Diversity and habitat preferences of Carabidae and Staphylinidae (Coleoptera) in two agroecosystems

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Abstract

The present study had as objective determine the diversity and abundance of adults Carabidae and Staphylinidae in two areas, constituted by forest fragment and soybean/corn crops under conventional tillage and no-tillage systems and to analyze the distribution and preference of those beetles for the habitat. The beetles were sampled with 48 pitfall traps. In both experimental areas, two parallel transects of pitfall traps were installed. Each transect had 100 m in the crop and 100 m in the forest fragment. Four traps were close to each other (1 m) in the edge between the crop and the forest fragment, the other traps were installed each 10 m. The obtained data were submitted to the faunistic analysis and the preference of the species by habitat was obtained by cluster analysis. The results demonstrated that the type of crop system (conventional tillage or no-tillage) might have influenced the diversity of species of Carabidae and Staphylinidae. The cluster analysis evidenced that the carabids may prefer a specific habitat. In the present study, the distribution of carabids and staphylinids in the three habitats showed that these beetles have potential to be dispersed at great distances inside the crop.

Key words: ground beetles, rove beetles, no-tillage systems, forest fragment, edge.

Diversidade e preferência de habitat de Carabidae e Staphylinidae (Coleoptera) em dois agroecossistemas

Resumo

Este estudo teve como objetivo determinar a diversidade e abundância de adultos de Carabidae e Staphylinidae em duas áreas, constituídas por fragmentos florestais e culturas de soja/milho sob sistemas de plantio convencional e direto, e analisar a distribuição e a preferência desses insetos para o habitat. Os besouros foram amostrados com o uso de 48 armadilhas de solo do tipo Pitfall. Em ambas as áreas experimentais, foram instalados dois transectos paralelos de armadilhas; cada transecto teve 100 m na culturas e 100 m no fragmento florestal. Na borda entre a cultura e o fragmento de floresta foram instaladas quatro armadilhas, que ficaram distantes entre si por 1 m e as outras armadilhas, a cada 10 m. Os dados obtidos foram submetidos à análise faunística e a preferência das espécies para o habitat foi obtida pela análise cluster. Pelos resultados, observa-se que o tipo de sistema de cultivo (convencional ou plantio direto) pode ter influenciado a diversidade de espécies de Carabidae e Staphylinidae. A análise de cluster evidenciou que os carabídeos tiveram preferência por um habitat específico. Neste estudo, a distribuição de carabídeos e estafilinídeos nos três habitats mostraram que estes besouros têm potencial para se dispersarem em grandes distâncias no interior da cultura.

Palavras-chave: Carabídeos, estafilinídeos, sistemas de plantio direto, fragmento florestal, borda.

1. INTRODUCTION

The diversity and abundance of insect predators in agricultural areas are affected by the type of agriculture and by the presence of natural habitats (Kromp, 1989; Kromp, 1999; Pfiffner and Luka, 2000). Natural habitat is an important component of agroecosystems because it encourages insect predators dispersal (Thomas et al., 1991), an important component of sustainable agriculture (Altieri et al., 2003). Furthermore, the absence of natural habitats near agricultural systems limits the potential of natural enemies in pest control (Coombes and Sotherton, 1986; Thomas et al., 1991).

Predators are important because they persist in crops during periods of low pest density and can prevent early season build-up of pest numbers (Curry, 1993). Ground beetles (Carabidae) and rove beetles (Staphylinidae) are common generalist predators in agricultural soils (Ekschmitt et al., 1997). Carabids feed on ants, aphids, caterpillars, insect eggs, springtails and mites, and staphylinids feed on small nematodes, mites and collembola (Ekschmitt et al., 1997). They so can limit some prey populations in agroecosystems (Edwards et al., 1979; Kromp, 1999; Lang et al., 1999).

Natural refuges have a positive influence on natural enemy populations in temperate climates and benefit adjacent agricultural crops (Thomas et al., 1991; Dennis and Fry, 1992; Thomas et al., 2002; Collins et al., 2002; Collins et al., 2003; Fiedler and Landis, 2007). In Brazil, a few studies have been done on the influence of natural refuges on the diversity, abundance and distribution of natural enemies in agricultural crops. Vegetation coverage in perennial crops increases the number of natural enemies (Fadini et al., 2001; Altieri et al., 2003). Moreover, the use of plants in the field margins and the use of native plants attract natural enemies to agricultural crops (Macedo and Martins, 1998; Gonçalves and Souza-Silva, 2003; Silveira et al., 2005; Bellini et al., 2005; Demite and Feres, 2005).

An understanding of the composition and distribution of insect predator species and of their habitat preferences is fundamental to determine whether biological control can be improved by habitat manipulation (Clark et al., 1997; Holland et al., 1999). In this study, the diversity and abundance of adult Carabidae and Staphylinidae in forest fragments and in conventional tillage and no-tillage crops (soybean/corn) were investigated to analyze the distribution and preference of those beetles for those habitats.

