantea* (Perty, 1833) had similar returning behavior (Fourcassié & Oliveira, 2002). It is likely that *D. lucida* has returning strategy that uses directional fidelity within a home range, such as a sense of visual orientation.

In our field interventions, we removed the leaf litter excluding chemical tracks and visual cues, as proposed by Fresneau (1985) for *Neoponera apicalis* (Latreille, 1802). However, this removal did not change the course of *D. lucida* workers. This may indicate that *D. lucida* uses fixed visual cues in the environment that go beyond the leaf litter landmarks, such as trunks, branches, roots and shrubs, being important to define its stereotyped routes. In the *Dinoponera* genus the use of visual cues has already been reported to *D. gigantea* (Fourcassié et al., 1999) and *D. quadriceps* (Azevedo et al., 2014). It is known that solitary forager ants learn individual stereotyped routes to increase their navigation efficiency (Wystrach et al., 2011b), to obtain a food source (Fresneau, 1985) or to return to the nest (Wystrach et al., 2011a). Forest ants, as *D. lucida* workers in foraging activity can have highly stereotyped routes between the nest and the feeding locations (Niven, 2007). This orientation strategy was also reported for *D. gigantea* (Fourcassié & Oliveira, 2002) and *D. quadriceps* (Azevedo et al., 2014).

Dinoponera lucida displayed permanent guard and maintenance of their nest. We observed sentinel workers at the nest's openings demonstrating guarding behavior (Fig 1A). Permanent nest guarding and maintenance were previously reported for *D. lucida* (Peixoto et al., 2010) and *D. quadriceps* (Medeiros et al., 2016). Probably, guarding activity inhibits non-nestmates intruders to access the nest. In addition, the workers also performed nest opening maintenance, such as removal of leaves, sticks, soil pellets and fallen plant fragments. The maintenance of nests was more evident on the third sampling day, with an increase in the number of workers at nest openings after rain (Fig 1B). This behavior seems to be an immediate response of the workers of *D. lucida* to the environmental changes that could lead to risk-altering nest's functions.

Fig 1. *Dinoponera lucida* nest opening at Reserva Natural Vale, state of Espírito Santo, Brazil. (A) Guard activity by a worker-sentinel, (B) workers in nest maintenance after raining.

We observed two non-agonistic interactions between workers from the same nest. In the first interaction, two workers displayed rapid antennation, moving away and continued solitary foraging. In the second interaction, workers cooperated in the transport of a seed to the nest. The first worker carrying a seed (*Swartzia myrtifolia* var. *elegans*; Fig 2A), dropped it when founded another worker, and returned to forage. Immediately, the second worker took the seed and returned to the nest (Fig 2B). In addition, we observed that the second worker foraged the leaf litter unlikely to follow a predefined route to find the nestmate. Generally, poneromorph ants do not cooperate during foraging (Fourcassié & Oliveira, 2002; Araújo & Rodrigues, 2006), but cooperation in *D. lucida* should not be a rare behavior. Labor division, and thus the observed cooperation between workers in the species, seem to follow age polyethism (individual age) (Peixoto et al., 2008).

We observed two agonistic interactions, both between foraging workers from nests 1 and 2 that occurred about 4 m from the openings of their nests (Fig 3). The interactions lasted 1 to 5 minutes. On both occasions, we observed the movements and behavior typical of agonistic interactions described for *D. lucida* and congeners, such as antennal

Fig 2. *Dinoponera lucida* workers at the Reserva Natural Vale, state of Espírito Santo, Brazil. (A) Seed of *Swartzia myrtifolia* var *elegans* transported by a worker, (B) foraging workers from the same nest in cooperative interaction to transport the seed.

boxing, gaster bending, bite in the legs and attempts to sting the opponent. At the end of the agonistic interactions, the workers moved away without any apparent damage and returned to forage. Agonistic encounters observed herein for *D. lucida* were similar to other *Dinoponera* species (Fourcassié & Oliveira, 2002; Peixoto et al., 2008). Peixoto et al. (2010) observed that the maximum distance reached by *D. lucida* workers in foraging activity was inversely related to the density of nests in the area, which indicates a strategy to minimize agonistic interactions. We found nests distant from each other at least 8.5 m (the distance between nests 1 and 2) and the mean reached distance by a worker was 3.8 ± 0.4 m (mean ± standard error). The low frequency of agonistic encounters may be due to the fact that workers from different nests usually do not forage in the same area.

Our results expand knowledge about natural history of *D. lucida* through data on foraging activities, guarding and maintenance of the nests, orientation mode and intraspecific interactions. However, descriptive data on *Dinoponera* species are still scarce. In addition, we suggest that long-term monitoring is feasible to assess natural history aspects of *D. lucida*, improving knowledge about the lifestyle of poneromorph ants.

Fig 3. Agonistic interaction between two *Dinoponera lucida* workers from different nests at the Reserva Natural Vale, state of Espírito Santo, Brazil.

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Authors' Contributions

CZ: conceptualization, methodology, investigation, and writing
FC: conceptualization, methodology, investigation, and writing
RBF: conceptualization, methodology, and writing
TGS: writing
CW: writing
ACSA: conceptualization, methodology, and writing

References

Araujo, A., Medeiros, J.C., Azevedo, D.L.O., Medeiros, I.A., Neto, W.A.S. & Garcia, D. (2015). Poneromorfas sem rainhas – *Dinoponera*: Aspectos ecológico-comportamentais. In: As formigas poneromorfas do Brasil (eds. Delabie, J.H.C., Feitosa, R.M., Serrão, J.E., Mariano, C.S.F. & Majer, J.D.). Editus, Ilhéus, pp. 237-246.

