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ORIGINAL ARTICLE

Edaphic insect fauna associated with reforestation with *Schizolobium parahyba* Barneby in Amazonia

Entomofauna Edáfica associada a reflorestamentos com paricá na Amazônia

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ABSTRACT: Currently, little is known about the edaphic insect fauna associated with forest ecosystems with parica (*Schizolobium parahyba* var. *Amazonicum*) (Fabaceae) in the Brazilian Amazon Rainforest. The species presents great economic value to the timber market; however, insects with potential damage to this crop have been identified in periodic surveys. The purpose of this study was to evaluate, in commercial plantations of different ages in the dry and rainy seasons, the abundance and dominance of major functional groups of insects in forest ecosystems with parica. Collection was carried out using pitfall traps exposed for 24 h. Insect identification contemplated order and family. The results showed that the number of insects was directly related to the precipitation regime, because the total density of the insect fauna in the rainy season was 61% higher than in the dry season. During the study period, 17,595 insects belonging to 11 orders and 37 families were captured. The order Hymenoptera was the most abundant in the dry season, representing 92.20% of the individuals captured. The highest number of families (15) was found in the order Coleoptera. In the rainy season, the two and three year-old plantings showed greater richness of orders (9), but fewer families (22 and 21), respectively. Five-year-old plantings were the richest regarding families (26), mainly for being more stable environments. The most important functional groups were herbivores, predators, and social insects.

RESUMO: *Atualmente, pouco se sabe sobre a entomofauna edáfica associada aos ecossistemas florestais com paricá (Schizolobium parahyba var. amazonicum) (Fabaceae), na Amazônia brasileira. A espécie possui grande valor econômico para o mercado madeireiro; no entanto, há insetos com potenciais de danos a esta cultura e que podem ser identificados a partir de levantamentos periódicos. Objetivou-se avaliar, em plantios comerciais com diferentes idades, nos períodos seco e chuvoso, a abundância e a dominância dos grupos funcionais dos principais insetos presentes em ecossistemas florestais com paricá. A coleta foi com armadilhas do tipo pitfall, expostas durante 24 horas. A identificação contemplou ordem e família. Os resultados demonstraram que o número de insetos teve relação direta com o regime hídrico, pois a densidade total da entomofauna na época chuvosa foi 61% superior à do período seco. Foram capturados 17.595 insetos, pertencentes a 11 ordens e 37 famílias. A ordem Hymenoptera foi a mais abundante no período seco, representando 92,20% dos indivíduos capturados. O maior número de famílias (15) foi na ordem Coleoptera. No período chuvoso, os plantios de dois e três anos apresentaram maior riqueza de ordens, em número de nove; entretanto, houve menor número de famílias, 22 e 21, respectivamente. Os plantios de cinco anos, por serem ambientes mais estáveis, foram os mais ricos, com 26 famílias. Os grupos funcionais de maior importância foram os herbívoros, os predadores e os insetos sociais.*

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1 Introduction

The parica tree, *Schizolobium parahyba* var. *amazonicum* is a native species of the Amazon region. Currently, it is the forestry species most cultivated in reforestation areas in northern Brazil. According to the Brazilian Association of Forest Plantation Producers - Abraf (2010), the parica tree wood is used in the manufacturing of plywood, laminates, medium density fiberboard (MDF), ceilings, toothpicks, paper, furniture, interior finishing and moldings. Some studies identified the aerial insect fauna associated with the parica tree (Lunz et al., 2011; Batista et al., 2013), but there are no reports of the edaphic insect fauna in the specialized literature. It is known that forest ecosystems accumulate a layer of organic residues on the soil. These residues, associated with leaf litter, favor important habitat for many interacting organisms such as plants, microbes and the soil fauna itself.

Soil arthropods stand out by their great diversity and high number of species, especially in natural environments and in those little disturbed by human activities, such as plantation forests and natural grasslands. Among the arthropods, the insects appear in large numbers, both in biomass and number of individuals and species; however, in areas of monoculture or impacted, the scenario is usually different: the presence of large populations and reduced number of species have been observed (Ferraz et al., 2010).

