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Semi-Natural Habitats and Field Margins in a Typical Agroecosystem of the Argentinean Pampas as a Reservoir of Carabid Beetles

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Changes in edaphic carabidofauna abundance in a wheat crop plot, its field margins, and four semi-natural adjacent habitats were evaluated. A low specific richness of carabids was found in the wheat crop. No species was found exclusively in the wheat plot, but there were species found in the surrounding habitat. The observed responses of different species regarding moisture conditions determined their presence or absence in these semi-natural habitats as well as in dominance structures of each particular ambient. A gradual decrease in the number of captured individuals from the field margin to the center of the wheat plot was observed. Semi-natural habitats and field margins become an important requirement for habitat and shelter of the best represented species of ground beetles, particularly for predatory and omnivorous varieties.

KEYWORDS *specific richness, dominance, boundaries, biodiversity, ecological role*

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INTRODUCTION

Increasing concern about the need to preserve biodiversity in agroecosystems has been noted by several authors (Swift et al. 2004, Feehan et al. 2005, Waldhardt et al. 2003, Waldhardt 2003), leading to research into the traits and conditions that allow the maintenance or enhancement of biodiversity. The creation of alternative habitats or the maintenance of undisturbed vegetation assemblages surrounding arable fields has been extensively researched by several authors (Sotherton, 1985; Thomas and Marshall, 1999; French and Elliot, 1999; Dennis et al., 1994; Kromp and Steimberg, 1992; Thomas et al., 1991; Coombes and Sotherton, 1986; Asteraki et al., 2004).

In Argentina, agricultural area with extensive monocultures has increased during recent years. Nevertheless, the grassland Pampean agroecosystems have maintained most of their associated biodiversity. Many areas that have been minimally, if at all, disturbed, and that have been considered predominantly unproductive characterize this region. Moreover, during many years, agronomists have regarded the non-crop areas within agricultural landscapes as hostile and as sources of limitation to production, for example, from weeds, pests, and diseases (Marshall, 2002). Currently, this reductionistic vision is being replaced by a new view that recognizes the ecological role of these undisturbed semi-natural habitats. The challenge is to take advantage of the agroecological benefits gained as a result of the diversity maintained in the spontaneous vegetation composed by native as well as exotic species. As an example, the role played by Carabidae inhabiting those habitats in relation to the regulation of pests has been recognized (Landis et al., 2002; Magura, 2002).

From an ecological point of view, agroecosystems must be considered as a complex pattern of cultivated and non-cultivated habitats or patches. This approach can bring valuable information about the behavior of several taxa and may be useful in understanding the role that such biodiversity has in a sustainable agricultural system (Marshall and Moonen, 2002). Landscape structure is a determinant component of the spatial and temporal distribution of some important groups of polyphagous predators, such as ground beetles (Coleoptera, Carabidae) (French and Elliot, 1999; Landis et al., 2002; Swift et al., 2004). This group can be severely affected by agricultural landscape simplification, especially if certain minimal needs of feeding resources, mating sites, refuge,s and adequate habitats for its mobility are limited or scarce (Altieri and Letourneau, 1982; Carmona and Landis, 1999; Portauf et al., 2005).

Thomas et al. (1991) found an increase in predator carabid abundance in winter if natural vegetation islands were incorporated into cultivated systems. Different field margins and vegetative groundcover also provide habitats for overwintering of some predatory carabid species that can show a permanent and cyclic mobility from field margins to cultivated field (Sotherton 1985; Dennis et al., 1994; Thomas and Marshall, 1999; Asteraki et al., 2004).

In Argentina, important edaphic groups have been identified specifically for their predaceous habits (Marasas et al., 2001; Cicchino et al., 2003) because they play an important role as natural enemies of potential pests of main crops in arable fields. One of the most important families is Carabidae, which is represented by species ranging from medium to large size (2.5 to 25 mm) with cursorial and burrowing behavior (Marasas et al., 2001; Cicchino et al., 2003).

