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The effects of agricultural management on the reproductive activity of female rodents in Argentina

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Abstract

The aim of this study was to test if female rodents in border habitats of organic farms have higher reproductive activity than those of conventional farms in south-east Córdoba province, Argentina. The study was conducted in field borders of organic and conventional farms in 2012 and 2013 during the summer months, the time of the year when reproductive activity is more likely. We sampled field borders through a CMR trapping session and recorded vegetation cover, plant litter, vegetation volume, bare ground cover and land use of the field on both sides of the border (crop/crop or crop/pasture). We recorded the number of reproductive females and the rate of postpartum estrus. Green vegetation cover was higher in organic borders whereas plant litter was higher in borders of conventional farms. We used Generalized Linear Mixed Models (GLMM) to determine the factors that influence the number of reproductive females in borders of organic and conventional farms. The number of reproductive females was mainly determined by agriculture management and field type. There were more reproductive females in organic than in conventional borders, and borders associated with crop fields at both sides supported the highest number of reproductive females. The rate of postpartum estrus was higher in organic than in conventional borders. Our results showed that in border habitats of farms under organic management reproductive activity of female rodents was higher than in borders of conventional farms. Organic farm borders may provide high quality habitats that provide resources for reproduction and persistence of rodent populations.

Zusammenfassung

Das Ziel dieser Untersuchung war zu überprüfen, ob Kleinsäugerweibchen in Saumhabitaten biologischer Betriebe höhere reproduktive Aktivität zeigten als in jenen von konventionellen Betrieben. Die Untersuchung wurde in Saumhabitaten von biologischen und konventionellen Betrieben in der südöstlichen Córdoba-Provinz (Argentinien) durchgeführt, und zwar in den Sommermonaten 2012 und 2013, der Jahreszeit, zu der reproduktive Aktivität wahrscheinlicher ist. Wir beprobten die Feldsäume mit der Fang-Wiederfang-Methode und registrierten die Vegetationsbedeckung, Pflanzenstreu, Vegetationsvolumen, Kahlstellen und die Landnutzung auf beiden Seiten des Saumhabitats (Feld/Feld oder Feld/Weide). Wir registrierten die Zahl reproduktiver Weibchen und das Auftreten von Post-partum-Östrus. Die grüne Vegetationsschicht der Saumhabitate war höher bei biologischen Betrieben, während es bei den konventionellen Betrieben mehr Pflanzenstreu in den Saumhabitaten gab. Wir nutzten Generalisierte lineare gemischte Modelle (GLMM), um die Faktoren zu bestimmen, die die Anzahl der reproduktiven Weibchen in Saumhabitaten von biologischen und konventionellen Betrieben beeinflussten. Die Zahl der reproduktiven Weibchen wurde hauptsächlich von der Bewirtschaftungsform und dem Feldtyp beeinflusst. Es gab mehr

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reproduktive Weibchen auf biologischen als auf konventionellen Betrieben, und Saumhabitate mit Feldern auf beiden Seiten beherbergten die meisten reproduktiven Weibchen. Post-partum-Östrus trat in biologischen Saumhabitate häufiger auf als in konventionellen Saumhabitaten. Unsere Ergebnisse zeigten, dass die reproduktive Aktivität der Kleinsäugerweibchen in Saumhabitaten von biologischen Betrieben höher war als in denen von konventionellen Betrieben. Die Saumhabitate von biologischen Betrieben sind vermutlich qualitativ hochwertige Lebensräume, die den Kleinsäugerpopulationen Ressourcen für die Reproduktion und das Überleben bieten.

Keywords: Organic vs. conventional farms; Border habitat; Habitat quality; Rodent populations; Reproductive activity; Postpartum estrus; Vegetation volume; GLMM