2. MATERIAL AND METHODS

Field work was performed during the 2004/2005, 2005/2006 and 2006/2007 seasons, in two study areas located in the Guaíra county, State of São Paulo, Brazil. Both were comprised of a forest fragment adjacent to an agricultural crop (soybean, *Glycine max* L. and corn, *Zea mays* L.).

Experimental area 1 was located in the "Barracão" farm (20°21'18"S and 48°14'47"W). The plot was 88.6 ha and was subjected to no-tillage farm practices with soybean-corn rotation for 10 years prior to our study. There is a 48 ha-fragment of seasonal semideciduous forest adjacent to the plot. The soybean was cultivated with 0.5 m row spacing. In the off-season, corn was cultivated with 0.8 m row spacing.

Experimental area 2 was located in the "Mangues" farm, (20°19'32"S and 48°15'06"W) approx. 2 km from the experimental area 1. The plot was 12 ha and was subjected to conventional tillage practices with soybean-corn rotation. There is a 6-ha fragment of seasonal semideciduous forest adjacent to the plot. The soybean was cultivated with 0.5 m row spacing. In the off-season, corn was cultivated with 0.8 m row spacing.

Beetles were collected using pitfall traps (500 mL) containing a mixture of water (150 mL), formaldehyde (1%) and some drops of neutral detergent. Pitfall traps were made of plastic cups (80 mm diameter x 140 mm height) set in another plastic cup with holes in the base to drain the rain water. Each trap was covered with plastic (15 cm diameter) about 3 cm above the plastic cup.

In both experimental areas, two parallel transects of pitfall traps were installed. Transects were 10 m apart from one another. Each transect was 200 m in length, with 100 m in the crop and 100 m in the forest fragment. Four traps were 1 m apart from one another in the edge between the crop and the forest fragment and the other traps were each 10 m apart from one another. There were 48 traps in total (Figure 1).

Sampling was done twice a month during the growing season and once a month in the off-season (winter), from November 25th, 2004 to April 26th, 2007, for a total of 44 sampling dates. The traps were kept in the field for one week, then removed and taken to the laboratory to screen and to identify the beetles. For identification a dichotomous key and comparison with the existing collections at the Museum of Zoology, Universidade de São Paulo and the Museum of Entomology, Instituto Biológico de São Paulo were used.

Data were analyzed using the faunistic software Anafau, and dominance, abundance, frequency and constancy were determined. Dominant species had the largest faunistic indexes for frequency, constancy, abundance and dominance (Silveira Neto et al., 1995).

Preference of a species for a habitat was determined by cluster analysis (Jaccard distance) (Krebs, 1999). This kind of analysis is used to gather the species by family (Carabidae or Staphylinidae) according to the position of the traps in the transect, which means, identifying the species as their preference for the habitat: species of forest fragment, crop and/or border. When two or more individuals had been captured during the whole sampling period, they were included in the analysis. This reduced the effect of species present in low quantities on the results. The species that were observed in fewer than five traps were considered rare and were also removed from the analyzed data following the methodology of Bedford and Usher (1994).

The distribution of a species along of transects was subjected to cluster analysis. This distribution was used to verify the distance that the species were found in each habitat and if this happens preferably at a certain distance.

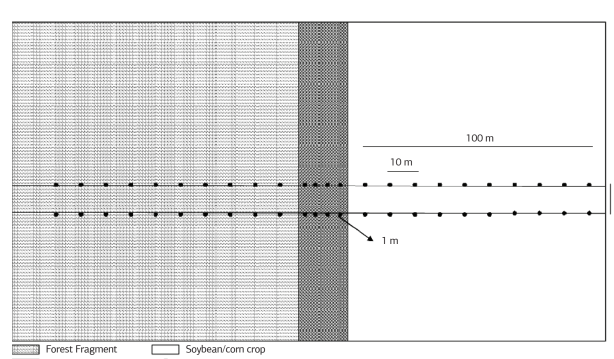

Figure 1. Arrangement of pitfall traps in the experimental areas.

3. RESULTS AND DISCUSSION

In experimental area 1 (forest fragment and soybean/corn crop under no-tillage system), 47 species of Carabidae (800 specimens/79.8% of total collected) and 32 of Staphylinidae (203/20.2%) were captured (Table 1). In experimental area 2 (forest fragment and soybean/corn crop under conventional tillage system), 38 species of Carabidae (1010 specimens/94.1% of total collected) and 18 Staphylinidae (63/5.9%) were captured (Table 2). The results demonstrated that the type of crop system might have influenced the diversity of species these beetles. According to House and Stinner (1983), the soil of soybean crops under no-tillage systems support a higher density and diversity of arthropods compared to in the soil of soybean crops under conventional tillage systems. Thomazini and Thomazini (2000) and Pichancourt et al. (2006) reported that the border effect and the size of the fragment could interfere in the diversity of insects, especially ground beetles. This is supported by our results in the area under no-tillage system, which had a forest fragment eight times larger than area under conventional tillage system and had a higher diversity of Carabidae and Staphylinidae species.

