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Original Article

Spatial distribution, ecological indices and interactions of arthropods on *Sapindus saponaria* (Sapindaceae) plants

Distribuição espacial, índices ecológicos e interações de artrópodes em plantas de *Sapindus saponaria* (Sapindaceae)

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Abstract

Sapindus saponaria L. (Sapindaceae) is a pioneer species used in programs to recover degraded areas. The trees also assist in the pest control of some insects due to the composition of saponins on their leaves. In addition, these chemical components are important to pharmaceutical product production. The objective was to evaluate the impact of spatial distribution, indices and ecological relationship of arthropods on *S. saponaria* leaves to preserve the balance of biodiversity. Aggregated distribution of arthropods was observed; the numbers of phytophagous arthropods were higher on the adaxial leaf face than on the abaxial part. Only Aleyrodidae (Hemiptera) had a higher presence on the abaxial leaf face of *S. saponaria* saplings. Abundance, diversity, and species richness of natural enemies correlated positively with phytophagous and pollinators insects. On the other hand, the number of *Lyriomyza* sp. mines correlated negatively with *Pseudomyrmex termitarius* (Smith) (Hymenoptera: Formicidae). All this information can assist and guide integrated pest management programs.

Keywords: degraded areas, diversity, pollinators, predators, bioindicators.

Resumo

Sapindus saponaria L. (Sapindaceae) é uma espécie pioneira utilizada em programas de recuperação de áreas degradadas. As árvores também auxiliam no controle de alguns insetos pragas devido à composição de saponinas em suas folhas. Além disso, esses componentes químicos são importantes para a produção de produtos farmacêuticos. O objetivo foi avaliar o impacto da distribuição espacial, índices e relações ecológicas de artrópodes nas folhas de *S. saponaria*, a fim de preservar o equilíbrio da biodiversidade. Observou-se distribuição agregada; os números de artrópodes fitófagos foram maiores na face adaxial da folha do que na parte abaxial. Apenas indivíduos de Aleyrodidae (Hemiptera), tiveram maior presença na face abaxial das folhas, em mudas de *S. saponaria*. Abundância, diversidade e riqueza de espécies de inimigos naturais correlacionaram-se positivamente com insetos fitófagos e polinizadores. Por outro lado, o número de minas de *Lyriomyza* sp. correlacionou-se negativamente com o de *Pseudomyrmex termitarius* (Smith) (Hymenoptera: Formicidae). Todas essas informações podem ser usadas para auxiliar e orientar programas de manejo integrado de pragas.

Palavras-chave: áreas degradadas, diversidade, polinizadores, predadores, bioindicadores.

1. Introduction

Sapindus saponaria Linnaeus (Sapindaceae) can be found in tropical and subtropical areas (Frazão and Somner, 2016). Trees can reach from eight to nine meters in height. The leaves of *S. saponaria* are compound and alternate, imparipinnate and petiolate. The branches have a whitish color and short hairiness. Its fruits, yellow when ripe, generally ripen between September and October; fruits have single carpels and are multiglobose (Lorenzi, 1992). This species occurs in semi-deciduous rainforests and is used to control pest insect growth due to biochemical composts on leaves, branches and fruits with an insecticidal effect.

Biomolecules from *S. saponaria*, such as tannins and saponins, provide larvicidal action in several species of arthropods (Fernandes et al., 2005). The application of oils, and extracts of plants with insecticidal activities, has been used as an alternative to controlling several insect

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pests with fast degradation in nature, low toxicity, and slow development of insect resistance (Martins et al., 2024). Over time, excessive use of synthetic insecticides leads to the uncontrolled growth of resistant populations. Therefore, it is important to diversify the insect pest control methods (Cavalcanti et al., 2010).

