INSECT RICHNESS IN DUNG PATCHES OF CATTLE RAISED IN TWO LIVESTOCK SYSTEMS

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ABSTRACT
The negative impact of livestock breeding on the environment has been mitigated through the combination of pastures and trees, characterizing the silvopastoral systems, an alternative to conventional pasture systems. The silvopastoral systems provide environmental services, particularly the recovery of degraded areas and carbon sequestration. Furthermore, the complexity of the silvopastoral systems can improve other environmental services, for example, enhance biodiversity and reduce pests through biological control. However, it is not clear the relationship between microclimate, pasture, trees, cattle, and invertebrate present in this environment. The purpose of this research was to characterize the richness and abundance of insects associated with dung patches of cattle raised in Integrated Livestock Forestry System (ILFS) and Conventional Pasture System (CPS) during one year in Brazil. The insect diversity associated with dung patches in the ILFS and CPS systems were respectively, 1.84 and 1.79. The morph species equivalent in the ILFS and CPS systems were 7 and 6 species, respectively.
Key words: Insect diversity; silvopastoral systems; integrated livestock forestry system

INTRODUCTION

The integrated livestock forestry system (ILFS) is a variation of silvopastoral systems which is an important socioeconomic component of the economies of countries of Tropical America. When implanted and well managed, they become key land-use systems for the provision of environmental services, particularly the recovery of degraded areas and carbon sequestration. Also, they can provide viable economic alternatives to farmers (AMÉZQUITA et al., 2004).

The ILFS combines trees (generally eucalyptus) with pasture and needs more labor and financial resource per hectare than existing technologies i.e. conventional pasture system (CPS); consequently, they have the potential of reducing the conversion of natural forestry to pasture (KAIMOWITZ and ANGELSEN, 2008). The combination of pastures and trees can contribute to mitigating the negative impact of livestock breeding on the environment.

The adoption of ILFS can favor adequate microclimate environmental conditions for cattle (PEZZOPANE et al., 2015), improve soil fertility and groundwater recharge, reduce erosion, improve water quality, sequester carbon, enhance biodiversity and consequently reduce pests and diseases (GUSMÃO et al., 2020).

Tropical climates favor the development of various ectoparasites that afflict cattle, especially the horn fly *Haematobia irritans*, the botfly *Dermatobia hominis* and the cattle tick *Rhipicephalus microplus* (GRISI et al., 2014). However, on the same climatic conditions, a diversity of invertebrate organisms living on ground soil and in dung patches can contribute to biological control of ectoparasites, maintaining its populations below the economic threshold (MENDES and LINHARES, 2002). The environmental services, as biological control, delivered from sylvopastoral systems, are described in the literature (NAVAS et al., 2008). However, the relationship between microclimate, pasture, trees, cattle, and invertebrate present in this environment is still not clear. The objectives of this study were the characterization of insect diversity associated with dung patches of cattle raised in ILFS and CPS systems.

MATERIAL AND METHODS

The study was conducted from August 2018 to May 2019 in São Carlos, São Paulo, Southern Brazil (22°01' S, 47°53' W, alt 860 m), where the climate is characterized as Cwa (Köppen), with a cool and dry season from April to September (mean air temperature of 19.9°C; and total rainfall of 250 mm), and a warm and wet season from October to March (mean air temperature of 23.0°C; and total rainfall of 1100 mm), according to Alvares et al. (2014).

The study included a 6-ha open pasture of the palisadegrass *Urochloa* (syn. *Brachiaria*) *brizantha* Stapf 'BRS Piatã', which was a CPS system, and a second 6-ha pasture, which contained the same palisadegrass with rows of *Eucalyptus urograndis* (*E. grandis* × *E. urophylla*) 'GG100', which was the integrated livestock forestry system (ILFS).

The trees in the silvopastoral system were planted in April 2011 and were arranged in simple rows, with an East-to-West orientation, with 15 m between rows, 2 m between trees within rows, and density of 333 trees ha^{-1}. In 2016 July was carried out thinning trees which result in a density of 166 trees ha^{-1}. In 2019 August was carried out thinning trees which result in a density of 83 trees ha^{-1}.

The herd consisted of male Nelore cattle, weaned at eight months of age. The cattle were submitted to rotational grazing, according to Euclides and Euclides Filho (1998). At the end of the seventh day of grazing, 15 recently dropped dung patches were selected randomly and covered by a trap (Figure 1) to evaluate the insects at the seven and 14 days after the trap installation. Then the insects collected through the trap were taken to the laboratory for the separation the morph-species (S) which were identified to the order *taxon*. The identifications to the family and specific *taxa* are still in course.