Among dominant carabids, *Scarites* sp.1, *Abaris basistriata* Chaudoir, 1873, *Odontocheila nodicornis* (Dejean, 1825), *Calosoma granulatum* Perty, 1830 and *Loxandrus* sp.1 were dominant in both areas, while *Scarites* sp.2, *Tetracha brasiliensis* Kirby, 1818, *Selenophorus seriatoporus* Putz, 1878, *Pentacomia cupricollis* Kollar, 1836, and *Selenophorus* sp.1 were dominant only in the area under no-tillage system (Tables 1 and 2). The number of dominant Staphylinidae was lower than dominant Carabidae. The dominant Staphylinidae were Staphylinidae ind.2, Xantholinini sp.1 and *Eulissus chalybaeus* Mannerheim, 1830 (Table 1); all in forest fragment and soybean/corn under no-tillage system.

Concerning the species preference to the habitat, only Carabidae species were selected by the criteria used. In the forest fragment and soybean/corn crop under no-tillage system, most of the species were gathered as crop and edge species or just as crop, being in a smaller number than the ones related to forest fragment (Figure 2). The number of species associated with the forest fragment was largest in conventional tillage system (Figure 3). These results demonstrated that, in the area under conventional system, carabids preferred the forest fragment. Thus, the structure of the vegetation is fundamental to the composition and distribution of ground beetles species (French and Elliott, 1999; Weibull and Östman, 2003).

Carabids are generalists in crops and in natural habitats (Thiele, 1977; French and Elliott, 1999; Fournier and Loreau, 1999). The cluster analysis showed that *A. basistriata* did not show a preference for a specific habitat in either experimental area, being considered a generalist with respect to habitat preference (Figures 2 and 3). *C. granulatum* and *Scarites* sp.1 preferred soybean and corn crops under no-tillage system and was distributed until edge with the forest fragment. Those species, in the area under conventional tillage system, were limited just in the annual crop (Figures 2 and 3).

In the area under no-tillage system, *P. cupricollis*, *T. brasiliensis* and two species of the genus *Scarites* preferred the soybean and corn crop, being distributed until edge between the crop and the forest fragment. However, *O. nodicornis* and *Loxandrus* sp.1 preferred the forest fragment (Figure 2). In the area under conventional tillage system, *S. seriatoporus*, *Loxandrus* sp.1 and *O. nodircornis* preferred the forest fragment, being distributed up to the edge with the soybean and corn crop (Figure 3). The edge between the crop and the forest fragment was used by species with a preference for the crop and for the forest fragment.

Abaris basistriata, a habitat generalist, was distributed from the edge up to 100 m into the crop and 100 m into the forest fragment. However, the distribution of *A. basistriata* differed among the experimental areas. In the area under no-tillage system, it was concentrated in the edge between crop and forest fragment. In the area under conventional tillage system, it was concentrated in the edge and up to 100 m into the forest fragment (Figures 4 and 5).

Odontocheila nodicornis and *Loxandrus* sp.1 were distributed from the edge to 100 m in the forest fragment in both experimental areas (Figures 4 and 5). *S. seriatoporus* was concentrated in the edge between fragment forest and crops under conventional tillage system (Figure 5).

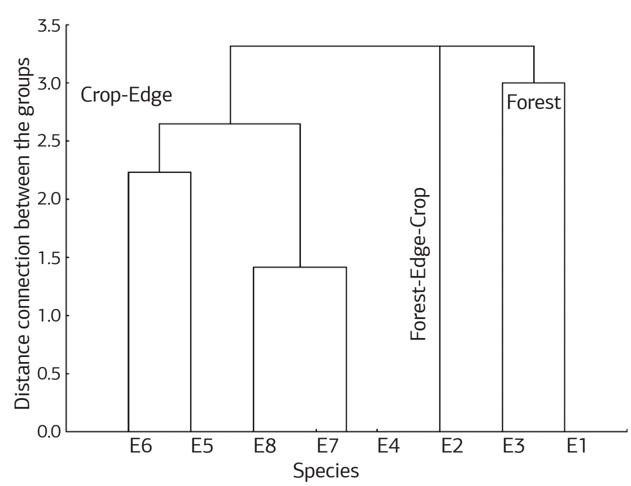

Figure 2. Cluster analysis dendrogram of species Carabidae depending on the position of the trap. Euclidian distance. No-tillage system – 2004/2007. E1: *Odontocheila nodicornis*, E2: *Abaris basistriata*, E3: *Loxandrus* sp.1, E4: *Scarites* sp.1, E5: *Pentacomia curpricollis*, E6: *Calosoma granulatum*, E7: *Scarites* sp.2, E8: *Tetracha brasiliensis*.

