



## **Ethnomirmecology and agroecological perspectives in leaf-cutting ants control**

*Etnomirmecologia e perspectivas agroecológicas no controle de formigas cortadeiras*

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### **RESUMO EXPANDIDO TÉCNICO CIENTÍFICO**

#### **Eixo Temático: Biodiversidade e Conhecimentos das/os Agricultoras/es, Povos e Comunidades Tradicionais**

**Abstract:** We investigated the relationship between the socioeconomic profile and the agroecological knowledge of MST peasants regarding leaf-cutting ants. Interviews were conducted with 80 farmers, recording information about their socioeconomic profile, agroecological knowledge, and control methods used. We identified similarities among older farmers with no formal education, who were unfamiliar with agroecology and had a negative environmental perception of leaf-cutting ants, and use of chemical baits for control. On the other hand, younger farmers with agroecological knowledge and access to education, attributed positive functions, to the leaf-cutting ants and so, the use of agroecological control methods was cited. Additionally, we conducted behavioral experiments on *Acromyrmex subterraneus* using three agroecological techniques more cited in laboratory conditions. Cow urine extracts and isopathy were effective in repelling leaf-cutting ants. Agroecology proved to be an ally in promoting sustainable agriculture.

**Keywords:** animal behavior; alternative control; ethnobiology; ethnoentomology. traditional knowledge.

#### **Introduction**

Leaf-cutting ants (*Atta* and *Acromyrmex*) are considered the main neotropical herbivorous insects and are known for cultivating and maintaining the symbiotic fungus *Leucoagaricus gongylophorus* Möller (Singer) (HÖLLDOBLER & WILSON, 2011). The eusocial organization of the group allows colonies, containing thousands of individuals, to function as a superorganism, with a notable complex division of labor among the workers (LOPES et al., 2016). Through sophisticated foraging behavior, these insects engage in activities equivalent to human agriculture, they cut and incorporate fresh leaves from various plant species on the cultivation of this symbiotic fungus (DELLA LUCIA et al., 2014), which is used to feed all members of the colony (CAMARGO et al., 2007).

With the advent of human agriculture, people began to interact more closely with leaf-cutting ants, as they can cause losses in food productivity for commercial



purposes and family consumption (BRANSTETTER et al., 2017). The collective experiences and traditional knowledge about these insects have been accumulated and passed down through generations. As a result, they are reproduced and form distinct perceptions (BOFF et al., 2016). In agribusiness, that leaf-cutting ants are seen as agricultural pests, and consequently, the control of leaf-cutting ants are currently carried out using toxic-attractive bait formulations or dry powder formulations based on sulfluramid, a non-selective and residual organofluoride (BRITTO et al., 2016), which leads to soil and water contamination, causing the mortality of other invertebrates and fish (GIBBONS et al., 2015). It has also been proven to have pathological effects when in contact with farmers, causing kidney, liver, and cancerous diseases (WANG et al., 2019).

Agroecology has emerged as a political, scientific, and anti-hegemonic movement to agribusiness in the effort to promote agricultural alternatives that do not harm the environment, as well as the decreasing use of agrochemicals in farming fields (ALTIERI & TOLEDO, 2011). In order to promote socially equitable, economically successful, environmentally sustainable, and culturally sensitive agriculture, it reintroduces the traditional methods and values of family farmers and peasants (MEEK, 2015; MCCUNE et al., 2017). Therefore, it is expected that the aggregation of mitigating solutions for the damages caused by leaf-cutting ant herbivory will occur through management actions based on agroecological principles in production systems. This reality, in return, can be influenced by socioeconomic and political factors, and consequently, in the processes of land use and management (CAMPOS et al., 2019). Given that it is essential for this knowledge to be recognized and that agroecology values popular wisdom, this study aimed to contribute to the collective construction of agroecological knowledge by bridging the popular knowledge of farmers from the Assentamento Dênis Gonçalves (ADG), Goianá/MG, regarding leaf-cutting ants with academic knowledge. Thus, we investigated the influence of socioeconomic factors and agroecological knowledge on the environmental representation of farmers from the ADG regarding leaf-cutting ants and the types of control methods used. Additionally, we conducted systematic tests, under laboratory conditions, of the three most commonly used agroecological control methods by farmers from the ADG on *Acromyrmex subterraneus* (Forel, 1893), aiming to evaluating the repellent potential of these extracts in relation to worker foraging behavior.

## Metodology

The study was conducted with peasants living in the ADG (21.574363 S, 43.209851 W), covering four municipalities of Minas Gerais, in the Zona da Mata region. Eighty families from MST were interviewed and asked about their relationship with ants, agriculture, environment, the employed control practices employed and agroecological knowledge. Some personal questions were made to define their socioeconomic profile. Data was collected from September to December 2018 using two semistructured interviews (SILVA et al. 2014) and both were recorded with a



digital voice recorder. Also, for the enrichment and filing of information a field diary was employed (CAMPOS, et al. 2019).

The first interview aimed to socioeconomically characterize the peasants, surveying about: (i) age; (ii) gender; (iii) number of residents in each lot; (iv) local of ; (v) agricultural or nonagricultural activities that guarantee the family's economy; (vi) formal educational level; (vii) government public policy; (viii) declare to know the term agroecology or to have heard of it. When positive, a personal definition of agroecology was asked. Per capita income was not included as most peasants have no steady income.