Wheat *(T. aestivum* L.) is among the most important crops in Argentina, and is cultivated in extensive areas (6 millions ha) of landscape homogeneity that could negatively impact the availability of adequate conditions for survivorship of these ground beetles. Cereal or oilseed monocultures are surrounded by permanent or semi-permanent habitat that increases agricultural landscape heterogeneity. It is thought that adjacent low-disturbed habitats, which are typically grassland of the Pampean agricultural landscape (Baldi et al., 2006), can play an important role as reservoirs for the best represented predatory carabid species (Cicchino et al., 2003). Nevertheless, these species' abundance can decrease from field margins to the center of the arable fields (Kromp and Steinberger, 1992; Altieri, 1992; French et al., 2001). In order to advance this knowledge, four typical habitats of the Pampean region (larger plains with little drainage) were studied.

The aim of this article is to evaluate species richness, ecological role, dominance structure, and change in the edaphic carabidofauna abundance in a wheat crop plot and its field margins as well as the adjacent semi-natural habitats present in most of the Pampean agroecosystems.

MATERIALS AND METHODS

Study Area

Research for this study was carried out at the Experiment Station of the Faculty of Agricultural Sciences, La Plata, Argentina (35° South Latitude). The climate is temperate with mean annual temperature varying between 22 °C for the hottest month (January) and 8 °C for the coldest one (July). Mean annual rainfall varied from 800 to 1000 mm, with no dry season. The field has a typical argiudol soil with some internal drainage deficiencies and the following values at sowing time (0 to 20 cm deep): organic matter 4.2 %, a pH of 6.1, and a C/N ratio of 11.5.

Sampling Procedures

Carabid beetles were sampled using pitfall traps. Each trap consisted of plastic pots 150 mm deep, with a diameter of 100 mm, filled with 1/3 volume/volume with a mix of 4% formaldehyde in water, and some drops of detergent as a tensioactive agent. A non-transparent ceramic cover was placed 10 cm above each trap to prevent flooding from rainwater and evaporation of the inside solution. Total number of pitfall traps in each environment was selected according to Obrtel's (1971) criteria. The number of total individuals captured in pitfall traps was evaluated as a measure of the activity-density of the surface-living invertebrates (Thiele, 1977; Baars, 1979).

Two situations were evaluated. The first was conducted during the crop cycle 1996–1997, and the last during 1999. Their main characteristics and conditions were as follows.

Situation 1 was carried out in a patch of 7000 m^2 cropped with bread wheat (*Triticum aestivum* L.) sown at a density of 120 kg/ ha under conventional tillage with mouldboard plough, and fertilized with 100 kg/ ha of superphosphate (00-46-00) at sowing. After crop emergence, weeds were controlled with applications of 2-4D plus Picloran at 400 cm^3 /ha + 100 cm^3 /ha, respectively. In the crop plot, four strips of 10 m wide per 70 m length each were evaluated. In each strip, three pitfall traps placed 5 m apart from each other were established, resulting in a total of 12 traps. Pitfall traps were collected every 30 to 40 days, totalling 9 samples.

Four semi-natural habitats typical of Argentinean Pampas, located at a distance between 50 and 150 m surrounding cultivated plots, were analyzed:

1. Border of a small lagoon: an artificial and permanent lagoon of 2000 m^2, which was densely covered with natural vegetation, with a predominance of Poaceae and diverse broad leaf species. The field margins were flooded during times of intensive rainfall.
2. Cortaderia bushes *(Cortaderia selloana* (Schult.) Asch.et.Graeb.*)*: this habitat, typical of this region, is characterized by dense shrubs, each of which measure 4 to 10 m^2. These plant structures provide many microhabitats with relatively stable temperature and humidity conditions.
3. Reed bed: composed of Castilla cane *(Arundo donax* L.*)* covering a 500 m^2 area. This stand showed a great density of individuals as well as a thick layer of litter made up of fallen leaves, creating a very homogeneous habitat with stable conditions.
4. Small stand of *Myoporum laetum* Forst. F. of 200 m^2 composed of sparse low-height trees, the soil surface being covered by a thick layer of litter of dried fallen leaves.

In each of the four semi-natural habitats, 3 plots 5 m apart from each other were established. In each one, 3 pitfall traps were placed, resulting in a total of 9 traps per semi-natural habitat.