Table 1. Carabidae and Staphylinidae collected in areas of forest fragment and soybean crop in no-tillage system according to dominance (D), abundance (A), frequency (F) and constancy (C). Guaíra county, State of São Paulo, Brazil – 2004/2007

Species/Family	Number of specimens	%	D	A	F	C
Carabidae						
Scarites sp.2	152	15.2	D	ma	MF	W
Scarites sp.1	128	12.8	D	ma	MF	W
Abaris basistriata Chaudoir, 1873	97	9.7	D	ma	MF	W
Tetracha brasiliensis Kirby, 1818	91	9.1	D	ma	MF	W
Selenophorus seriatoporus Putz, 1878	66	6.6	D	ma	MF	W
Loxandrus sp.1	57	5.7	D	ma	MF	W
Pentacomia cupricollis Kollar, 1836	46	4.6	D	ma	MF	W
Calosoma granulatum Perty, 1830	27	2.7	D	ma	MF	W
Odontocheila nodicornis (Dejean, 1825)	19	1.9	D	a	MF	W
Selenophorus sp.1	19	1.9	D	a	MF	W
Selenophorus alternans Dejean, 1829	13	1.3	D	c	F	Y
Loxandrus subvittatus Straneo, 1953	13	1.3	D	c	F	Y
Galerita occidentalis (Olivier, 1795)	5	0.5	ND	d	PF	Z
Tetragonoderus laevigatus Chaudoir, 1876	5	0.5	ND	d	PF	Z
Lebiini sp.1	5	0.5	ND	d	PF	Z
Stratiotes sp.1	4	0.4	ND	r	PF	Z
Sphalera plaumanni Liebke, 1939	4	0.4	ND	r	PF	Z
Apenes marginalis Dejean, 1831	4	0.4	ND	r	PF	Z
Athrostictus sp.1	3	0.3	ND	r	PF	Z
Tichonilla festiva (Tschitscherine, 1898)	3	0.3	ND	r	PF	Z
Lebiini sp.2	3	0.3	ND	r	PF	Z
Pterostichini sp.1	3	0.3	ND	r	PF	Z
Cymindis sp.1	3	0.3	ND	r	PF	Z
Scarites sp.3	2	0.2	ND	r	PF	Z
Carabidae ind.1	2	0.2	ND	r	PF	Z
Pelecium brasiliense Straneo, 1962	2	0.2	ND	r	PF	Z
Carabidae ind.2	2	0.2	ND	r	PF	Z
Carabidae ind.3	2	0.2	ND	r	PF	Z
Polpochila impressifrons Dejean, 1831	2	0.2	ND	r	PF	Z
Notiobia sp.2	1	0.1	ND	r	PF	Z
Notiobia sp.1	1	0.1	ND	r	PF	Z
Pelecium foveicolle Chaudoir, 1866	1	0.1	ND	r	PF	Z
Lebiini sp.3	1	0.1	ND	r	PF	Z
Scarites sp.4	1	0.1	ND	r	PF	Z
Carabidae ind.4	1	0.1	ND	r	PF	Z
Barysomus punctatostriatus Emden, 1949	1	0.1	ND	r	PF	Z
Carabidae ind.5	1	0.1	ND	r	PF	Z
Carabidae ind.8	1	0.1	ND	r	PF	Z
Carabidae ind.9	1	0.1	ND	r	PF	Z
Notiobia cupripennis (Germar, 1824)	1	0.1	ND	r	PF	Z
Selenophorus sp.2	1	0.1	ND	r	PF	Z
Carabidae ind.6	1	0.1	ND	r	PF	Z
Carabidae ind.10	1	0.1	ND	r	PF	Z
Helluomorphoides squiresi (Chaudoir, 1872)	1	0.1	ND	r	PF	Z
Carabidae ind.11	1	0.1	ND	r	PF	Z
Carabidae ind.7	1	0.1	ND	r	PF	Z
Carabidae ind.20	1	0.1	ND	r	PF	Z
Total Carabidae	800	79.8				
Staphylinidae						
Staphylinidae ind.2	44	4.4	D	ma	MF	W
Staphylinidae ind.1	37	3.7	D	ma	MF	Y
Xantholinini sp.1	34	3.4	D	ma	MF	W
Eulissus chalybaeus Mannerheim, 1830	28	2.8	D	ma	MF	W
Staphylinidae ind.5	10	1.0	ND	c	F	Y
Staphylinidae ind.3	8	0.8	ND	c	F	Y

(to be continued)

Table 1. Continuation

Species/Family	Number of specimens	%	D	A	F	C
Glenus chrysis (Gravenhorst, 1806)	5	0.5	ND	d	PF	Z
Smilax pilosa (Fabricius, 1787)	5	0.5	ND	d	PF	Z
Staphylinidae ind.9	3	0.3	ND	r	PF	Z
Staphylinidae ind.10	2	0.2	ND	r	PF	Z
Renda formicarius (Laporte de Castelnau, 1835)	2	0.2	ND	r	PF	Z
Xantholinini sp.2	2	0.2	ND	r	PF	Z
Renda sp.1	2	0.2	ND	r	PF	Z
Staphylinidae ind.7	2	0.2	ND	r	PF	Z
Staphylinidae ind.4	2	0.2	ND	r	PF	Z
Xanthopygus cyanelytrius (Perty, 1830)	1	0.1	ND	r	PF	Z
Staphylinidae ind.11	1	0.1	ND	r	PF	Z
Staphylinidae ind.12	1	0.1	ND	r	PF	Z
Staphylinidae ind.6	1	0.1	ND	r	PF	Z
Paederus sp.1	1	0.1	ND	r	PF	Z
Lathropinus torosus (Erichson, 1840)	1	0.1	ND	r	PF	Z
Staphylinidae ind.13	1	0.1	ND	r	PF	Z
Staphylinidae ind.14	1	0.1	ND	r	PF	Z
Staphylinidae ind.15	1	0.1	ND	r	PF	Z
Staphylinidae ind.16	1	0.1	ND	r	PF	Z
Staphylinidae ind.17	1	0.1	ND	r	PF	Z
Staphylinidae ind.18	1	0.1	ND	r	PF	Z
Staphylinidae ind.19	1	0.1	ND	r	PF	Z
Staphylinidae ind.20	1	0.1	ND	r	PF	Z
Staphylinidae ind.21	1	0.1	ND	r	PF	Z
Staphylinidae ind.8	1	0.1	ND	r	PF	Z
Staphylinidae ind.22	1	0.1	ND	r	PF	Z
Total Staphylinidae	203	20.2				