Sapindus saponaria still stands out in the manufacture of soaps and cosmetics, used on a large scale by the pharmaceutical industries because of the substance called saponin. This secondary metabolite has astringent, anxiolytic and antineoplastic activity (Silva et al., 2018). It also combats cough and throat irritation and helps heal wounds. In addition, the extract taken from the fruit has fungicidal action (Garcia et al., 2012).

The *S. saponaria* has been widely used also in landscaping and models of recovering degraded areas (Paoli and Santos, 1998). It is a pioneer species with characteristics providing advantages in its adaptability, especially in pioneer plantations and areas near the rivers. Considering the plant's location and conditions, it will be most successful in adapting when it is similar to native sources (Santos et al., 2012). The use of native forest species such as *S. saponaria* is a practice that favors the restoration of degraded areas. It helps recover ecosystems that have been excessively anthropized or deteriorated, reduces costs and eliminates the seedling production phase in nurseries (Santos et al., 2012). To better understand the interactions between plants and insects, it is necessary to analyze distribution on the leaf surface, type of attack, ecological indices and ecological interactions (Zanuncio, et al., 2015; Silva et al., 2023).

The purpose of this research was to study ecological relationships on *S. saponaria*, their indices (abundance, diversity, and species richness) per leaf face (adaxial and abaxial), and arthropod distribution (aggregated, random, or regular), for 24 months, in a degraded area.

2. Material and Methods

2.1. Experimental site

The work was established in a degraded area of the "Instituto de Ciências Agrárias da Universidade Federal de Minas Gerais (ICA/UFMG)" in Montes Claros, Minas Gerais State, Brazil (latitude 16º 51' 38" S, longitude 44º 55' 00" W, 943 m.a.l.s.) from April 2020 to March 2022. According to the Köppen climate classification, this area's climate is tropical dry, with annual precipitation between 1000 and 1300 mm, dry winter and average annual temperature ≥ 26 °C. The soil is Neosol Litolic with an Alic horizon (Silva et al., 2020).

2.2. Experimental design

In March 2019, 48 *S. saponaria* seedlings were prepared in a nursery in plastic bags (16 x 24 cm) with reactive natural phosphate mixed with the substrate at a dosage of 160 grams. After that, they were planted in the final location in September of the same year. All of them were planted in holes (40 × 40 × 40 cm) when they were 30 cm high, with a 2-meter spacing between them. The soil was corrected with dolomitic limestone, increasing base saturation to 50%, natural phosphate, gypsum, FTE (Fried Trace Elements), potassium chloride and micronutrients equivalent to the need determined in the soil analysis. A total of 20 liters of dehydrated sewage sludge, in a single dose, was placed in each and the biochemical characteristics of this fertilizer have been reported (Silva et al., 2020). The seedlings were irrigated twice a week until the beginning of the rainy season (October). The design was completely randomized with 48 replications (one sapling each) with the adaxial and abaxial leaf surfaces as the treatments.

2.3. Counting the arthropods

All insects and spiders were counted, between 7:00 A.M. and 11:00 A.M., by visual observation, every two weeks on the adaxial and abaxial surfaces of the first 12 leaves expanded, per sapling. These leaves were assessed, randomly, on branches (one leaf per position) in the basal, middle and apical parts of the canopy - vertical axis - (0 to 33%, 33 to 66%, and 66 to 100% of total sapling height, respectively) and in the north, south, east and west directions horizontal axis. A total of 12 leaves/sapling/evaluation were observed on 48 *S. saponaria* saplings starting six months after transplantation during 24 months (27,648 total leaves), covering the entire sapling (vertical and horizontal axis), capturing the highest possible number of arthropods (insects and spiders), especially the rarest ones. The evaluator approached, carefully, firstly assessing the adaxial leaf surface and, if it was not possible to visualize the abaxial one, with a delicate and slow movement, lifting the leaf to visualize it. Insects with greater mobility (e.g., Orthoptera), that flew, on approach, were counted as long as they were recognized (e.g., Order). The arthropods (insects and spiders) were not removed from the saplings during the evaluation.

