Sociobiology 65(2): 337-339 (June, 2018) DOI: 10.13102/sociobiology.v65i2.2162

Sociobiology
An international journal on social insects

SHORT NOTE

Simarouba versicolor (Simaroubaceae) Dispersal by the Leaf-Cutter Ant *Atta sexdens*

DRS Lopes, RC Tavares, KOM Batista, PB Souza, MO Nascimento, DJ Souza

Federal University of Tocantins (UFT), *Campus* of Gurupi, Tocantins, Brazil

Article History

Edited by
Evandro Nascimento Silva, UEFS, Brazil
Received 13 October 2017
Initial acceptance 12 February 2018
Final acceptance 12 February 2018
Publication date 09 July 2018

Keywords
Myrmecochory, Cerrado, Forest Fragmentation.

Corresponding author
Danival José de Souza
Federal University of Tocantins (UFT)
Campus of Gurupi
Rua Badejós, Lote 7, Chácaras 69/72, Caixa postal 66, CEP 77402-970, Gurupi-TO, Brasil.
E-Mail: danival@uft.edu.br

Abstract

The importance of *Simarouba versicolor* St. Hil. fruit dispersal by the leaf-cutting ant *Atta sexdens* (L.) was studied in the Cerrado, Tocantins, Brazil. The trees and nests were located between a forest area and a *Brachiaria decumbens* Stapf pasture. Seeds were collected in October 2015 along foraging trails and on the anthill of an *A. sexdens* colony. Germination of three groups of seeds was tested: (1) seeds with the tegument removed by the ants; (2) seeds without tegument, cleaned manually, and (3) seeds with tegument. The germination rates for the three treatments were similar; however, it was verified that the seeds cleaned by ants germinated faster. In addition, it was verified that the ants dispersed the seeds by at least 20 meters in the study area. *Simarouba versicolor* is a plant studied for its insecticidal properties, and this is the first study to our knowledge reporting its dispersal by ants.

Simarouba versicolor is a semi-deciduous tree belonging to the family Simaroubaceae, which is a heliophite and a selective xerophytic pioneer, and occurs in Cerrado and Caatinga biomes, preferably in open areas and well-drained soils. In Brazil, it is found from the Northeast region to the state of São Paulo and in some parts of the states of Pará and Mato Grosso do Sul (Lorenzi & Flora, 2002). Rapid growth, efficient germination, and survival, in direct seeding in the field, are characteristics that make it important in forest restoration (Filho & Sartorelli, 2015). Its dispersal is zoocorical, since its drupe-type fruits serve as food for birds, fishes, and bats. So far, there have been no reports of myrmecochory, i.e., ants aiding its dispersal.

Ants can play an important role as secondary seed dispersers (Gallegos et al., 2014). Besides dispersal, ants also are able to deposit seeds in sites favorable to their germination and development (Culver & Beattie, 1983; Oliveira & Koptur, 2017), which helps to avoid seed consumption by predators (Heithaus, 1981; Tanaka et al., 2015), decrease interspecific and intraspecific competition between seedlings under the mother plant (Leal et al., 2015; Giliomee 1986), and protect seeds from fire (Bond & Slingsby, 1984; Leal et al., 2015; New, 2014).

The objective of the present study was to evaluate *S. versicolor* fruit dispersal by the leaf-cutter ant *Atta sexdens*, and its potential benefits to the plant at the edges of a Cerrado-type forest remnant, in the southern state of Tocantins.

The study was carried out near the urban area of the municipality of Gurupi - TO (11°44'42.4"S - 49°00'53.1"W) in a Cerrado area near a pasture composed primarily of *Brachiaria decumbens*. The climate of the region is classified as tropical humid (Aw) according to Köppen's climate classification (Alvares et al., 2013), with rainy summers and dry winters, and an average temperature of 25 °C. Annual precipitation varies from 1,327 to 1,798 mm (Marcuzzo et al., 2012). In September 2015, seeds of *S. versicolor*, clean and with tegument, were observed along *A. sexdens* trails at the edges of the forest. *Simarouba versicolor* has a fleshy drupe-type fruit with a single seed, which can only be mechanically separated. Some fruits dry in the plant, whereas those that fall may be transported to ant nests where they are

ISSN: 0361-6525

cleaned and removed. Seeds collected for the germination tests came from an individual *S. versicolor* located 21 m from the *A. sexdens* nest. The seeds of *S. versicolor* were collected from the soil, along the trail, under the plant and in the deposit formed near the anthill. More seeds cleaned by the ants (drupes in which the tegument and pulp were removed) were collected near the anthill than along the trail, whereas non-cleaned seeds (dried drupe still containing the pericarp) were found scattered under the mother tree and along the ant-foraging trail.