Introduction

Agricultural intensification is one of the key causes of habitat destruction and subsequent biodiversity loss, due mainly to the increasing use of pesticides and fertilizers at local scales (Bengtsson et al. 2003; Hole et al. 2005) and the loss of natural habitats at landscape scales (Roschewitz, Gabriel, Tscharntke, & Thies 2005; Tscharntke, Klein, Kruess, Steffan-Dewenter, & Thies 2005). Organic farming practices are more environmental friendly than conventional agriculture, which is dependent on the routine use of herbicides, pesticides and inorganic nutrient applications in the production of crops and animals (Bengtsson, Ahnström, & Weibull 2005). Studies conducted in plants, insects, birds and mammals have shown that organic farming practices can counteract the negative effects of agriculture intensification in Europe (Beecher, Johnson, Brandle, Case, & Young 2002; Roschewitz et al. 2005; Holzschuh, Steffan-Dewenter, Kleijn, & Tscharntke 2007; Macdonald, Tattersall, Service, Firbank, & Feber 2007; Fischer, Thies, & Tscharntke 2011). However, some studies about the effects of organic agriculture on biodiversity have shown that complexity at the farm and landscape scale, independent of farming system, explain biodiversity differences between organic and conventional farms (Weibull, Ostman, & Granqvist 2003; Clough, Kruess, Kleijn, & Tscharntke 2005). The introduction of organic farming practices would make a difference for biodiversity in simple landscapes (Batáry, Matthiesen, & Tscharntke 2010; Fischer et al. 2011).

Argentina agricultural systems differ from the well-studied European systems (D'Acunto, Semmartin, & Ghersa 2014). They consist of a homogeneous cropland mosaic made of large arable fields and a sparse network of linear habitats such as field borders, roadsides and railways that maintain high plant cover of native flora and introduced weeds throughout the year. The linear habitats frequently receive intentional or unintentional spraying of total herbicides from the neighbouring crops (Ghersa et al. 2002; de la Fuente, Perelman, & Ghersa 2010; Poggio, Chaneton, & Ghersa 2010). In spite of the large structural and functional differences between Argentina and Europe agricultural systems, linear habitats can also attenuate the effects of agricultural intensification by providing suitable habitats for conservation of species biodiversity in modified environments (Simone, Cagnacci, Provensal, & Polop 2010; Gomez, Sommaro, Steinmann, Chiapero, & Priotto 2011).

In the last decades the rate of agricultural expansion in Argentina has increased considerably due to technological changes (e.g., no-tillage techniques, genetically modified crops) and market conditions (e.g., global increase in soybean demand) (Baldi & Paruelo 2008). The farming area dedicated to no-tillage cropping systems increased from 2 Mha in 1992–1993 to 27 Mha in 2010–2011 (Aapresid 2012). During this process, many field borders were removed to enlarge crop areas (Aizen, Garibaldi, & Dondo 2009). In Argentina, the area of organic farmland relative to conventional is small; currently there are 3.6 Mha under organic practices, only 240,000 of them are intended to crop production, whereas the rest is dedicated to pastures for cattle production (SENASA 2013).

The south-east area of the Córdoba province (Juárez Celman, Union and Marcos Juárez Departments) has not been free from agricultural intensification with approximately 1,879,900 ha under crop production, and only 7344 ha of these are under organic management (MAGyA 2013; SENASA 2013). In this region, the small mammal assemblage is mainly represented by the sigmodontine rodents *Calomys musculinus*, *Calomys venustus*, *Calomys laucha*, *Akodon azarae*, *Akodon dolores*, *Oxymycterus rufus* and *Oligoryzomys flavescens* (Simone et al. 2010). In agricultural systems, all species use more stable linear habitats like field borders (Priotto & Polop 1997; Polop & Suárez 2010). Besides *C. musculinus* and *C. laucha* are considered habitat generalists since they occasionally use highly modified habitats such as crop fields (Mills, Ellis, McKee, Maiztegui, & Childs 1992).

Organic farms have higher levels of habitat heterogeneity, and contain greater densities of uncropped habitats compared with conventional farms (Fuller et al. 2005). Organic practices recognize the importance of providing uncropped border habitats for wildlife. The lack of pesticides and inorganic fertilized treatment promote well maintained and more suitable border habitats (Norton et al. 2009) providing important corridors for movement of small mammals (Gelling, Macdonald, & Mathews 2007; Sommaro et al. 2010; Gomez et al. 2011) and nesting and feeding sites for birds (Chamberlain, Fuller, Garthwaite, & Impey 2001). In heterogeneous landscapes, variations in habitat quality, either in terms of food or cover, create the context in which individuals choose habitat types. Particularly, the border habitats play an essential role for the survival and reproduction of many small mammal species by providing food and shelter. Individuals of different sex, age, and life history respond in diverse ways to variation in habitat quality (Lin & Batzli 2004). Considering the high costs associated with pregnancy, lactation and young guarding, females generally invest more in their offspring than males, and typically compete with each other for food and space to rear offspring, whereas males mainly compete for access to estrous females (Trivers 1972; Steinmann, Priotto, & Polop 2009). Thus the effects of the type of farming management should be more apparent in females than in males, influencing the number of females and their reproductive activity in border habitats. Thus organic farms in contrast with conventional farms could play an important role in the agricultural ecosystem providing suitable habitat for female small mammals.