Studies indicate that several taxa of insects can be used as bio-indicators of forestry environmental impact assessment (Ribas et al., 2005; Leidner et al., 2010; Ferraz et al., 2010). They present wide geographical distribution, are locally abundant, functionally important at various trophic levels, and easily identified; they occupy diversified niches in the ecosystem and can be classified into functional groups.

The invertebrate fauna is of great importance for the processes that structure terrestrial ecosystems; therefore, studies on communities of invertebrates such as insects and their use in conservation strategies for the management of forest ecosystems are essential to forestry research. The aim of this study was to investigate the main groups of insects in homogeneous parica plantations, as well as their abundance and dominance at different reforestation ages in the dry and rainy seasons.

2 Materials and Methods

The present study was carried out in 2009 and 2010 in commercial areas (03°30'; 03°45' S and 48°30'; 48°45' W) in the municipality of Paragominas, Amazonia, Brazil, located at 2° 25'; 4º 09' S and 46° 25'; 48° 54' W.

The soil in the study area is Yellow Latosol according to the New Brazilian System of Soil Classification. These soils, which are predominant in the region, present medium to very clayey texture and good depth, drainage, permeability and brittleness. According to Petillon et al. (2006) and Lachat et al. (2006), soil type and vegetation cover, as well as the temporal and regional scales, are important factors to determine the composition and richness of collected arthropods.

Biological sampling was conducted using pitfall traps in permanent inventory plots. Each plot consisted of 50 trees, spaced 4 x 4 m, where 20 traps were placed per period, as recommended by Aquino et al. (2006), but with modified spacing (Figure 1): the traps were spaced 12 x 4 m, positioned 1 m from the root of each tree and buried up to the soil surface. Collection was performed in three plots by reforestation age, which corresponded to 2, 3, 4, and 5 years. In this study, we selected the months of May and September for the collections of the rainy and dry seasons, respectively.

The traps were prepared with wide neck plastic bottles of 500 ml, containing 200 ml of 70% alcohol and drops of

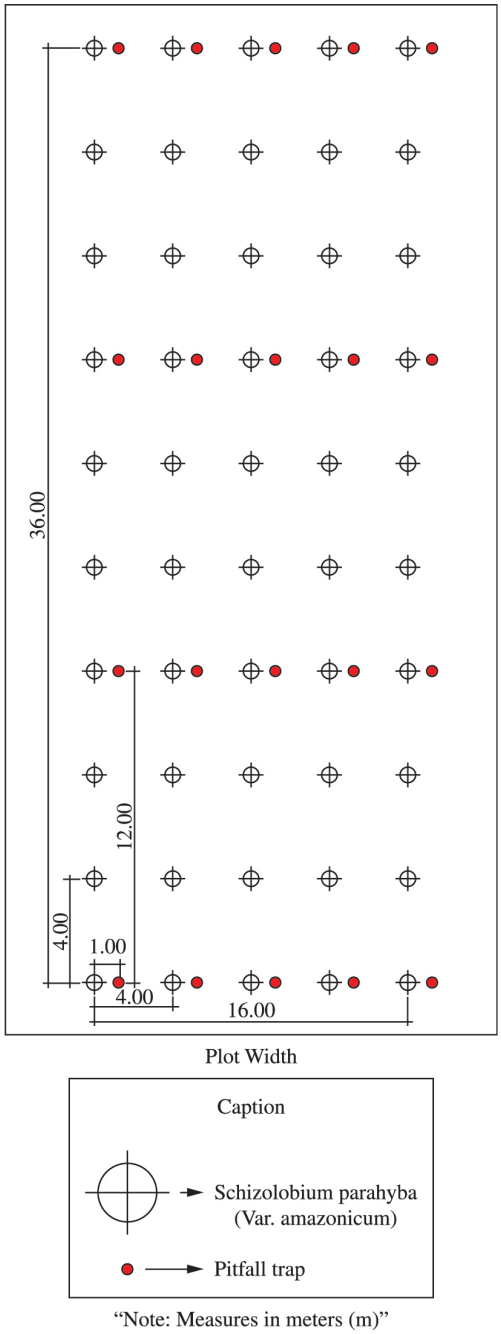

Figure 1. Sketch of a permanent inventory plot containing the location of the 20 pitfall traps.