Situation 2 was carried out in a crop plot of 10.000 m^2. Half of the plot was cultivated with bread wheat *(Triticum aestivum* L.*)* under conventional tillage with mouldboard plough (treatment A). The other half was maintained without crop during the whole sampling period (treatment B) by means of frequent tillage. The crop plot was surrounded by margins of a ridge 0.5 m high and 2.00 m wide, covered mainly by broad leaf annual species *(Brassica sp., Capsella bursa-pastoris* (L.) Medikus, *Taraxacum officinale* Web. and *Trifolium sp.*) and grasses such as *Bromus unioloides* H.B.K. and *Avena sp.* Three parallel transects were established across the plot at center, 10 m apart from each other from one field margin to another. In each transect, pitfall traps were placed 10 m apart, totalling 17 traps per transect. Pitfall traps were placed on September 18 and were collected 4 times during each 30-day period during spring, which had been determined to be the period of highest activity of the studied species (Marasas et al., 1997) and is in accordance with the results of Biaggini et al. (2007).

Material Identification and Data Processing

In both experiments, all collected individuals were identified at the species level. Carabidae number was recorded and a dominance structure in crop plots and in semi-natural habitats was constructed, based on the proportional distribution of the individuals per species over the total number of individuals sampled. Categories cited by Agosti and Sciaky (1998) were used, as follows: Eudominant: > 10%; Dominant: between 5% and10%; Subdominant: between 2% and 5%; Recedent: between 1% and 2%; and Subrecedent: < 1%.

Species characterization according to their habitat preferences and for their humidity affinities was done according to Cicchino et al. (2003) and Cicchino and Farina (2005), as follows: Hygrophilic: only tolerate very humid environments, near water bodies Mesophilic: tolerate environments with important humidity variations near or far from water bodies; Xerophilic: live in very open environments and with very low soil and environmental humidity levels.

Individuals belonging to the Carabidae, which is the most abundant and representative family in the Coleoptera order (Marasas et al., 1997; Biaginni et al., 2007), were identified at species level consulting the current bibliography as well as the collections of the Museum of Natural Sciences La Plata and the Museum of Natural Sciences Bernardino Rivadavia of Argentina.

Data were analysed by an unbalanced analysis of variance (ANOVA) considering the mean value of the five traps of each plot. The values were previously transformed by log function. To facilitate interpretation of the data, figures were presented untransformed. A regression analysis between some variables was done. Differences of means were determined by LSD test at $p < 0.05$.

RESULTS

Situation 1: During the entire sampling period (June 1996 to January 1997), a total of 1567 individuals of Carabidae were captured and grouped according to their humidity affinity, habitat preference and relative dominance (Table 1). Ten species were exclusively found in semi-natural habitats: *Selenophorus alternans* (Dejean, 1829), *Notaphus (N) laticollis* (Brullé, 1838), *Notiobia (Anisotarsus) cupripennis* (Germar, 1824), *Brachinus (Neobrachinus) pallipes* (Dejean, 1826), *Incagonum lineatopunctatum* (Dejean, 1831), *Metius circumfusus* (Germar, 1824), *Stenocrepis (Stenocrepis) laevigata* (Dejean, 1831), *Polpochila (P) pueli* (Negrè, 1963), *Paratachys bonariensis* (Steinheil, 1869), and *Apenes cfr. Erythrodera* (Chaudoir, 1875). None of these were found in the wheat plot during the entire sampling period.

For all of the species, a similar proportion of groups of humidity affinity were found between crop plot and *Cortaderia* habitat (60% vs. 65% of mesophilic, 35% vs. 35% hygrophilic, and 5% vs. 0% xerophilic). In the border of the lagoon, a dominance of hygrophilic over the mesophilic species (58.4% vs. 41.6%) was observed. In the crop plot, all of the dominant species were of predatory behavior.

In the reed bed and stand of *Myoporum* habitats, a lower number of carabid individuals was observed (Figure 1) in comparison to the borders of small lagoon and *Cortaderia* bush habitat (F = 11.87; p = 0.000). Thus, only these last two habitats were compared with the cultivated one. Within these three habitats, only those species whose dominance was equal or higher than recedent were analyzed.