While some studies have shown effects of agriculture management on wildlife reproductive activity, most of them were conducted in birds (Bradbury et al. 2000; Kragten, Geert, & de Snoo 2008), and to our knowledge only one study has been conducted on rodents, yet at a small spatial scale (Macdonald et al. 2007). In Argentina, this is the first study to evaluate in border habitats the effects of conventional and organic farming on the biology of small mammal populations. Thus, we investigated the variations in the number of rodent females and their reproductive activity during the summer, the period with the highest reproductive activity in field borders of south-east Cordoba (Polop, Provensal, & Dauria 2005). The aim of this study was to test if border habitats of organic farms hold a higher female reproductive activity than those of conventional farms.

Materials and methods

This study was carried out in the summers of 2012 and 2013 in an agricultural landscape situated in south-east Córdoba province, Argentina. This region is a land mosaic where the original flora is restricted to uncultivated border habitats. These linear habitats support a mixed vegetation type dominated by native and invasive herbaceous species. The most frequent crop sequences are wheat-soybean or soybean-maize (as alternate single summer crops per year with a winter fallow), even though the soybean monoculture as a single summer crop per year is also a common practice (Puricelli & Tuesca 2005; Satorre 2005).

Conventional practices refer to a range of modern land management systems characterized by external inputs of synthetic pesticides and soluble fertilizers (Trewavas 2004). In Argentina this management includes no-tillage systems where weed control depends almost exclusively on the use of herbicides (Satorre 2005). In this management border habitats frequently receive intentional or unintentional spraying of total herbicides from the neighbouring crops. On the other hand, organic farming is characterized by the use of tillage to mechanical control weed and no use of synthetic fertilizers or pesticides, as well as there is not an intentional management on border habitats.

Our study was conducted in border habitats of organic and conventional farms. A border was defined as a 1.5–2.5 m wide vegetation strip located in the inner margin of crop or pasture fields. The fields associated with borders were classified as crop fields (fields cultivated with soybean or maize) or pasture fields (fields with grasses or alfalfa).

Farm selection was restricted to the scarce number of organic crop production fields found in the study area. Three farms were sampled: Las Gaviotas (Postel S.A.) (33°50′ S, 62°39′ W), Dos Hermanas (Foundation Rachel and Pamela Schiele) (33°39′ S, 62°30′ W) and Altos Verdes (Huanqui S.A.) (33°18′ S, 63°51′ W) (Table 1). The Dos Hermanas farm has always been under organic management; meanwhile organic plots of the other two farms have been under organic management for around 10 years. The three farms followed strict crop rotation schemes both in organic and conventional management. During the study period the main crops were soybean and maize both in organic and conventional farms. Organic fields from Las Gaviotas were certified by OIA (Organización Internacional Agropecuaria) (2014) while Altos Verdes and Dos Hermanas by Argencert (2014).

Capture, mark and recapture (CMR) trapping sessions were conducted in the summers of 2012 and 2013 (February–March). Trappings were carried out in two weeks. Altos Verdes was sampled during the first week and Dos Hermanas and Las Gaviotas during the second week. In each week trapping was conducted during four consecutive nights. During the summer of 2012, 15 and 21 lines were placed in border habitats of organic and conventional farms, respectively, while in the summer of 2013, 18 and 19 lines were placed in organic and conventional border habitats, respectively. Each line had 20 traps similar to Sherman live-traps, a trap was placed every 10 m in the middle of a border between two plots. The distribution of trap lines by year, farm and management is shown in Table 2. The minimum distance between lines was 300 m to avoid a correlation between neighbouring lines. Traps were baited with a mixture of peanut butter and cow fat.