Figura 1. Croqui de uma parcela permanente contendo a localização das 20 armadilhas do tipo "pitfall traps"

detergent; they remained in the field for a period of 24 hours, with a total of 240 samples per season.

The climate in the region is Aw according to Köeppen classification, tropical rainy with clearly defined dry season, 27.2 °C mean annual temperature, 81% relative humidity and average rainfall of 1,766 mm year^{-1}. Water availability is lower from July to October and higher from December to May.

The insects were identified according to order and family and the collection was preserved in the Museum of Entomology at the Federal Rural University of Amazonia -UFRA. Characterization of the insect fauna community was carried out using faunal measures: abundance, dominance and diversity. Relative abundance was expressed as percentage of the average number of individuals per order in the traps over the total number of individuals for each functional group. We used the sum of the number of individuals per orders in the traps gathered at each collection season. Functional groups were classified into categories of abundance. The formula used for this study was: Abundance (mean number of individuals per trap) = (**Total t * 100**) **/ T ind.**

Where:

Total t = Total number of individuals per trap of that order for collection **n**

T ind. = Total number of insects per trap for collection **n**

n = collection season

The software program BioDiversity Pro 2 (Mcaleece, 2004) was used to process the diversity index. Analysis of variance (ANOVA) was performed and the means were compared by the Tukey test ($p \geq 0.05$).

3 Results and Discussion

Variations in the number of individuals presented direct relation with variations in the precipitation regime of the region. 17,609 insects belonging to 11 orders and 37 families were captured in the different ages assessed - 10,846 in the rainy season and 6,763 in the dry season (Table 1). Regarding this difference, Bandeira and Harada (1998) emphasized that in tropical ecosystems such as the Amazonia, with defined rainy and dry seasons, the soil fauna usually migrates from the organic soil surface, when it presents water deficiency, to the deeper mineral layer, returning to surface when moisture is restored. Overall, the number of insects collected in both periods was considered low, because disturbed areas with intensive management of mechanization and pesticide can replace natural dispersion methods, control of populations, changes in levels of soil fertility, and reduction of insect biodiversity. The richness of families found was higher for the order Coleoptera with 15 families, followed by Diptera (6), Hemiptera (5), Blattodea, Orthoptera and Hymenoptera (2 each), and Dermaptera, Isoptera, Lepidoptera, Thysanoptera and Zoraptera with just one family each (Table 1). The rainy season showed higher richness compared with the dry season, because monocultures, despite their economic importance, have a negative impact on insects due to the low diversity of plant products in the field (Aquino et al., 2006). The dominance of the previously mentioned orders may be directly related to the use of pitfall traps, which are intended primarily to capture terrestrial animals that forage on the ground or dwell there at one of their developmental stages (Aquino et al., 2006).

The richness of families of order Coleoptera, in the rainy season, can also be explained by the vertical movement of beetles and other leaf litter organisms, because they are associated with changes in soil temperature and, once sedentary, are more vulnerable to environmental changes. (Freitas et al., 2002).

The presence of beetles of the family Carabidae, which are more sensitive than scarabs, is an indicator of temperature and humidity; they are, therefore, more present in the rainy season (Milhomem et al., 2003).

The family Scolytidae stood out by the number of insects; however, we stress that these beetles create galleries in parica trees, especially in the rainy season (personal observation).

The family Nitidulidae, present in all parica tree reforestation ages, consists of insects commonly found in decaying organic substrates, which are present in the soil during the rainy season, and some of its species present predatory habits (Triplehorn and Johnson, 2005); nevertheless, little is known about these insects in Brazil.

Beetles of the family Scarabaeidae are important because they feed on feces and carcasses of vertebrates (Nichols et al., 2008). Their local distribution is strongly influenced by vegetation cover, and this group is an ecological indicator because it responds to structural differences between different vegetation types. They are detritivores and promote the removal and restoration of organic matter in nutrient cycling, increasing soil aeration and extending its production capacity (Milhomem et al., 2003).