D: dominant, ND: not dominant; ma: very abundant, a: abundant, c: common, d: dispersed, r: rare; MF: very frequent, F: frequent, PF: little frequent; W: constant, Y: incidental, Z: accidental. Species ind: indeterminate species.

Table 2. Carabidae and Staphylinidae collected in areas of forest fragment and soybean crop in conventional tillage system according to dominance (D), abundance (A), frequency (F) and constancy (C). Guaíra county, State of São Paulo, Brazil – 2004/2007

Especies/Family	Number of specimens	%	D	A	F	C
Carabidae						
Scarites sp.1	471	43.9	SD	sa	SF	W
Abaris basistriata	292	27.2	SD	sa	SF	W
Odontocheila nodicornis	59	5.5	D	ma	MF	W
Calosoma granulatum	55	5.1	D	ma	MF	W
Loxandrus sp.1	27	2.5	D	ma	MF	W
Selenophorus seriatoporus	21	2.0	D	ma	MF	Y
Lebiini sp.2	11	1.0	D	ma	MF	Y
Carabidae ind.12	8	0.7	D	c	F	Y
Tetragonoderus laevigatus	6	0.6	D	c	F	Y
Stratiotes sp.1	5	0.5	ND	c	F	Y
Selenophorus alternans	5	0.5	ND	c	F	Y
Megacephala brasiliensis	5	0.5	ND	c	F	Y
Carabidae ind.14	4	0.4	ND	c	F	Y
Carabidae ind.13	4	0.4	ND	c	F	Y
Morion cycloma Chaudoir, 1854	3	0.3	ND	c	F	Y
Galerita brasiliensis Dejean, 1826	3	0.3	ND	c	F	Y
Sphalera plaumanni	3	0.3	ND	c	F	Y
Loxandrus sp.2	3	0.3	ND	c	F	Y
Tichonilla festiva	2	0.2	ND	d	PF	Z
Cymindis sp.1	2	0.2	ND	d	PF	Z
Loxandrus subvittatus	2	0.2	ND	d	PF	Z

(to be continued)

Table 2. Continuation

Especies/Family	Number of specimens	%	D	A	F	C
Scarites sp.3	2	0.2	ND	d	PF	Z
Carabidae ind.15	2	0.2	ND	d	PF	Z
Colliuris brasiliensis	1	0.1	ND	r	PF	Z
Athrostictus nobilis (Brulle, 1838)	1	0.1	ND	r	PF	Z
Notiobia sp.2	1	0.1	ND	r	PF	Z
Lebiini sp.1	1	0.1	ND	r	PF	Z
Lebiini sp.3	1	0.1	ND	r	PF	Z
Carabidae ind.17	1	0.1	ND	r	PF	Z
Carabidae ind.16	1	0.1	ND	r	PF	Z
Pentacomia cupricollis	1	0.1	ND	r	PF	Z
Pseudaptirus albicornis	1	0.1	ND	r	PF	Z
Carabidae ind.8	1	0.1	ND	r	PF	Z
Lebia concinna Brulle, 1838	1	0.1	ND	r	PF	Z
Carabidae ind.18	1	0.1	ND	r	PF	Z
Notiobia cupripennis (Germar, 1824)	1	0.1	ND	r	PF	Z
Carabidae ind.19	1	0.1	ND	r	PF	Z
Pterostichini sp.2	1	0.1	ND	r	PF	Z
Total Carabidae	1010	94.1				
Staphylinidae						
Smilax pilosa	14	1.3	D	ma	MF	Y
Staphylinidae ind.3	11	1.0	D	ma	MF	Y
Xantholinini sp.1	11	1.0	D	ma	MF	Y
Staphylinidae ind.23	3	0.3	ND	c	F	Y
Xantholinini sp.2	3	0.3	ND	c	F	Y
Staphylinidae ind.26	3	0.3	ND	c	F	Y
Staphylinidae ind.12	3	0.3	ND	c	F	Z
Glenus chrysis	2	0.2	ND	d	PF	Z
Xenopygus sp.2	2	0.2	ND	d	PF	Z
Staphylinidae ind.2	2	0.2	ND	d	PF	Z
Eulissus chalybaeus	2	0.2	ND	d	PF	Z
Paederus sp.1	1	0.1	ND	r	PF	Z
Scytalinus sp.1	1	0.1	ND	r	PF	Z
Staphylinidae ind.24	1	0.1	ND	r	PF	Z
Staphylinidae ind.25	1	0.1	ND	r	PF	Z

D: dominant, ND: not dominant; ma: very abundant, a: abundant, c: common, d: dispersed, r: rare; MF: very frequent, F: frequent, PF: little frequent; W: constant, Y: incidental, Z: accidental. Species ind: indeterminate species.