In each line, vegetation measurements were made using a quadrat of 1 m^2 centred in a trap, 10 traps were surveyed. Variables recorded in each quadrat unit were: (1) percentage of vegetation cover, (2) percentage of plant litter, (3) height (cm) of vegetation and plant litter, (4) vegetation volume (m^3), and (5) percentage of bare ground cover. Height was obtained as the mean value of ten measurements randomly registered in the 1 × 1 m quadrat and vegetation volume was estimate as shelter × height, where shelter was the combination of the percentage of vegetation cover and plant litter. Values from the ten quadrats were averaged to obtain a unique value of each variable for each line. The land use of the fields on

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Table 1. Description of sampled farms by management during the study period. Mean plot size (ha) and percent area covered by crops, pastures and border habitats are shown.

	Organic					Conventional				
	Total (ha)	Mean plots (ha)	Crops (%)	Pastures (%)	Borders (%)	Total (ha)	Mean plots (ha)	Crops (%)	Pastures (%)	Borders (%)
Las Gaviotas	400	64.8	67.2	31.6	1.2	1000	69.4	92.0	7.0	1.0
Dos Hermanas	2000	53.0	20.7	78.0	1.3	–	–	–	–	–
Altos Verdes	400	33.7	15.5	82.9	1.6	600	47.5	82.9	15.8	1.3

both sides of the border was also recorded: crop/crop (CC) or crop/pasture (CP).

Trapped animals were identified, sexed, weighed and ear-tagged. Body and tail length were also registered. Reproductive condition of females was determined on the basis of external characters. We classified reproductive females as: females with pregnancy evidence and/or visible nipples. Considering that, independently of rodent species, the general pattern is that females choose habitats that guarantee food and cover to rear their offspring (Trivers 1972), we did not consider species differences. We decided to use as the response variable the total number of reproductive females for each line. Combining all species in a single analysis was also necessary to increase the statistical power as the sample size for each species was relatively low. However, separate analyses for individual species are presented in Appendix A: Table 2. For all species combined, we estimated: (a) the rate of postpartum estrus as number of females with both visible nipples and pregnancy evidence/total number of reproductive females, and (b) the proportion of reproductive females as the number of reproductive females/total number of females.

Vegetation cover, plant litter, vegetation volume and bare ground cover were analyzed using Linear Mixed Models (LMMs). We included farm as a random factor (to control for the lack of independence between observations from the same farm, Crawley 2007) and year (2012 and 2013) and farming management (organic and conventional) as fixed factors. The null model with the intercept only was also evaluated. Akaike Information Criterion, corrected for small sample size (AICc), was used as a measure of the fit of a model. Model comparison was based on the differences in AICc values (ΔAICc), when these were greater than two units, the model with the lowest AICc was considered as a statistically better description of the process that generated the data. We also calculated normalized Akaike weights (wi) for each model; this value is the evidence strength of model i relative to other models in the set of models considered (Burnham & Anderson 2002).

Table 2. Distribution of trap lines by year, farm and management type.

Farm	Year			
	2012		2013	
	Organic	Conventional	Organic	Conventional
Altos Verdes	4	10	7	9
Dos Hermanas	8	–	8	–
Las Gaviotas	3	11	3	10
Total	15	21	18	19

Reproductive activity of females was analyzed using Generalized Linear Mixed Models (GLMMs, with Poisson distribution). We included farm as a random factor. The number of reproductive females was considered as the response variable, and year (Y), farming management (M), field (F) and vegetation volume (Vv) as predictors. Due to the fact that vegetation variables were highly correlated, only Vv was used to analyze reproductive activity of females. This variable was selected as it was found to be a better descriptor of the vegetation of the border. Several models were correlated using one explanatory variable and the combinations of two, three or four explanatory variables. The null model was also evaluated. Model selection was performed using the same procedure as that for the analyses of the vegetation variables. All analyses were performed using package "MuMIn" implemented in R 2.15.1 software (R Development Core Team 2011).

Results

There were two models with similar statistical support for vegetation cover, percentage of plant litter and vegetation volume that included management (M) or the additive effect of year and management (Y + M). Vegetation cover was higher in field borders under organic management, with the highest differences in the first year (model M: AICc = 656.52, wi = 0.51; model Y + M: AICc = 656.69, wi = 0.47; Fig. 1A). Percentage of plant litter showed the opposite pattern (model Y + M: AICc = 666.07, wi = 0.54; model M: AICc = 626.41, wi = 0.46; Fig. 1A). Vegetation volume showed higher values in borders under organic management only in 2012 (model M: AICc = −36.90, wi = 0.51; model Y + M: AICc = −35.55, wi = 0.16; Fig. 1B). For percentage of bare ground cover, two models had similar statistical support, Null model (AICc = 575.2, wi = 0.53) and management (AICc = 577.00, wi = 0.22; Fig. 1A).