The family Gryllidae also showed a larger number of insects in the rainy season (Table 1), indicating that individuals migrated to the surface, because they have the habit of staying in galleries in the soil during the dry season. In addition, the vegetation provides a more closed environment and mild temperatures in the rainy season; these conditions are ideal for the community of crickets, mainly owing to the formation of leaf litter and organic matter (Sperber et al., 2007). In general, the fauna of these insects is poor in species and their abundance is relatively low in forest areas. Physical disturbances cause rapid responses in the community of crickets, and these can be indicators at a local level (Sperber et al., 2007).

In the rainy season, reforestation areas of two and three years of age presented greater richness of orders (9), and the lowest richness was observed in four and five year-old areas (7 orders). Regarding the number of families in this period, the five year-old area was the richest, with 26 families, followed by reforestation areas of 4, 2 and 3 years of age, with 24, 22 and 21 families, respectively (Table 1). In the dry season, the two-year-old area remained as the richest in number of orders (7), and the areas of 3, 4 and 5 years of age showed the lowest richness for the period, with five orders each. The number of families captured in the dry season was higher in the four-year-old area (10) and lower in areas of three and five years of age, with only 7 families found (Table 1). Also, this reforestation area stood out for presenting the highest and lowest values regarding the abundance of samples, with the highest abundance of insects in the rainy period (3815 individuals) and the lowest abundance in the dry period (1475 individuals).

Table 1. Distribution of orders, families and abundance of insects in parica plantations of different ages and at different collection periods.
Tabela 1. Distribuição de ordens, famílias e abundância de insetos em plantios de paricá com diferentes idades e períodos de coleta

	Rainy season				Dry season				
Orders/Families	2 years	3 years	4 years	5 years	2 years	3 years	4 years	5 years	Total
BLATTODEA									
Blaberidae	5	5	15	10	-	-	-	-	35
Blattidae	-	-	-	1	-	-	-	-	1
COLEOPTERA									
Anthribidae	1	-	-	1	-	-	-		2
Bruchidae	2	-	1	4	-	-	2	-	9
Carabidae	8	17	19	22					66
Cerambycidae	-	-	1	1	-	-	-	-	2
Chrysomelidae	1	-	-	-	-	-	-	-	1
Curculionidae	1	-	-	1	-	-	-	-	2
Elateridae	-	-	1	1	-	-	-	-	2
Histeridae	1	-	1	1	-	-	-	-	3
Lagriidae	-	2	-	-	-	-	-	-	2
Nitidulidae	66	35	35	74	-	1	2	1	214
Passalidae	1	4	-	-	-	-	-	-	5
Platypodidae	-	-	2	-	-	-	-	-	2
Scarabaeidae	28	2	14	3	-	-	-	-	47
Scolytidae	291	242	102	185	105	107	92	37	1.161
Staphylinidae	21	20	29	19	13	15	27	10	154
DERMAPTERA									
Forficulidae	302	193	500	300	3	28	25	9	1.360
DIPTERA									
Ceratopogonidae	-	1	-	-	-	-	-	-	1
Culicidae	2	2	2	1					7
Drosophilidae	6	7	14	6	-	2	-	1	36
Muscidae	-	-	1		-	-	-	-	1
Simulidae	-	-	-	1	-	-	-	-	1
Tachinidae	-	-	-	1	-	-	-	-	1
HEMIPTERA									
Cicadellidae	4	8	1	1	4	-	3	9	30
Cydnidae	3	3	3	2	2	-	1	-	14
Delphacidae	-	-	1	-	-	-	-	-	1
Reduviidae	-	-	-	-	-	-	1	-	1
Rhopalidae	-	1	-	-	-	-	-	-	1
HYMENOPTERA									
Formicidae	3.022	1.441	1.214	2.261	1.345	1.387	1.528	1.999	14.197
Vespidae	-	-	1	-	-	-	-	-	1
ISOPTERA									
Kalotermitidae	1	1	-	1	-	-	-	-	3
LEPIDOPTERA									
Noctuidae	1	1	2	-	-	-	-	-	4
ORTHOPTERA									
Acrididae	6	5	1	2	1	-	-	-	15
Gryllidae	42	34	109	19		1			205
THYSANOPTERA									
Thripidae	-	-	-	-	1	-	-	-	1
ZORAPTERA									
N.I.	-	-	-	-	-	-	1	-	1
Subtotal	3.815	2.024	2.089	2.918	1.474	1.541	1.682	2.066	
Grand total		10.846				6.763			17.609

N.I. – insect whose family has not been identified.