Species richness and dominance structure of carabidae showed differences among habitats. All of the eight species considered relevant according to their dominance in the wheat crop plot (Table 1) were present in lagoon borders, and of those, five were also found in the *Cortaderia* bush. No exclusive species were found in wheat plots. The most represented species were *Paranortes cordicollis* (Dejean, 1828), *Scarites (Scarites) anthracinus* (Dejean, 1831), *Aspidoglossa intermedia* (Dejean, 1831), and *Pachymorphus striatulus* (Fabricius, 1792). All of them were ubiquitous eurytopic and synanthropic species (Cicchino, 2003; Cicchino et al., 2005). Other species, such as *Metius circumfusus* (Germar, 1824), were only found in the lagoon borders and *Cortaderia* bush and with very different dominance, and *Bradycellus sp* was only found in this latter habitat. These last two hygrophilic species have a marked tendency to omnivorism (Cicchino and Farina, 2005).

Carabid abundance in the wheat crop plot, lagoon borders and *Cortaderia* bush, showed seasonal fluctuations (Figure 2). At the beginning of the sampling period, during autumn and winter months, just after wheat was sown (samplings 1, 2, 3, 4, and 5), the highest abundance was found in

TABLE 1 List of Species Captured in Wheat Crop Plot, Lagoon Borders, *Cortaderia* Bush, Reedbed and Small Stands of *Myoporum laetum*; Habitat Preference, Affinities for Humidity (Cicchino and Farina, 2005) and Dominance Structure of the Argentinean pampa: (SubR: subrecedent; R: recedent; SubD: subdominant; D: dominant; EuD: eudominant)

Species	Habitat preference	Affinities humidity	Wheat crop		Lagoon borders		Cortaderia bush		reedbed		*Myoporum laetum*	
			(n%)	Dominance	(n%)	Dominance	(n%)	Dominance	(n%)	Dominance	(n%)	Dominance
Pachymorphus striatulus (Fabricius,1792)	Eurytopic	Mesophilic	7	*D*	3.5	SubD	8.1	D	14.7	EuD	0.63	SubR
Pachymorphus sp.	Stenotopic	Mesophilic	0.39	SubR	0.13	SubR	1	R				
Paranortes cordicollis (Dejean, 1828)	Eurytopic	Mesophilic	23.9	EuD	21.5	EuD	47.3	EuD	13.6	EuD	2.5	SubD
Selenophorus anceps (Dejean, 1831)	Eurytopic	Mesophilic	0.39	SubR	0.34	SubR	8.1	D	0.98	R		
Selenophorus alternans (Dejean, 1829)	Eurytopic	Mesophilic					2.3	SubD				
Selenophorus punctulatus (Dejean, 1829)	Stenotopic	Xerophilic	0.39	SubR								
Notaphus (N) laticollis (Brullé, 1838)	Stenotopic	Hygrophilic			0.34	SubR						
Aspidoglossa intermedia (Dejean, 1831)	Eurytopic	Hygrophilic	33.7	EuD	9.2	D	0.3	SubR	1.96	R	6.3	D
Scarites (S.) melanarius (Dejean, 1831)	Eurytopic	Mesophilic	0.39	SubR	1.3	R	3.4	SubD				
Scarites (S) anthracinus (Dejean, 1831)	Eurytopic	Mesophilic	19.6	EuD	11.9	EuD	0.67	SubR				
Clivina (Paraclivina) breviuscula (Putzeys, 1866)	Eurytopic	Hygrophilic	5.49	D	0.34	SubR						
Clivina (Paraclivina) media (Putzeys, 1866)	Eurytopic	Mesophilic	0.78	SubR	0.34	SubR						
Bradycellus sp.	Eurytopic	Hygrophilic	0.39	SubR	2.2	SubD	0.3	SubR			0.63	SubR

(*Continued*)

TABLE 2 (*Continued*)