A few arthropod specimens (up to 3 individuals) per species were collected using an aspirator (two hours per week) at the beginning of the study (between transplantation and first evaluation, six months after), stored in flasks with 70% alcohol, separated into morphospecies, and sent to specialists for identification (see acknowledgments). Any visible arthropod, not yet computed in previous evaluations, was collected, coded and sent to a taxonomist of its group.

2.4. Statistic of the ecological indices

Each replication is the total of individuals collected on 12 leaves (three heights and four sides of the sapling). The type of arthropod distribution was defined by the Chi-square test using the BioDiversity Professional, *version* 2 (© 1997) (Krebs, 1998). The ecological indices (abundance, diversity, and species richness) were calculated per group (phytophagous insects, pollinators, and natural enemies) and treatments (adaxial and abaxial surfaces) using the aforementioned program. Abundance and species richness were the total numbers of individuals and species (Begon et al., 2007), respectively, per sapling. Diversity was calculated using the Hill' formula (1^{st} order): N1= exp (H'), where H' is the Shannon–Weaver diversity index, calculating the diversity with the actual species number (Hill, 1973).

The data for abundance, diversity and species richness of phytophagous insects, pollinators and natural enemies were subjected to a non-parametric statistical hypothesis, the Wilcoxon signed rank test (p-value < 0.05) (Wilcoxon, 1945) using the Statistics and Genetics Analysis (SAEG) program, version 9.1 (SAEG, 2007) (Supplier: "Universidade Federal de Viçosa", Brazil). The data were subjected to second-degree regression or principal component regression (PCR), when linear (p-value < 0.05) to verify the possible interactions (e.g., protocooperation) between groups of arthropods (phytophagous insects, pollinators, natural enemies, and spiders). All arthropods sampled were included in the analyses.

Simple equations were selected based on the criteria: i) distribution of the data in the figures (linear or quadratic response), ii) the parameters used in these regressions were the most significant ones (p-value < 0.05), iii) p-value < 0.05 and *F* of the Analysis of Variance of these regressions, and iv) the determination coefficient of these equations (R^2). The PCR model uses principal component analysis to obtain the regression based on a covariance matrix. These reduce the regression dimensions, excluding those that contribute to collinearity, that is, linear relations between the independent variables (Bair et al., 2006). The parameters used in these equations were all significant (p-value <0.05) according to the selection of the variables by the "Stepwise" method using the statistical program mentioned. The data presented are the significant ones (p-value <0.05) (Tables 1-3), and the others are in Supplementary Material.

3. Results

Aggregated distributions of phytophagous arthropods: *Charidotis* sp., *Stereoma anchoralis* (Lacordaire), and *Walterianela* sp. (Coleoptera: Chrysomelidae), *Lyriomyza* sp. (Diptera: Agromyzidae), *Phenacoccus* sp. (Hemiptera: Pseudococcidae), Tettigoniidae (Orthoptera); pollinators: *Trigona spinipes* (Fabricius) (Hymenoptera: Apidae); natural enemies: *Leucauge* sp. (Araneae: Tetragnathidae), Salticidae (Araneae), Dolichopodidae (Diptera), *Brachymyrmex* sp., *Camponotus* sp., *Ectatoma* sp., *Pheidole* sp. and *Pseudomyrmex termitarius* (Smith) (Hymenoptera: Formicidae), *Polybia* sp. (Hymenoptera: Vespidae), and *Chrysoperla* sp. (Neuroptera: Chrysopidae) were observed in *S. saponaria* leaves (Table 1).

The number of phytophagous arthropods: *Cerotoma* sp. (Coleoptera: Chrysomelidae) and *S. anchoralis*, Curculionidae (Coleoptera), *Lyriomyza* sp., *Balclutha hebe* (Kirkaldy) (Hemiptera: Cicadellidae), *Quesada gigas* (Olivier) (Hemiptera: Cicadidae), Pentatomidae (Hemiptera), Tettigoniidae, and *Tropidacris collaris* (Stoll) (Orthoptera: Romaleidae), their ecological indices (diversity and

Table 1. Aggregated (Ag), distribution (D) of arthropods on *Sapindus saponaria*/saplings.