Araújo, A. & Rodrigues, Z. (2006). Foraging behavior of the queenless ant *Dinoponera quadriceps* Santschi (Hymenoptera: Formicidae). Neotropical Entomology, 35: 159-164. doi: 10.1590/S1519-566X2006000200002

Azevedo, D.L.O., Medeiros, J.C. & Araújo, A. (2014). Adjustments in the time, distance and direction of foraging in *Dinoponera quadriceps* workers. Journal of Insect Behavior, 27: 177-191. doi: 10.1007/s10905-013-9412-6

Curbani, F., Zocca, C., Ferreira, R.B., Waichert, C., Sobrinho, T.G. & Srbek-Araujo, A.C. (2021). Litter Surface Temperature: A Driving Factor Affecting Foraging Activity in *Dinoponera lucida* (Hymenoptera: Formicidae). Sociobiology, 68: e6030. doi: 10.13102/sociobiology.v68i1.6030

Fourcassié, V., Henriques, A. & Fontella, C. (1999). Route fidelity and spatial orientation in the ant *Dinoponera gigantea* (Hymenoptera, Formicidae) in a primary forest: A preliminary study. Sociobiology, 34: 505-524.

Fourcassié, V. & Oliveira, P.S. (2002). Foraging ecology of the giant Amazonian ant *Dinoponera gigantea* (Hymenoptera, Formicidae, Ponerinae): Activity schedule, diet and spatial foraging patterns. Journal of Natural History, 36: 2211-2227. doi: 10.1080/00222930110097149

Fresneau, D. (1985). Individual foraging and path fidelity in a ponerine ant. Insectes Sociaux, 32: 109-116. doi: 10.1007/BF02224226

Greene, H. (2005). Organisms in nature as a central focus for biology. Trends in Ecology and Evolution, 20: 23-27. doi: 10.1016/j.tree.2004.11.005

Instituto Chico Mendes de Conservação da Biodiversidade. (2018). Livro Vermelho da Fauna Brasileira Ameaçada de Extinção: Volume I. 1st edn. Instituto Chico Mendes de Conservação da Biodiversidade, Brasília.

Kaspari, M. (2000). A Primer on Ant Ecology. In: Ants: Standard methods for measuring and monitoring biodiversity (eds. Augusti, D., Majer, J.D., Alonso, L. & Schultz, T.). Smithsonian Institution Press, Washington, pp. 9-24.

Krell, F.T. (2004). Parataxonomy vs. taxonomy in biodiversity studies – Pitfalls and applicability of "morphospecies" sorting. Biodiversity and Conservation, 13: 795-812. doi: 10.1023/B:BIOC.0000011727.53780.63

Medeiros, J.C., Azevedo, D.L.O., Santana, M.A.D. & Araújo, A. (2016). Nest Maintenance Activity of *Dinoponera quadriceps* in a Natural Environment. Journal of Insect Behavior, 29: 162-171. doi: 10.1007/s10905-016-9550-8

Ministério do Meio Ambiente. (2014). Lista nacional oficial de espécies da fauna ameaçada de extinção. Portaria no 444, de 17 de dezembro de 2014. Diário Oficial da União. Brasil.

Niven, J.E. (2007). Invertebrate Memory: Wide-Eyed Ants Retrieve Visual Snapshots. Current Biology, 17: 85-87. doi: 10.1016/j.cub.2007.01.018

Peixoto, A.V., Campiolo, S. & Delabie, J.H.C. (2010). Basic ecological information about the threatened ant *Dinoponera lucida* Emery (Hymenoptera: Formicidae: Ponerinae), aiming its effective long-term conservation. In: Species Diversity and Extinction (ed. Tepper, G.H.). Nova Science Publishers, Inc., New York., pp. 183-213.

Peixoto, A.V., Campiolo, S., Lemes, T.N., Delabie, J.H.C. & Hora, R.R. (2008). Comportamento e estrutura reprodutiva da formiga *Dinoponera lucida* Emery (Hymenoptera, Formicidae). Revista Brasileira de Entomologia, 52: 88-94. doi: 10.1590/S0085-56262008000100016

Planqué, R., van den Berg, J.B. & Franks, N.R. (2010). Recruitment strategies and colony size in ants. PLoS ONE, 5: e11664. doi: 10.1371/journal.pone.0011664

Simon, S.S., Schoereder, J.H. & Teixeira, M.C. (2020). Environmental response of *Dinoponera lucida* Emery 1901 (Hymenoptera: Formicidae), an endemic threatened species of the Atlantic Forest Central Corridor. Sociobiology, 67: 65-73. doi: 10.13102/sociobiology.v67i1.3662

Wystrach, A., Cheng, K., Sosa, S. & Beugnon, G. (2011a). Geometry, Features, and Panoramic Views: Ants in Rectangular Arenas. Journal of Experimental Psychology: Animal Behavior Processes, 37: 420-435. doi: 10.1037/a0023886

Wystrach, A., Schwarz, S., Schultheiss, P., Beugnon, G. & Cheng, K. (2011b). Views, landmarks, and routes: How do desert ants negotiate an obstacle course? Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology, 197: 167-179. doi: 10.1007/s00359-010-0597-2