Germination tests were performed on 9 cm diameter Petri dishes, properly sterilized and lined with two sheets of filter paper, moistened with 5 ml of distilled water. Seeds that presented physical damage, such as perforations, were excluded from the germination tests. The treatments consisted of eight replicates (plates) containing eight seeds, with a total of 64 seeds for each of the three treatments: (T1) seeds cleaned by ants, (T2) seeds cleaned manually, and (T3) non-cleaned seeds. The seeds were incubated in a germination chamber at 25 °C and photoperiod of 12 h, and were observed every 2 d in the morning for a maximum period of 36 d. Seeds were considered germinated when they had a root length ≥ 3 mm. Based on these results, the average germination percentage and germination speed index were obtained at 36 d after sowing. The germination percentage was calculated by the following formula: G = (N/100) x 100, where: N = number of seeds germinated at the end of the test. The germination speed index (GSI) was calculated based on the methodology proposed by Maguire (1962) using the formula:

GSI = Σ (ni /ti), where: ni = number of seeds germinating at time 'i'; ti = time after test installation; i = 1 → 36 days. Unit: dimensionless.

The data of germination percentage and speed index did not present a normal distribution. Therefore, the values were transformed using the following formulas: for the average germination percentage (2 × arc sine √ (y/100) + 0.5)) and for the germination rate (Logarithm (y) +1). Subsequently, they were submitted to analysis of variance using the F-test and compared by Tukey's test at 5% significance level. All analyses were performed using the software Statistica 7.0.

Regarding the average germination percentage of *S. versicolor* at the end of the 36 d of observation, it was verified that there was no significant difference between the treatments (ANOVA, $F_{2.21}$ = 1.36, p = 0.28), i.e., the leaf-cutting ant cleaning did not change the chances of germination. The treatments showed the following germination rates (G): G = 37.5% for T1 (seeds cleaned by ants), G = 25% for T2 (seeds cleaned manually), and G = 29.7% for T3 (non-cleaned seeds). A significant difference was observed in the germination rate between the three treatments $F_{2.21}$ = 7.24, p = .004, and the seeds cleaned by the ants had a higher average GSI than those in the other two treatments (Fig 1, Tukey's test, α = 5%).

The ants did not reduce the germination rate of the seeds by consuming the fruit pulp, which characterizes the positive effects of dispersion by the ants. In the study site, fruit dispersal was observed for distances up to 21 m from the mother plant. It should also be noted that the foraging distance of *A. sexdens* workers may exceed this distance by many meters depending on several factors, such as the size of the colony and availability of plant resources (Della Lucia, 2011).

After a period of drought, which may begin in May, the first rains appear at the beginning of October in the southern Tocantins. Therefore, the fruits of *S. versicolor* and other species, although occasional, are important items in the survival of the leaf-cutter ant, particularly in regions and periods in which dry conditions prevail. At the same time that we observed the interaction of *A. sexdens* with *S. versicolor*, we also observed seeds of the following forest species: *Hirtella glandulosa* (Chrysobalanaceae), *Diospyros hispida* (Ebenaceae), and *Copaifera langsdorffii* (Fabaceae) in the trails and anthills. Germination tests were not performed because of the small amount of seeds collected; however, these observations reinforce the importance of these fruits to leaf-cutting ants at this time of year.

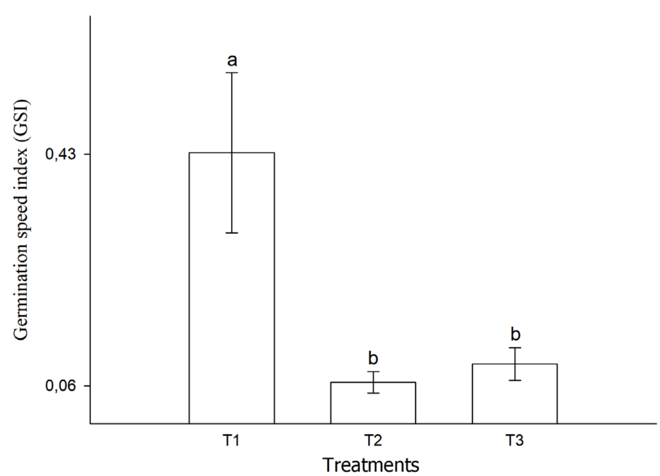

Fig 1. Germination speed index of T1, T2, and T3 treatments, where T1: seeds cleaned by ants (free of the pericarp, without pulp, and endocarp); T2: aryl-free seeds, cleaned manually; and T3: seeds with aryl. Means followed by the same letters between columns do not differ from each other based on the Tukey's test at 5%.

Regarding the differences in speed germination, the myrmecochory may be an important ecological advantage for *S. versicolor* in the study area, since the rainy period, favorable for the development of the plants, is more restricted than that of other regions, and the presence of grasses and other common invasive species at this edge of the forest may inhibit the development of native species (Machado et al., 2013). In this situation, the seedlings would have a longer time to develop and settle before the dry season.