Arthopods			Chi-square test		
	Var.[£]	**M.**[§]	**Chi-sq**	*P*	**D**
Acari: Tetranychidae	1,461.18	8.66	13,831.40	0.00	Ag
Araneae: Araneidae	1.00	0.39	211.81	0.00	Ag
Salticidae	0.20	0.15	112.50	0.01	Ag
Tetragnathidae, *Leucauge* sp.	1.23	0.16	644.62	0.00	Ag
Coleoptera: Chrysomelidae, *Charidotis* sp.	0.07	0.05	120.55	0.00	Ag
Stereoma anchoralis	0.13	0.06	177.6	0.00	Ag
Walterianela sp.	0.05	0.02	164.00	0.00	Ag
Diptera: Agromyzidae, *Lyriomyza* sp.	141.34	5.75	2,016.65	0.00	Ag
Dolichopodidae	0.20	0.11	147.78	0.00	Ag
Hemiptera: Aleyrodidae	3,130.33	27.84	9,218.96	0.00	Ag
Fulgoridae	0.06	0.04	135.33	0.00	Ag
Pseudococcidae, *Phenacoccus* sp.	5.97	0.36	1,353.33	0.00	Ag
Hymenoptera: Apidae, *Trigona spinipes*	0.30	0.06	410.00	0.00	Ag
Formicidae: *Brachymyrmex* sp.	25.13	2.16	955.64	0.00	Ag
Camponotus sp.	4.77	0.99	395.76	0.00	Ag
Ectatoma sp.	0.48	0.19	201.88	0.00	Ag
Pheidole sp.	4.90	0.83	483.13	0.00	Ag
Pseudomyrmex termitarius	5.88	1.08	444.89	0.00	Ag
Vespidae, *Polybia* sp.	0.14	0.07	160.00	0.00	Ag
Neuroptera: Chrysopidae, *Chrysoperla* sp.	0.06	0.04	135.33	0.00	Ag
Orthoptera: Tettigoniidae	0.93	0.57	134.89	0.00	Ag

[£]Var. = variance; [§]M. = median. *fd* = 82; *P* = P-value; D = distribution.

species richness); natural enemies: Araneidae (Araneae), *Quemedice* sp. (Araneae: Sparassidae), *Leucauge* sp., *Camponotus* sp., *Ectatoma* sp., *Pheidole* sp., and *Polybia* sp., and their ecological indices (abundance, diversity, and species richness) were higher on the adaxial leaf face. On the other hand, Aleyrodidae (Hemiptera) had a higher presence on abaxial leaf face compared to adaxial portion of *S. saponaria* saplings (Table 2).

The abundance, diversity, and species richness of natural enemies were correlated positively with phytophagous and pollinator insects. Araneidae correlated positively with Dolichopodidae, Salticidae, *Cycloneda sanguinea* Linnaeus (Coleoptera: Coccinellidae), *Phenacoccus* sp., *Polybia* sp., and *Lyriomyza* sp. However, the number of *Lyriomyza* sp. mines correlated negatively with the ant *P. termitarius* (Table 3).

Table 2. Number and ecological indices (average ± SE) of arthropods in the leaf face on *Sapindus saponaria* (Sapindaceae)/saplings.