Species	Habitat preference	Affinities humidity	Wheat crop		Lagoon borders		Cortaderia bush		reedbed		*Myoporum laetum*	
			(n%)	Dominance	(n%)	Dominance	(n%)	Dominance	(n%)	Dominance	(n%)	Dominance
Loxandrus simplex (Dejean, 1831)	Eurytopic	Hygrophilic	0.39	SubR	0.13	SubR	1	R	0.98	SubR	3.2	SubD
Loxandrus confusus (Dejean, 1831)	Eurytopic	Hygrophilic	1.96	R	2.53	SubD	1	R	1	R	3.2	SubD
Notiobia (Anisotarsus) cupripennis (Germar, 1824)	Eurytopic	Mesophilic					1.7	R				
Galerita collaris (Dejean, 1826)	Eurytopic	Mesophilic	0.78	SubR	0.34	SubR	0.67	SubR	3.9	SubD	0.63	SubR
Calosoma retusum (Fabricius, 1775)	Eurytopic	Mesophilic	0.39	SubR					0.98	R		
Argutoridius bonariensis (Dejean, 1831)	Eurytopic	Mesophilic	1.56	R	4	SubD	8.8	D	24.5	EuD	85	EuD
Argutoridius chilensis ardens (Dejean, 1828)	Eurytopic	Hygrophilic	1.17	R	3.4	SubD	12.2	EuD	1	R	1.3	R
Brachinus (Neobrachinus) pallipes (Dejean, 1826)	Stenotopic	Hygrophilic			1.7	R						
Incagonum lineatopunctatum (Dejean, 1831)	Eurytopic	Mesophilic					1	R	1.96	R	1.3	R
Metius circumfusus (Germar, 1824)	Eurítopics	Hygrophilic			33.5	EuD	2	SubD	4.9	SubD		

Stenocrepis (Stenocrepis) laevigata (Dejean, 1831)	Stenotopic	Hygrophilic			0.92	R			2.9	SubD		
Pericompsus (Eidocompsus) metallicus (Bates, 1871)	Stenotopic	Hygrophilic	0.39	SubR	0.52	SubR						
Pericompsus (Pericompsus) callicalymma (Erwin, 1974)	Stenotopic	Mesophilic	0.39	SubR	0.13	SubR	0.3	SubR				
Polpochila (P) pueli (Negrè, 1963)		Hygrophilic			0.13	SubR	0.3	SubR				
Paratachys bonariensis (Steinheil, 1869)	Stenotopic	Hygrophilic			0.4	SubR						
Apenes cfr. Erythrodera (Chaudoir, 1875)		Mesophilic									0.63	SubR
Pelmatellus sp.		Mesophilic	0.39	SubR			0.3	SubR			0.63	SubR
Total number (1567)			255		757		296		102		157	

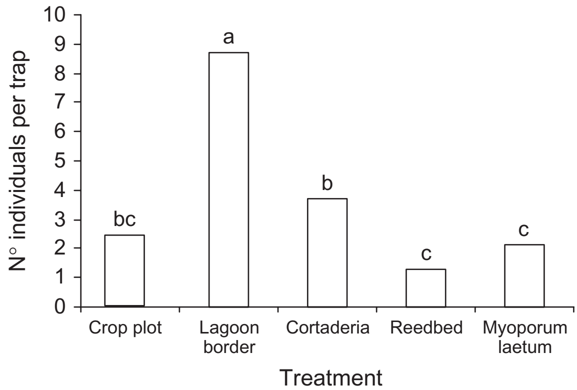

FIGURE 1 Number of individual ground beetles captured per trap in crop plots, lagoon borders, *Cortaderia* bush, reed bed and *Myoporum laetum* stands. Letters above bars indicate significant differences according to LSD Test at $p = 0.05$.