The second interview was designed to investigate the environmental representation about leaf-cutting ants. To detail local knowledge, a free listing was used (CASSINO et al. 2019) which surveyed about the following topics: (i) ant diversity in the property; (ii) personal opinion about the ants mentioned; (iii) ants' function in the environment; (iv) period of higher ant occurrence in crops; (v) crops most affected by the foraging behavior of leaf-cutting ants; (vi) used control methods.

All interviews were transcribed and the peasants' answers were categorized and grouped in levels within analytic variables. Expressions used by the interviewees regarding definitions and concepts of agroecology were arranged in a word cloud graph. To measure how socioeconomic variables and declared agroecological knowledge can influence the environmental representation about controlling practices of leaf-cutting ants, a Multiple Correspondence Analysis (MCA) was performed seeking drawing and spatially visualizing the correlation between two or more categorical variables (KASSAMBARA, 2017).

Subsequently, we applied the isopathy, homeopathy and cow urine extracts in the superior path of artificial foraging trails to determine if they act as a chemical barrier. To evaluate the repellent potential of the agroecological extracts applied along the artificial trail, we compared the worker foraging flow between paths at each segment using a GLM with Gamma distribution, considering the extracts as fixed factor. Worker foraging flow data was transformed to  $\log(x+1)$  due to zeros occurrence. The leaf delivery rate was submitted to the same analysis. After that, we applied the same extracts to leaf discs and conducted a paired selection test. The proportion of transported leaf discs with different extracts of each paired trial was determined based on the number of discs with the extract compared to the total number of transported leaf discs. In the case of presenting Control (+) discs in both branches, the proportion refers to the data from the branch whose discs were fully loaded, and in the case of Control (+) and Control (-), the proportion refers to the number of Control (-) discs relative to the total of transported discs. For each experiment, ten repetitions were performed. Chemical analysis was carried out using a gas chromatograph (Hewlett Packard 6890) coupled with a selective mass detector (Hewlett Packard 5972) equipped with a DB-5MS capillary column (30 m, 0.25 mm, 0.25 m) for identify possible repellents compounds in the agroecological extracts.



## Results and Discussion

The ADG population cited 54 different leaf-cutting ants control methods, which were grouped in (i) commercial toxic baits (synthetic compounds) and (ii) alternative methods (physical and natural compounds). Peasants' environmental representations about leaf-cutting ants were often conflicting, since 52% attributed exclusively negative opinions to the insect. In this scenario, the environmental functions attributed to them were limited to crop cutting and economic losses that compromise the family's agricultural production. On the other hand, 35% perceived ants positively and negatively, imputing both productive damage and ecological functions such as (i) soil aeration, fertilization and humidification; (ii) incorporation of organic matter; (iii) nutrient cycling; (iv) element of food webs.

Two peasants' profiles were identified, one composed by older peasants who had never studied, did not know the term agroecology, had a negative conception about leaf-cutting ants and does use commercial formicides. The second profile was constituted by peasants with opposite characteristics. Agroecology concepts and practices seem to have a high potential to change environmental representations about leaf-cutting ants and used control methods in the studied area. By comprehending the leaf-cutting ants' role in the ecosystem a gradative transition to alternative control methods, rather than the commercial, ones was observed. This gradual transition enables a better relationship between ADG peasants and leaf-cutting ants (OLLIVER et al., 2018). The organic compounds commonly used are clues to the urgent search for a sustainable leaf-cutting ant control method.

We observed that the agroecological extracts represented an effective repellent. At the barrier segment, the foraging flow switched from the superior path to the lateral path of the trails. This repellency effect was confirmed since the foraging flow remained on the superior path in the control treatments.

Also, we found that the leaf delivery rate in trails with isopathic extract was lower than in all the other treatments, indicating a reduction in foraging activity. Although the leaf delivery rates in trails with Homeopathy and Cow Urine were lower than the Positive and Negative Controls, they were not different from the Water treatment. The proportion of transported leaf discs at the paired trials with isopathy ( $Z = -11.84$ ,  $p < 0.0001$ ) and cow urine ( $Z = -11.00$ ,  $p < 0.0001$ ) was lower than the positive control, indicating a repellent effect of these extracts following their application over the leaves.

The same was not verified for the homeopathic extract ( $Z = -2.41$ ,  $p = 0.06$ ). Among the chemical constituents identified, we highlight the presence of 2-propanone in the isopathic extract, which belongs to the same chemical group listed as a component of the alarm pheromone in *Acromyrmex* (NORMAN et al., 2017). Cow urine extract presents urea, which has a pungent odor. We believe that these compounds generated the repellent response in the treatments where the agroecological extracts were applied.





## Conclusions

The role of traditional knowledge and agroecological practices in developing countries has been gaining recognition in scientific curricula. It should be considered that this knowledge stems from experiences, skills, and technologies accumulated and transmitted over thousands of years, derived from the direct interaction of human beings with the natural environment in which they are immersed. The experimental tests carried out, in conjunction with the many other agroecological techniques mentioned by MST peasants, demonstrate that traditional agroecological methods are a viable alternative to be invested in by public policies that promote agroecological production and empower and value farmers in relation to their rich and complex knowledge. It is worth noting that the purpose of conducting laboratory tests was to contribute to improving the control practices of leaf-cutting ants used. Thus, this study can pave the way for further research that also advances new sustainable forms and technologies for controlling leaf-cutting ants, thereby strengthening the food sovereignty and security of small-scale family farmers while demystifying negative perceptions about leaf-cutting ants.

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