Figure 1. Trap for collecting insects associated with dung patches of cattle

The data of insect associated with the dung patches were analyzed from the number of individuals (n_i) of each morph-species (S), and the insect diversities related to the systems (ILFS and CPS) were determined by applying the Shannon index (H'), calculated in function of the relative abundance (proportion) (p_i) of morph-species (S_i) in the sample (N), where:

$$H' = -\sum_{i=1}^{S} P_i \times LN_{P_i}, \text{ with } P_i = \frac{n_i}{N}$$

Through the diversity index H', the equivalent number of morph-species ($S_{H'}$) for each system was determined, given by the equation (ODUM, 1983; PIELOU, 1975).

$$S_{H'} = e^{H'}$$

RESULTS AND DISCUSSIONS

The solar radiation was lower in the ILFS in all seasons during the time evaluations, with the average value of 3.58 MJ m^{-2} day^{-1} in the ILFS, and 8.08 MJ m^{-2} day^{-1} in the CPS. Significant differences ($P<0.05$) were also observed for average maximum wind speed in the two systems, with means of 7.44 and 5.12 m/s for the CPS and ILFS, respectively (Table 1).

Average soil temperatures also differed significantly ($P<0.05$) between the systems, with values of 22.47±0.05 °C (CPS) and 21.67 °C (ILFS). However, did not observe statistical difference for air temperature and average relative humidity between the systems (Table 1).

The insect richness values (number of morph-species) for the ILFS and CPS in the seasonal periods were 16 and 15 morph-species in the winter; 17 and 16 morph-species in the spring; 18 and 18 morph-species in the summer and 16 and 11 morph-species in the autumn, respectively (Table 2). In the ILFS system were registered higher total richness (67) and abundancy (5,363) than in the CPS system with total richness (60) and abundancy (4,138) (Table 2).

The average diversity indices (H') for the ILFS and CPS were 1.84 and 1.79, respectively. The numbers of equivalent morph-species ($S_{H'}$) considering the diversity H' of each system were seven morph-species in the ILFS and six morph-species in the CPS (Table 3). These values represent the number of morph-species that would be expected in each system if all morph-species has the same abundance (maximum evenness).

Table 1. Meteorological parameters in area of the systems during the experimental period.

System	Season/year	Solar radiation	Average soil temperature	Average air temperature	Average relative humidity	Maximum wind speed
CPS	Winter/2018	7.11 b	19.18 f	19.38 e	66.50 b	7.63 ab
	Spring/2018	9.12 a	23.33 c	22.24 bc	76.83 a	8.29 a
	Summer/2019	9.12 a	24.95 a	23.34 a	76.46 a	7.26 bc
	Autumn/2019	6.97 b	22.43 d	21.50 cd	73.34 a	6.57 cd
	Mean	8.08 A	22.47 A	21.61 A	73.28 A	7.44 A
ILFS	Winter/2018	3.20 d	18.64 g	19.25 e	65.54 b	5.64 e
	Spring/2018	4.78 c	22.66 d	22.01 c	75.73 a	5.99 de
	Summer/2019	4.24 c	24.06 b	22.94 ab	77.22 a	4.72 f
	Autumn/2019	2.09 e	21.33 e	21.07 d	74.57 a	4.15 f
	Mean	3.58 B	21.67 B	21.32 A	73.26 A	5.12 B

Table 2. Richness and abundancy of insect associated with dung patches of cattle in the ILFS and CPS systems through the seasons.

System	Season/year	Richness	Abundancy
ILFS	Winter/2018	16	1,040
	Spring/2018	17	1,927
	Summer/2019	18	1,575
	Autumn/2019	16	821
	Total	67	5,363
CPS	Winter/2018	15	367
	Spring/2018	16	1,646
	Summer/2019	18	1,616
	Autumn/2019	11	509
	Total	60	4,138

Table 3. Insect diversity and equivalent morph species associated with cattle dung patches in the ILFS and CPS systems through the seasons.

Season/year	Diversity (H')		Equivalent morph species ($S_{H'}$)	
	LF	CP	LF	CP
Winter/2018	1.49	2.18	4	9
Spring/2018	1.69	1.45	5	4
Summer/2019	2.27	2.18	10	9
Autumn/2019	1.9	1.35	7	4
Mean	1.84	1.79	7	6

CONCLUSIONS

The presence of trees in pastures alters the environment, notably through the reduction of solar radiation, decrease in wind speed, attenuation of soil temperature, and diversification of food supply promoting insect richness in dung patches of cattle.

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