In the present study, it was possible to observe that some cleaned and non-cleaned seeds of *S. versicolor* remained on the foraging trail. The seed cleaning process occurred along the trail, but most seeds were cleaned inside the nests and then removed and deposited at the anthills. Thus, the colony did not suffer from the toxic effects of substances present in the seeds, including insecticides and fungicides (Alves et al., 2014), and seeds maintained their chances of germination, since no physical damage was observed.

Therefore, it is concluded that *S. versicolor* seed cleaning by *A. sexdens* ants does not alter the germination percentage, but increases the germination speed. The role of ants is important in the dispersal of this arboreal species.

Acknowledgments

We thank the anonymous reviewers for their careful reading of our manuscript and their many insightful comments and suggestions. This work was supported by grants of CNPq (Project 403708-2013-3) and research funds of Federal University of Tocantins for DJ Souza.

References

Alvares, C. A., Stape, J. L., Sentelhas, P. C., de Moraes Gonçalves, J. L. & Sparovek, G. (2013) Köppen's climate classification map for Brazil. Meteorologische Zeitschrift, 22: 711-728. doi: 10.1127/0941-2948/2013/0507

Alves, I. A. B. S., Miranda, H. M., Soares, L. A. L. & Randau, K. P. (2014). Simaroubaceae family: botany, chemical composition and biological activities. Revista Brasileira de Farmacognosia, 24: 481-501. doi: 10.1016/j.bjp.2014.07.021

Bond, W. & Slingsby, P. (1984). Collapse of an ant-Plant mutalism: the Argentine Ant (*Iridomyrmex humilis*) and myrmecochorous Proteaceae. Ecology, 65: 1031-37. doi: 10. 2307/1938311

Campos Filho, E. M. & Sartorelli, P. A. R. (2015). Guia de identificação de espécies-chave para a restauração florestal na região de Alto Teles Pires - Mato Grosso. São Paulo: The Nature Conservancy, 248 p.

Culver, D. C. & Beattie, A. J. (1983). Effects of ant mounds on soil chemistry and vegetation patterns in a Colorado montane meadow. Ecology, 64: 485-92. doi: 10.2307/1939968

Gallegos, S. C., Hensen, I. & Schleuning, M. (2014). Secondary dispersal by ants promotes forest regeneration after deforestation. Journal of Ecology, 102: 659-66. doi: 10.1111/1365-2745.12226

Della Lucia, T. M. C. (2011). Formigas-cortadeiras: da biologia ao manejo. Viçosa-MG: Editora UFV, 421 p.

Giliomee, J. H. (1986). Seed dispersal by ants in the Cape Flora treatened by *Iridomyrmex humilis* (Hymenoptera: Formicidae). Entomologia Generalis, 11: 217-19. doi: 10.1127/entom.gen/11/1986/217

Heithaus, E. R. (1981). Seed predation by rodents on three ant-dispersed plants. Ecology, 62: 136-45. doi: 10.2307/1936677

Köppen W. (1936) Das Geographische System der Klimate (The Geographic System of Climates). Handbuch der Klimatologie, Bd. I., Teil C. In: Köppen, W. & Geiger, R. BerslinBorntraeger, Berlin

Leal, I. R., Leal, L. C. & Andersen, A. N. (2015). The benefits of myrmecochory: a matter of stature. Biotropica, 47: 281-85. doi: 10.1111/btp.12213

Lorenzi, H. (2002) Árvores brasileiras: manual de identificação e cultivo de plantas arbóreas nativas do Brasil, Volume 2. Nova Odessa: Instituto Plantarum de Estudos da Flora, 368 p.

Machado, V.M., Santos, J. B., Pereira, I. M., Lara, R. O., Cabral, C. M. & Amaral, C. S. (2013) Avaliação do banco de sementes de uma área em processo de recuperação em cerrado campestre. Planta Daninha, 31: 303-12. doi: 10.1590/S0100-83582013000200007

Marcuzzo, F. F. N., Oliveira, N. L., Pinto Filho, R. F. & Faria, T. G. (2012) Chuvas na região Centro-Oeste e no estado do Tocantins: análise histórica e tendência future. Boletim de Geografia, 30: 19-30. doi: 10.4025/bolgeogr.v30i1.13418

New, T. R. (2014). Insect Responses to Fires. In T. R. New (Ed.), Insects, Fire and Conservation (pp. 21-57). Cham: Springer International Publishing.

Oliveira, P.S. & Koptur, S. (2017). Ant-plant interactions: impacts of humans on terrestrial ecosystems. Cambridge, Cambridge University Press, 452 p.

Tanaka, K., Ogata, K., Mukai, H., Yamawo, A. & Tokuda, M. (2015). Adaptive advantage of myrmecochory in the ant-dispersed herb *Lamium amplexicaule* (Lamiaceae): Predation avoidance through the deterrence of post-dispersal seed predators. PLoS ONE, 10: e0133677. doi: 10.1371/journal.pone.0133677