The two-year-old reforestation area presented the highest richness of orders and the greatest abundance of individuals. This fact is explained by the possible presence of species which face less competition and have fewer natural enemies (Freitas et al., 2002).

The families Blattidae, Isoptera and Curculionidae showed low abundance of individuals in the rainy season (Table 1) and did not predominate in any area. Although they present low abundance, they perform an important action in the development and cycling of organic matter in the soil - a major ecological role in the dynamics of forest ecosystems (Azevedo et al., 2011). Diptera of families Muscidae and Drosophilidae develop a biological function in the decomposition of organic matter in moist forests, because they act on fermented fruit and carcasses of wild animals, respectively.

Hymenoptera was the most abundant order in the two sampling periods (Table 2), representing 92.20% of the individuals in the dry season, with an average of 221.25 occurrences. Within this order, the Formicidae family stood out with 14,197 individuals, representing 80.6% of the total insects collected, followed by families Forficulidae (Order Dermaptera) and Scolytidae (Order Coleoptera), with 1360 and 1161 individuals, respectively. Family Formicidae is most frequently observed in soils with higher concentrations of potassium, phosphorus and organic matter, such as planted forests (Wink et al., 2005); in addition, the high densities observed in this group in all study areas may be explained by the sampling method used, which is considered satisfactory for collecting ants, because they move along the ground and are easily captured by pitfall traps.

Elimination of the understory through the anthropogenic management of natural ecosystems causes temporal disruption of the ant community and reduces the number of competitors and natural enemies. Thus, ants and many other soil organisms will have an ideal environment for propagation and occupation of areas which were previously unoccupied or occupied at low densities (Begon et al., 2007).

In the rainy season, Dermaptera was the second most abundant order, with an average of 12.97% of the present individuals, probably because of the presence of large populations of caterpillars of the species *Syssphinx molina* (Lepidoptera: Saturniidae), which were causing great defoliation in reforestation areas with parica during the study period (Table 2).

Order Coleoptera reached 11.89%, representing the third most abundant order with mean of 112.5 registered individuals. In the dry season, Coleoptera was the second order in abundance (6.40%) and Dermaptera was third with 0.99% of the individuals collected (Table 2).

The orders Blattodea, Lepidoptera and Isoptera occurred only in the rainy season, with average percentages of 0.37,

Table 2. Abundance of individuals according to orders, percentage (%) and frequency of insects caught in pitfall traps in areas of reforestation with parica *Schizolobium parahyba* var. *amazonicum*, Amazonia, Brazil.

Tabela 2. Abundância de indivíduos por ordens, porcentagem (%) e frequência de insetos capturados em armadilhas do tipo "pitfall traps", em áreas de reflorestamentos com paricá *Schizolobium* parahyba var. *amazonicum*, Amazônia, Brasil

	2 years		3 years		4 years		5 years		Means (%)	
Orders	R	D	R	D	R	D	R	D	R	D
Blattodea	0.13	0	0.25	0	0.72	0	0.38	0	0.37	-
	5	0	5	0	13	0	8	0	7.75	-
Coleoptera	11.04	8	15.9	7.98	9.95	7.31	10.68	2.32	11.89	6.4
	122	48	105	53	106	45	117	35	112.5	45.25
Dermaptera	7.92	0.2	9.53	1.82	24.15	1.49	10.27	0.44	12.97	0.99
	44	3	42	20	54	17	52	8	48	12
Diptera	0.21	0.07	0.54	0.13	0.82	0	0.41	0.05	0.5	0.06
	7	1	10	1	16	0	8	1	10.25	0.75
Hemiptera	0.18	0.41	0.59	0	0.24	0.3	0.1	0.44	0.28	0.28
	6	5	11	0	5	5	3	7	6.25	4.25
Hymenoptera	79.21	91.19	71.16	90.01	58.7	90.84	77.4	96.76	71.62	92.2
	315	250	301	219	266	192	292	224	293.5	221.25
Isoptera	0.03	0	0.05	0	0	0	0.03	0	0.03	-
	1	0	1	0	0	0	1	0	0.75	-
Lepidoptera	0.03	0	0.05	0	0.1	0	0	0	0.04	-
	1	0	1	0	2	0	0	0	1	-
Orthoptera	1.26	0.07	1.93	0.06	5.31	0	0.72	0	2.3	0.03
	32	1	22	1	27	0	14	0	23.75	0.5
Thysanoptera	0	0.07	0	0	0	0	0	0	-	0.02
	0	1	0	0	0	0	0	0	-	0.25
Zoraptera	0	0	0	0	0	0.06	0	0	-	0.01
	0	0	0	0	0	1	0	0	-	0.25