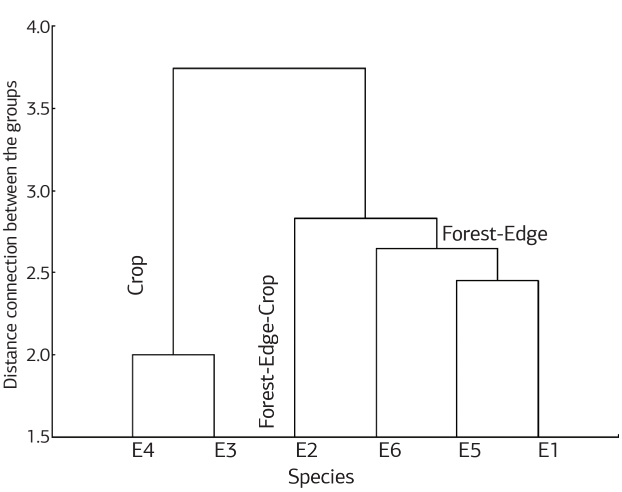

Figure 3. Cluster analysis dendrogram of species Carabidae depending on the position of the trap. Euclidian distance. Conventional tillage system – 2004/2007. E1: *Odontocheila nodicornis*, E2: *Abaris basistriata*, E3: *Scarites* sp.1, E4: *Calosoma granulatum*, E5: *Loxandrus* sp.1, E6: *Selenophorus seriatuporus*.

As discussed previously, *Scarites* sp.1 and *C. granulatum*, *P. cupricollis*, *Scarites* sp.2 and *T. brasiliensis* showed preference for crops and were collected in the edge and up to 100 meters into the crops. *C. granulatum* occurred in larger numbers from 50 to 100 meters into the crop in both systems, while *P. curpicollis* was concentrated in the edge (Figures 4 and 5). These results suggest that the edge habitat between the crop and the forest fragments was inhabited by the majority of species, and could have been used as a refuge area or shelter. According to Kromp and Steinberger (1992), Holland and Luff (2000) and Altieri et al. (2003), crop marginal areas can shelter natural enemies when the conditions of the crop are adverse due to cultural practices.

The staphylinids *E. chalybaeus*, Xantholinini sp.1 and Staphylinidae ind.2 preferred the crops and were distributed up to 100 meters into the crop. These species were observed in higher numbers in the edge, while Xantholinini sp.1 was more numerous starting from 20 m into the crop (Figure 6).

Some ground beetles can move long distances as they search for prey (Thomas et al., 1997; Zhang et al., 1997; Horgan and Chávez, 2004). In the