Arthropods	Leaf face		TW*	
	Adaxial	Abaxial	*VT*[£]	*P*
Aleyrodidae	6.38±2.33	41.77±9.94	2.58	0.01
Araneidae	0.52±0.17	0.15±0.05	2.42	0.01
Balclutha hebe	0.17±0.06	0.00±0.00	2.73	0.00
Brachymyrmex sp.	2.25±0.76	1.48±0.58	1.29	0.09
Camponotus sp.	1.52±0.39	0.19±0.06	3.56	0.00
Cerotoma sp.	0.08±0.04	0.00±0.00	2.03	0.02
Charidotis sp.	0.04±0.02	0.04±0.04	0.56	0.29
Chrysoperla sp.	0.06±0.04	0.00±0.00	1.42	0.07
Curculionidae	0.06±0.03	0.00±0.00	1.75	0.04
Dolichopodidae	0.19±0.08	0.00±0.00	2.52	0.01
Ectatoma sp.	0.31±0.12	0.02±0.02	2.67	0.00
Fulgoridae	0.06±0.04	0.00±0.00	1.42	0.07
Leucauge sp.	0.27±0.20	0.00±0.00	2.03	0.02
Lyriomyza sp.	9.19±2.10	0.75±0.33	4.42	0.00
Pseudomyrmex termitarius	1.06±0.27	0.81±0.37	2.11	1.01
Pentatomidae	0.10±0.04	0.00±0.00	2.29	0.01
Pheidole sp.	1.35±0.40	0.08±0.06	4.00	0.00
Phenacoccus sp.	0.00±0.00	0.63±0.46	1.42	0.07
Polybia sp.	0.13±0.07	0.00±0.00	2.03	0.02
Quesada gigas	0.06±0.03	0.00±0.00	1.75	0.04
Quemedice sp.	0.06±0.03	0.00±0.00	1.75	0.04
Stereoma anchoralis	0.10±0.06	0.00±0.00	1.75	0.04
Salticidae	0.19±0.07	0.06±0.03	1.35	0.08
Tropidacris collaris	0.38±0.09	0.00±0.00	4.19	0.00
Trigona spinipes	0.10±0.10	0.00±0.00	1.00	0.15
Tetranychidae	1.85±1.61	13.13±7.03	0.81	0.20
Tettigoniidae	0.92±0.16	0.06±0.03	5.02	0.00
Walterianela sp.	0.04±0.04	0.00±0.00	1.00	0.15
Abundance of phytophagous	19.81±4.44	56.58±12.10	0.51	0.30
Diversity of phytophagous	3.99±0.52	1.51±0.22	3.08	0.00
Species richness of phytophagous	2.92±0.26	1.19±0.14	4.86	0.00
Abundance of pollinators	0.13±0.10	0.02±0.02	0.59	0.28
Diversity of pollinators	0.03±0.03	0.03±0.03	0.00	0.50
Species richness of pollinators	0.04±0.02	0.02±0.02	0.58	0.28
Abundance of natural enemies	8.52±1.22	3.19±0.80	4.16	0.00
Diversity of natural enemies	4.59±0.81	1.83±0.34	1.69	0.04
Species richness of natural enemies	3.17±0.33	1.13±0.19	4.57	0.00

*TW = test of Wilcoxon; [£]VT = value of test. n = 48 per treatment; *P* = P-value.

Table 3. Relationships between abundance (Ab.), diversity (D.), and species richness (S.R.) of phytophagous (Phy.) and pollinators insects (Pol.), natural enemies (N.E.), number of Araneidae (Ara.), Dolichopodidae (Dolic.), Salticidae (Salt.), *C. sanguinea* (C.sang.), *Phenacoccus* sp. (Phen.), *Polybia* sp. (Poly.), *Lyriomiza* sp. mines (Lyri.), and *P. termitarius* (P.ter.) on *Sapindus saponaria* (Sapindaceae) saplings.