Rainy season (R); dry season (D).

0.04 and 0.03%, with 7.75, 1 and 0.75 records of individuals, respectively. Thysanoptera and Zoraptera were the least abundant orders in this period, being present only in the dry season with averages of 0.02% and 0.01%, respectively. Order Hemiptera remained constant (0.28%) in both periods.

The difference in the abundances of the most frequent orders can be related to the sampling periods and the microclimate and/or ecological conditions that occurred in the plots, because the municipality of Paragominas is located in a transition region of biomes, with adjacent native forests with characteristics of the Cerrado and/or the Amazon Rainforest.

The results showed that the number of orders decreased as reforestation age increased in the dry period, indicating a stable trend of the edaphic insect fauna in older plantations. Furthermore, insect fauna distribution can be directly related to the seasonality of collection cycles and forest maintenance practices of the planting made by the company, such as mechanical weeding and pest control with the use of chemicals.

The following classification was obtained for the functional groups of the orders found in the study (Table 3). Predators and herbivores - according to the predominant feeding habit in each group. The designation of other groups was given to those whose dietary habits are widely varied, such as insects of the order Coleoptera, where adults and larvae present oral masticatory apparatus, showing great variation in feeding behavior. The group of social insects included the Hymenoptera (Formicidae and Vespidae) and Isoptera orders. In general, in most of the orders found in the functional groups in areas with parica, those with chewing mouthparts should be highlighted. We also highlight the populations of Carabidae beetles that can increase with soil fertilization, because they depend seasonally on landscape - to breed in the spring, and survive the winter (Varchola and Dunn, 1999; Hunter, 2002). Hunter (2002) reports that field areas can act as reserves of predators, especially carabids.

The insects classified in other groups, along with the herbivores, showed low frequency and abundance in both collection periods. These results corroborate those by Siira-Pietikainen et al. (2003), who verified that the functional group of herbivores is prevalent in intact forest.

Order Dermaptera (group of predators) has been reported as abundant in the rainy season because of the large presence of individuals (11%). The group of social insects (Formicidae) was dominant in both collection seasons with more than 50% of the individuals in each sampling period (Table 4). Silva et al. (2012) also observed 76% prevalence for ants in different systems; this figure has also been reported by other authors in tropical forests. Another important factor that can influence the density of insects is the presence of leaf litter (Campos et al., 2003), because it contains diversity of fauna and flora, which contributes to the interaction between the groups and the ecological processes (Silva et al., 2012).

In May, rainy season, the average monthly rainfall was 280 mm/m^2 and the mean temperature was 28.4 °C (Figure 2). In this period, the largest number of individuals was collected in the traps. The presence of soil moisture owing to heavy rainfall during the rainy season was a crucial factor for the maintenance of the edaphic insect fauna in areas forested with parica - of the 40 families found in this study, 36 occurred in the rainy season and 15 in the dry season, with 11 families common to both periods, namely Bruchidae, Nitulidae, Scolytidae, Staphylinidae, Forficulidae, Drosophilidae, Cicadellidae, Cydnidae, Formicidae, Acrididae and Gryllidae.