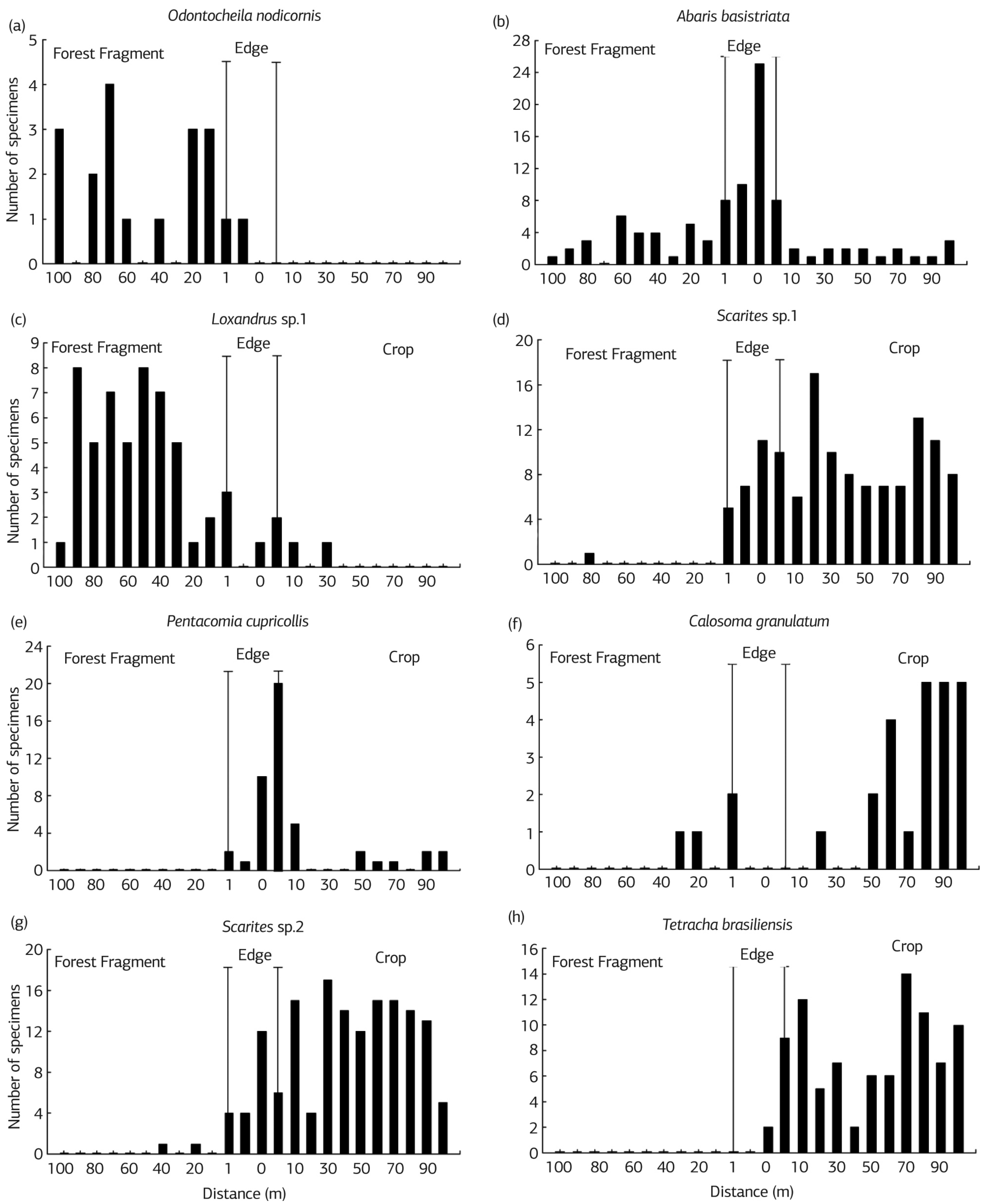

Figure 4. Total number of specimens and horizontal distribution of Carabidae: (a) *Odontocheila nodicornis*; (b) *Abaris basistriata*; (c) *Loxandrus* sp.1; (d) *Scarites* sp.1; (e) *Pentacomia cupricollis*; (f) *Calosoma granulatum*; (g) *Scarites* sp.2; (h) *Tetracha brasiliensis*, in the tree habitats: Forest fragment, edge (weeds) and crop (rotation soybean/corn). Experimental area: No-tillage system – 2004/2007.