Principal component regressions	R^2	***F***	***P***
Ab.N.E.= 4.57 + 2.94 x Ab.Pol. + 0.03xAb.Phy.	0.10	4.93	0.01
D.N.E.= 0.92 + 0.83 x D.Phy.	0.31	42.45	0.00
S.R.N.E.= 0.39 + 1.85 x S.R.Pol.+ 0.83 x S.R.Phy.	0.49	44.72	0.00
Ara.= 0.22 + 1.24 x Dolic.	0.30	39.73	0.00
Salt.= 0.08 + 1.59 x C.sang.	0.45	75.70	0.00
C.sang.= 0.02 + 0.04 x Phen.	0.26	32.15	0.00
Poly.= 0.01 + 0.01 x Lyri.	0.19	22.61	0.00
Second degree regression			
Lyri. = 2.56 + 4.55 x P.ter.- 0.31 x $P.ter.^2$	0.18	10.15	0.00

n= 48; *F* = F test; *P* = P-value.

4. Discussion

The aggregated distribution of phytophagous arthropods on *S. saponaria* saplings was similar to other insects, such as *Aethalion reticulatum* Linnaeus (Hemiptera: Aethalionidae) and *Camponotus* sp. on *Bauhinia forficata* Linnaeus (Fabaceae), Acrididae (Orthoptera) in several plants, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) on *Capsicum annuum* Linnaeus (Solanaceae), *Dendroctonus ponderosae* (Hopkins) (Coleoptera: Curculionidae) on pine, and *T. spinipes* on cucurbits (Bashir and Hassanali, 2010; Serra and Campos, 2010; Barônio et al., 2012; Goodsman et al., 2016; Kim et al., 2017). Aggregated distribution can increase the local population density of these arthropods (Goff et al., 2009), thus facilitating the acquisition of food, sexual partners, and protection against predators; however, it can also result in conflicts (e.g., competition) between them (Goff et al., 2009; Boulay et al., 2019).

The highest numbers of phytophagous arthropods (e.g., *S. anchoralis*) and natural enemies (e.g., Araneidae), increasing their respective ecological indices (e.g., species richness), in the adaxial leaf face on *S. saponaria* saplings, which is probably due to the lower force applied by these arthropods to remain on this face compared to the abaxial one (Salerno et al., 2018). The *S. saponaria* compound leaves (10-16 cm long x 3-4 cm wide) with seven leaflets, without trichomes, are imparipinnate (Lorenzi, 1992), thus, are probably an example of a surface with low contact for insects to fix themselves on, which may have affected the number of arthropods on the adaxial leaf face.

Factors such as wax content, hairiness, roughness, regular shape or not and the type and number of veins in the leaves of host plants can affect the ability of insects to walk, opting for the leaf surface (adaxial or abaxial) that requires a lower force applied to the movement (Peeters, 2002; Gorb et al., 2008; Gorb and Gorb, 2009; Prüm et al., 2012; Salerno et al., 2018). Among the phytophagous insects, Aleyrodidae showed the highest numbers on *S. saponaria* saplings, and this insect can be a problem being polyphagous and a pest in several plants: e.g., *B. argentifolii* attacks *Cucumis melo* Linnaeus (Cucurbitaceae), *Glycine max* (Linnaeus) Merrill and *Phaseolus vulgaris* Linnaeus (Fabaceae), and *Solanum lycopersicum* Linnaus (Solanaceae), due to sucking sap, injecting toxins, viruses and promoting the development of sooty mold (Zhang et al., 2004; Espinel et al., 2008; Mansaray and Sundufu, 2009).

The positive correlation between ecological indices (e.g., abundance) of natural enemies with phytophagous and pollinators insects on *S. saponaria* saplings is probably, due to predators following their prey, as observed on *Caryocar brasiliense* Cambess (Caryocaraceae), *Leucaena leucocephala* (Lamark) (Fabaceae), and *Pistacia lentiscus* Linnaeus (Anacardiaceae) trees (Auslander et al., 2003; Damascena et al., 2017; Leite et al., 2017).