The results demonstrated a significant influence of rainfall on the abundance of beetles (Bruchidae, Nitulidae, Scolytidae, Scarabaeidae e Staphylinidae). According to Nichols et al. (2008), surface soil moisture directly affects the quality and quantity of food resources used by several species of beetles, influencing their survival. Beetles are considered sensitive indicators of environmental quality and play important roles in nutrient cycling, pollination, seed dispersal, and in the control of some parasites (Nichols et al., 2008). For this reason, the abundance of beetles, in spite of the non-use of specific traps for their collection, showed that the areas reforested with parica are in good repair.

In September - sampling period of the dry season - the precipitation regime mean was 90 mm, a decrease three times smaller than that occurred in the rainy season; however, the average temperature of 28.2 °C was maintained. This sampling period represented a dry summer, with lower moisture and precipitation in the areas of collection (Figure 2). A significant effect of seasonality occurred in the density of insects, because collection in the dry season was lower than in the rainy season.

In the rainy season (May), the two-year-old planting was the most abundant (1271.67 ± 2.3 insects), and the lowest abundance occurred in the three-year-old reforested area (675.00 ± 5.5 insects) ($F_{2.0633} = 2.3472$, $p < 0.05$). The five-year-old planting was also one of the most abundant in the dry and rainy seasons, with means of 688.87 ± 2.45 and 973.67 ± 4.8 individuals, respectively; however, there was no significant effect of age on the abundance of insect fauna in the dry season (Table 5). The greater canopy cover provided by the crowns of five-year-old parica trees allowed lower solar radiation and, consequently, higher soil water retention in these plots, which

Table 3. Composition of the functional groups found in reforestation areas with parica *Schizolobium parahyba* var. *amazonicum*, Amazonia, Brazil.
Tabela 3. Composição dos grupos funcionais encontrados em áreas de reflorestamento com paricá *Schizolobium* parahyba var. *amazonicum*, Amazônia, Brasil

Predators	Herbivores	Other	Social insects
Dermaptera	Hemiptera	Blattodea	Hymenoptera (Formicidae)
Hymenoptera (Vespidae)	Thysanoptera	Coleoptera	Hymenoptera (Vespidae)
Coleoptera (Carabidae)	Orthoptera	Diptera	Isoptera
		Zoraptera	
		Lepidoptera	

Table 4. Classification of abundance of the functional groups collected in areas reforested with parica in the rainy and dry seasons.

Tabela 4. Classificação da abundância dos grupos funcionais coletados em áreas de reflorestamento com paricá nas épocas chuvosa e seca.

Functional Groups	Rainy Season	Dry Season
Predators		
Dermaptera	3	1
Hymenoptera (Vespidae)	1	0
Herbivores		
Hemiptera	1	1
Thysanoptera	0	1
Orthoptera	2	1
Social Insects		
Hymenoptera (Formicidae)	4	4
Hymenoptera (Vespidae)	1	0
Isoptera	1	0
Other		
Lepidoptera	1	0
Blattodea	0	0
Coleoptera	0	0
Diptera	1	1
Zoraptera	0	0

Codes: Abundance > 50% = 4 (dominant); 10 - 50% = 3 (abundant); 2. 10% = 2 (incidental); < 2% = 1 (rare).

may have contributed to the reduction of litterfall, especially in the dry season, wherefore the abundance of insects in this period also remained higher for this age.

Considering that temperature and humidity have an important influence on the population dynamics of insects (Bandeira and Harada, 1998), it is possible that these abiotic factors have affected the dynamics of insects in parica plantations. Battigelli et al. (1994) emphasized that higher temperatures and soil water contents directly influence the permanence of macroinvertebrates in the upper layers of the soil. These fluctuations in the population of soil fauna in the surface horizons may be a result of fauna migration to obtain food resources, or a change in the birth and mortality of these communities.