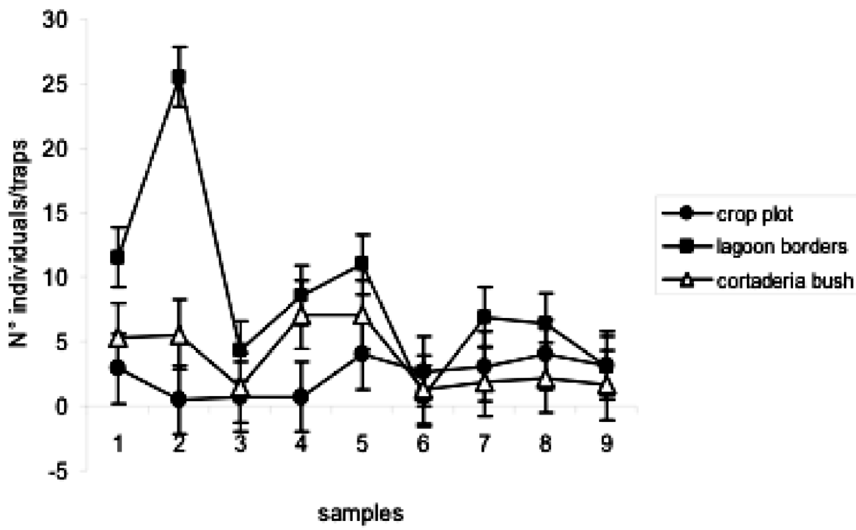

FIGURE 2 Seasonal changes in the abundance of the Carabidae family in different habitats: wheat crop plots, Lagoon borders and *Cortaderia* bush during all sampling period. Vertical lines represented mean standard error.

lagoon borders and *Cortaderia* bush habitat. In spring (sampling 6, 7, 8, and 9), a gradual increase of carabid individuals in the crop field was observed, particularly in comparison to the *Cortaderia* bush habitat.

Situation 2: A total number of 306 individuals were captured over the whole sampling period (September 18 to January 18). No significant differences were found between abundance and the species richness of individuals captured in both field margins.

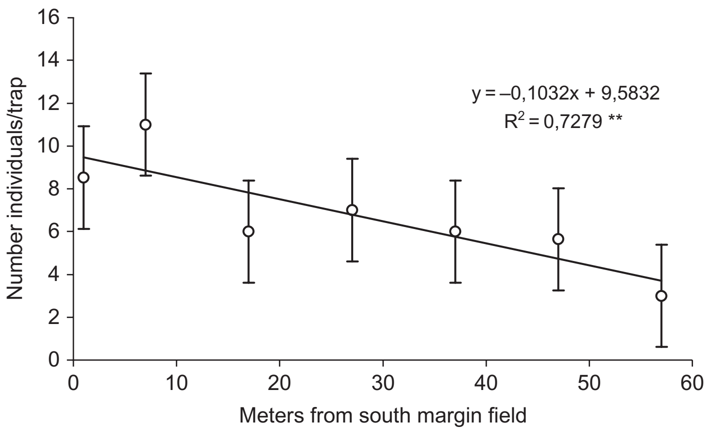

FIGURE 3 Relationship between the distance from field margin and number of individual Carabidae. Vertical lines represented mean standard error.

Within Carabidae species, the most representative were *Scarites (S) anthracinus, Aspidoglossa intermedia, Parypathes (P) cordicollis* and *Pachymorphus striatulus*. In the field-margins, the fosor and semifosor species (*Scarites anthracinus* and *Aspidoglossa intermedia)* account for 80% of the captured individuals. Total number of individuals captured in A and B treatments were similar.

A marked tendency toward a gradual decrease in total number of individuals from field margin to the center of the plot was observed in A treatment (wheat crop). A negative and significant relationship (R^2 = 0.7279 $^{**}p <= 0.01$) between the number of individuals and the distance from the field margin was observed. The number of individuals captured 50 m away from the field margin was significantly lower than those found in the margin (Figure 3).In contrast, no significant correlation was found between the distance from the margin and the number of individuals captured in the center of the plot in treatment B.

DISCUSSION

The ecological role of field margins is now being reconsidered, mainly in relation to agrobiodiversity conservation (Marshall and Moonen, 2002). The old vision that field margins constituted a barrier to the expansion of cropped areas is now changing, and the role of field margins as refuges for important predatory and polyphagous carabids is now being recognized (Marshall, 2002; Vanbergen et al., 2005). The conservation of non-disturbed field margins in crop fields would preserve these functional groups and could promote the sustainability of agroecosystems.

Results presented here suggest the importance of semi-natural reservoirs of vegetation for extensive cropping systems, such as the monoculture of cereal crops in Argentinean pampas. These habitats can act as refuges for predatory carabids, as well as for omnivorous soil arthropods, and can, in this way, mitigate the effects of monocultures (Sotherton, 1985; Dennis et al., 1994; Thomas and Marshall, 1999; Asteraki et al., 2004). Presence of Q3 such functional groups will help to keep phytophagous populations under control and to regulate insect pest outbreaks (Portauf et al., 2005; Swift et al., 2004; Fournier and Loreau, 2002; Krooss and Schaefer, 1998; Edwards et al., 1979).