The increase of spider numbers (e.g., Araneidae) with other predators (e.g., Dolichopodidae) on *S. saponaria* saplings is due to spiders prey on arthropods, pests or not, in natural and agricultural systems (Venturino et al., 2008; Leite et al., 2012, 2016). The positive correlation between the predator *C. sanguinea* and *Phenacoccus* sp. on *S. saponaria* saplings is also related to others species: *Hyperaspis polita* Weise (Coleoptera: Coccinellidae) and *Phenacoccus solenopsis* (Tinsley) (Hemiptera: Pseudococcidae) on *Hibiscus rosasinensis* Linnaeus (Malvaceae) plants (Seyfollahi et al., 2019), *Cheilomenes propinqua* (Mulsant) and *Hyperaspis vinciguerrae* (Capra) (Coleoptera: Coccinellidae); *H. polita* and *Exochomus nigripennis* (Erichson), *Parascymnus varius* (Kirsch) and *Scymnus flagellisiphonatus* (Fursch) (Coleoptera: Coccinellidae), with *P. solenopsis*, on *C. annuum*, *Gossypium hirsutum* Linnaeus (Malvaceae), *Hibiscus* sp., *Lantana* sp. (Verbenaceae), *Ocimum basilicum* Linnaeus (Lamiaceae), and *S. lycopersicon* (Spodek et al., 2018), respectively, and *Platynaspidius maculosus* (Weise) (Coleoptera: Coccinellidae) and *Aphis spiraecola* (Patch), *Aphis gossypii* (Glover) and *Toxoptera citricidus* (Kirkaldy) (Hemiptera: Aphididae) on *Citrus* sp. (Rutaceae) plants (Wäckers et al., 2017).

The increase in the *Polybia* sp. number with *Lyriomyza* sp. mines on *S. saponaria* saplings shows its importance in the biological control as related in *Brassica campestris* Linnaeus and *B. oleracea* Linnaeus var. *acephala* DC (Brassicaceae), *Coffea arabica* Linnaeus (Rubiaceae), and *S. lycopersicon* (Miranda et al., 1998; Picanço et al., 1998;

Leite et al., 2001; Picanço et al., 2012). The higher number of *P. termitarius* reduced *Lyriomyza* sp. mines on *S. saponaria* saplings indicates that this ant, among others tending ants (Hymenoptera: Formicidae), is important in the biological control of chewing and miner insects (e.g., Coleoptera and Lepidoptera) (Gonthier et al., 2013).

Numbers of *Crematogaster* sp. and *P. termitarius* reduced defoliation by Coleoptera and Lepidoptera and mines (Lepidoptera) on *C. brasiliense* trees (Leite et al., 2012). Those of *Pheidole* sp.2 and *Odontomachus troglodytes* Santschi (Hymenoptera: Formicidae) reduced *Cosmopolites sordidus* (Germar) (Coleoptera: Curculionidae) on *Musa paradisiaca* Linnaeus (Musaceae) plants (Abera-Kalibata et al., 2008), *Solenopsis invicta* (Buren) eggs, small caterpillars, and pupa of the *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae) on *G. hirsutum* plants (Ruberson et al., 1994), and those of 13 and 16 phytophagous taxas on *G. max* plants and *G. hirsutum*, respectively (Eubanks, 2001). In addition, *Solenopsis geminate* (Fabricius) (Hymenoptera: Formicidae) reduced *Nilaparvata lugens* (Stål) (Hemiptera: Delphacidae) on *Oryza sativa* Linnaeus (Poaceae) plants (Way et al., 2002).

The high number of arthropods (e.g., phytophagous) in the adaxial leaf face on *S. saponaria* saplings is probably due to the lesser effort when walking on this face. It favors the control of those potential pests (e.g., Aleyrodidae). Among the natural enemies, tending ants showed the highest numbers and can reduce *Lyriomyza* sp. mines.

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Supplementary Material

Supplementary material accompanies this paper.

Supplementary material I. Aggregated (Ag), Random (Ra), distribution (D) of arthropods on Sapindus saponaria/ saplings.

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