In the rainy season, the plantings of three and four years of age presented similar results regarding the abundance of insect fauna (Table 5) and number of orders, not differing significantly (Table 6), but the five and two year-old reforestation areas were the most divergent (Table 6). Nevertheless, an effect of the rainfall regime was verified, with the rainy season favoring the abundance of insects in the two-year-old reforestation areas (Table 5). The richness of orders found in both periods was higher in the rainy season for all ages assessed ($F_{1.0683} = 1.5467$, $p < 0.05$), and temporal effect occurred with respect to collection period; however, the effect of planting age was not significant (Table 6). The rainy season has caused an increase in insect population compared with the dry season, which was rigorous in the area evaluated. This association can also be explained by the fact that, in this

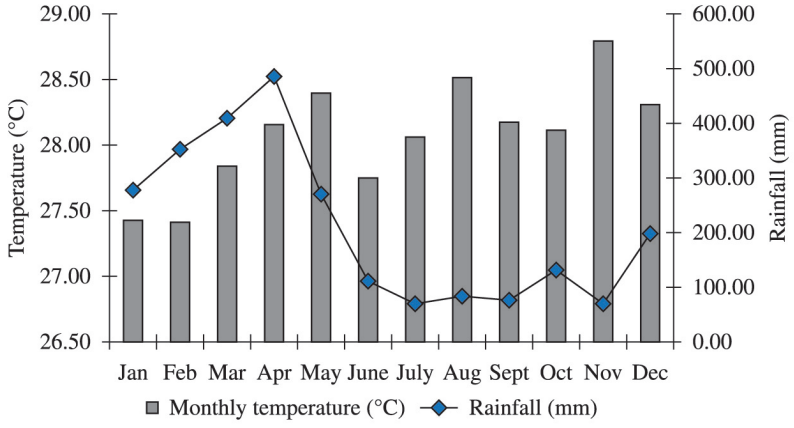

Figure 2. Means of rainfall and temperatures in 2009 and 2010. Paragominas, Amazonia, Brazil.

Figura 2. Médias de precipitação pluviométrica e temperaturas nos anos de 2009 e 2010. Paragominas, Amazônia, Brasil.

Table 5. Mean abundance of insect fauna associated with parica according to reforestation age and collection periods.

Tabela 5. Média de abundância da entomofauna associada ao paricá em função das idades dos plantios e períodos de coleta.

Reforestation age	May Rainy	September Dry	Overall mean
2 years	1.271.67 ± 2.3 Aa	491.67 ± 3.56 Ba	881.67 a
3 years	675.00 ± 5.5 Ab	513.67 ± 3.67 Ba	594.33 b
4 years	69.00 ± 4.2 Ab	560.67 ± 4.35 Aa	625.33 b
5 years	973.67 ± 4.8 Ab	688.67 ± 2.45 Aa	831.17 ab
Global	902.58 A	563.67 B	733.13 B

Uppercase letters, horizontally - effect of rainfall regime; lowercase letters, vertically - effect of reforestation age. Values preceded by the same letter do not differ significantly by Tukey test at 5% probability level.

Table 6. Mean richness of orders of insect fauna associated with parica according to reforestation age and collection periods.
Tabela 6. Média de riqueza de ordens da entomofauna associada ao paricá em função das idades dos plantios e período de coleta.

Reforestation age	May Rainy	September Dry	Overall mean
2 years	7.67* ± 3.36 Aa	4.67 ± 1.32 Ba	6.17 a
3 years	7.33 ± 4.22 Aa	3.67 ± 1.45 Ba	5.50 a
4 years	7.67 ± 2.90 Aa	4.33 ± 0.76 Ba	6.00 a
5 years	6.67 ± 3.76 Aa	4.00 ± 0. 50 Ba	5.33 a
Global	7.33 A	4.17 B	5.75

*Uppercase letters, horizontally - effect of rainfall regime; lowercase letters, vertically - effect of reforestation age. Values preceded by the same letter do not differ significantly by Tukey test at 5% probability level.

period, plants grow new leaves and branches that are potential sites for the development of insects, as already observed in native forests (Yamazaki et al., 1990). Moreover, the natural, partial and full defoliation observed in parica trees in the dry season may contribute to the low occurrence of insects in this period, therefore seasonality is directly related to insect population growth.

4 Conclusions

The edaphic insect fauna associated with parica reforestation presents high diversity, richness and abundance of insects, and the orders Hymenoptera and Coleoptera are the most frequent. The most important functional groups are herbivores, predators and social insects. The reforestation areas with two years of age present greater richness of orders, higher abundance and greater dominance of insects in the rainy season, while the five-year-old reforestation area shows higher abundance in the dry season.

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