These semi-natural habitats guarantee the conservation of stable arthropod communities (Woodcock et al., 2005). These are associated with plant species richness and landscape architecture at a local scale and with the conservation of habitats with different degrees of humidity (Gudleifsson, 2005; Cicchino et al., 2005).

It was observed that species had different habitat preferences. The higher number of species found in semi-natural habitats (lagoon borders and *Cortaderia* bush) in relation to wheat crop plots suggests the existence of several microhabitats associated with structural and functional diversity of these habitats (Swift et al., 2004). Lagoon margins are characterized by a high floristic richness and high plant density. Woodcock et al. (2005) and Asteraki et al. (2004) pointed out that non-disturbed vegetative diversity Q4 provides ecological niches that harbor a significant abundance and variety of predaceous species. Nevertheless, in the *Cortaderia* bush, the existence of microhabitats was determined, not by plant-specific diversity, but by the shrub structure itself, which has multiple vertical layers that create conditions of shadow and humidity favoring the permanence of carabid communities.

Lower abundance and a lower specific carabid richness were observed in arable field as compared to semi-natural habitats. This could be due to the existence of a reduced quantity of available microhabitats because of the system's homogeneity, as well as changing conditions due to the high disturbance associated with crop management techniques (Gudleifsson, 2005).

The observed responses of different species regarding humidity conditions (hygrophilic, mesophilic, and xerophilic) determined their presence or absence in these habitats and their dominance levels (Table 1). This was reflected in the high proportion of hygrophilic species found both in *Cortaderia* bush and lagoon borders habitats, which suggests that they provide necessary conditions for its permanence in the agroecosystem.

The fact that a non-exclusive carabid species was found in wheat crop plots, and a greater abundance of carabids was found in semi-natural habitats, suggests that the latter can act as a refuge and provide sites for reproduction and hibernation (Pfiffner and Luka, 2000). Landscape simplification because of crop monoculture would lead to a loss of these habitats and their associated species, increasing the risk of their disappearance in these agroecosystems. Dominant species in the crop field were also the dominant species in lagoon borders and *Cortaderia* bush. These semi-natural habitats, little disturbed, could act as reservoirs of a great percentage of predator carabids and could exert a strong influence on crops. These habitats would act as permeable boundaries from and to the field crop and would therefore be an efficient mode of colonizing predator carabid individuals. (Lopez Barrera, 2004). The seasonal variation in carabidofauna abundance found both in crop and in semi-natural habitats suggests that there could be a migration of carabids between the crop and those semi-natural habitats.

Field crop margins also provide adequate habitats to guarantee permanent mobility of the carabidofauna between these habitats (Sotherton, 1985; Dennis et al., 1994; Thomas and Marshall, 1999; Asteraki et al., 2004). The observed differences in the behavior of burrowing species as compared with those with cursorial habits confirm the existence of a close relationship between habitat characteristics and carabid behavior. The number of burrowing species (*Scarites* genus) found in field margins was higher than that found in crop plots. Marasas et al. (1997) found that such species prefer these low or non-disturbed habitats (like field margins and crops under no till management) to build their colonies. The behavior of the cursorial species was more variable and erratic because their presence is more conditioned by their search for food (Fournier and Loreau, 2002).

The localization of field margins as compared to field crops is an important fact that must be taken into account in the design of sustainable agroecosystems. Our study showed a decrease in carabidae abundance from field margins to the center of the plot cultivated with wheat (Treatment A), and is similar to that found in cultivated plots of temperate regions (Kromp and Steinbeger, 1992; Altieri, 1992; French et al., 2001). This can probable be related to the higher uniformity of the crop landscape that causes a low mobility of those species of Carabidae of big size as these seems to be more vulnerable to predation in open spaces or fields (Brose, 2003). Nevertheless, this decrease in carabid number toward the center of the plot did not occur in the other half of the plot (treatment B) which was maintained without crop throughout the entire sampling period, which suggests that under different conditions, other variables could be important in an analysis of the influence of field margins. These results confirm the importance of patterns of land-use in beetle community structure (Vanbergen et al., 2005). Those landscape characteristics that favor appropriate habitats for shelter, moving, feeding, as well as other landscape characteristics that guarantee the permanence and activity of carabid species, must be enhanced or recreated.

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