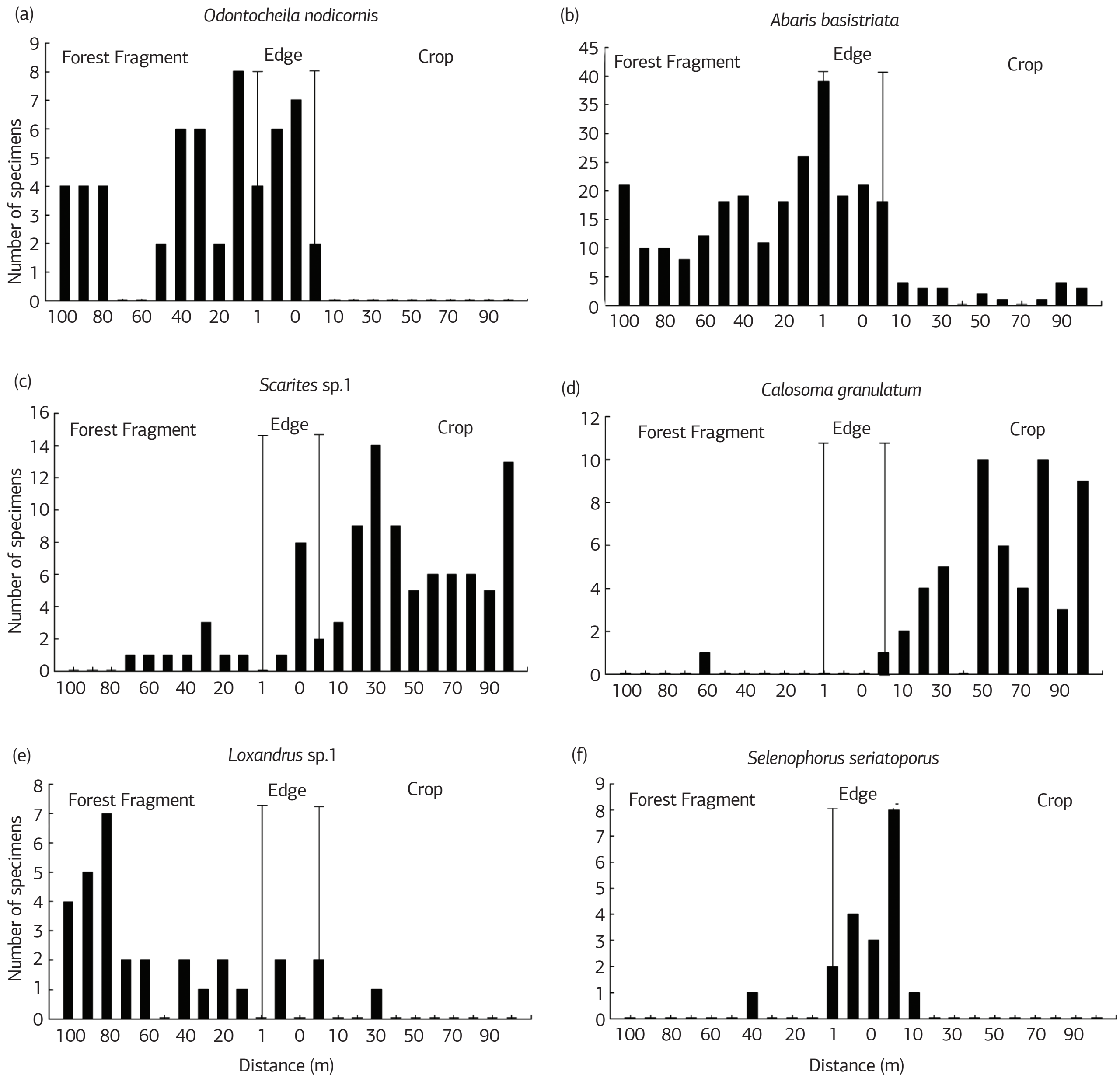

Figure 5. Total number of specimens and horizontal distribution of Carabidae: (a) *Odontocheila nodicornis*; (b) *Abaris basistriata*; (c) *Scarites* sp.1; (d) *Calosoma granulatum*; (e) *Loxandrus* sp.1; (f) *Selenophorus seriatoporus*, in the tree habitats: Forest fragment, edge (weeds) and crop (rotation soybean/corn). Experimental area: No-tillage system – 2004/2007.

present study, the distribution of ground beetles and rove beetles in the three habitats suggest that they have the potential to move great distances inside and out of the crop.

4. CONCLUSION

The area with no-till and largest forest fragment has a higher diversity of Carabidae and Staphylinidae species when compared with the area of conventional tillage. The carabids *Scarites* sp.1, *Abaris basistriata*, *Odontocheila nodicornis*, *Calosoma granulatum* and *Loxandrus* sp.1 are dominant species in soybean/corn agroecosystems. *Abaris basistriata* is a generalist species in relation to the type of habitat, unlike other species of Carabidae occurring preferentially in agricultural or natural areas.

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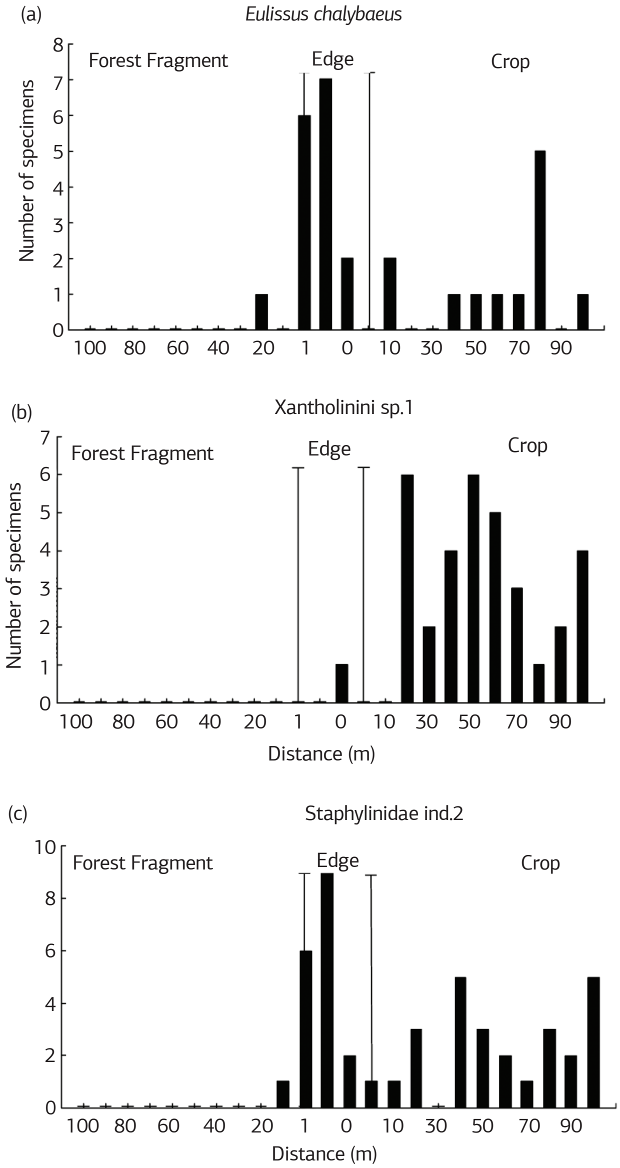

Figure 6. Total number of specimens and horizontal distribution of Staphylinidae: (a) *Eulissus chalybaeus*; (b) Xantholinini sp.1; (c) Staphylinidae ind.2, in the tree habitats: Forest fragment, edge (weeds) and crop (rotation soybean/corn). Experimental area: No-tillage system – 2004/2007.

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