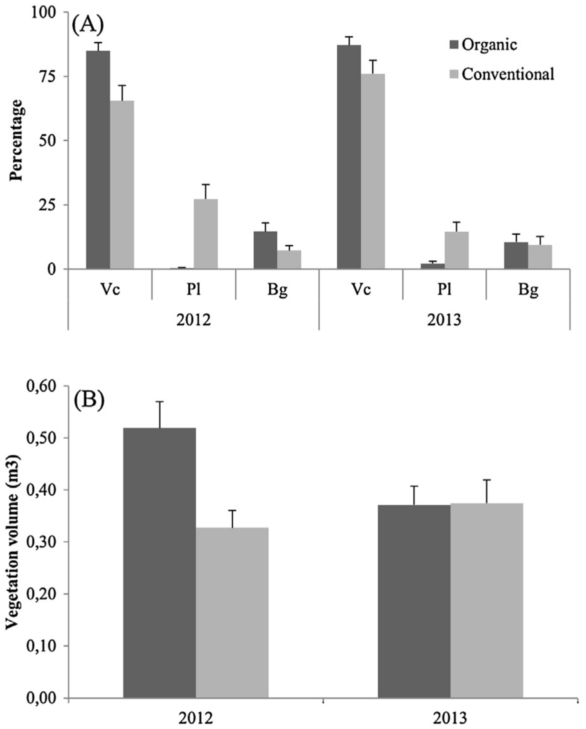

Fig. 1. (A) Percentages (mean + SE) of vegetation cover (Vc), plant litter (Pl) and bare ground cover (Bg) and (B) vegetation volume (mean + SE) under organic or conventional management for the two study years (2012 and 2013).

During the samplings a total of 258 individuals belonging to six rodent species were caught in 5840 trap-nights, 110 and 148 individuals in border habitats of conventional and organic managements, respectively. The number of individuals of each species is shown in Table 3. The most captured species was *C. musculinus* in both managements. Twenty one (70%) and 39 (81%) females were reproductively active in conventional and organic management, respectively (Table 3 and Appendix A: Table 1). GLMM analysis revealed that there were two models with similar statistical

Table 3. Total number of individuals of the six rodent species captured in border habitats under conventional or organic management combined for summers 2012 and 2013. Percentages of reproductive females are given in parentheses.

Species	Conventional		Organic	
	Male	Female	Male	Female
Akodon azarae	9	3 (67)	7	6 (83)
Calomys laucha	23	10 (80)	40	12 (92)
C. musculinus	41	15 (67)	43	21 (86)
Mus musculus	3	2 (50)	7	7 (57)
Oligoryzomys flavescens	2	0	3	2 (50)
Oxymycterus rufus	2	0	0	0
Total	80	30 (70)	100	48 (81)

Table 4. Model selection, based on AICc comparison, of Generalized Linear Mixed Model (GLMM) describing female reproductive activity. M: management; F: field on both sides of the border; Vv: vegetation volume; Y: year.

Model	AICc	ΔAICc	Weight
M + F + Vv	166.88	0.00	0.476
M + F	168.07	1.19	0.263
Y + M + F + Vv	169.19	2.30	0.151
Y + M + F	170.37	3.49	0.083

Only models with ΔAICc < 4.

support; management, field and vegetation volume were the most important factors affecting the number of reproductive females in borders (Table 4). There were more reproductive females in border habitats of organic than of conventional farms, and also in borders between C/C than in borders between C/P fields regardless of management type; the differences in vegetation volume were less evident (Fig. 2). Vegetation volume was analyzed considering the number of reproductive females by border. In organic farms up to five reproductive females were captured per border, whereas in conventional farms there was no more than two reproductive female trapped per border (Fig. 3). The number of reproductive females in borders of organic farms was independent of vegetation volume (Fig. 3A) while in conventional ones it increased with vegetation (Fig. 3B). Separate analyses for each species (Appendix A: Table 2) shows that the most abundant species (*C. musculinus*), seems to contribute more to the general pattern observed in the pooled analysis. However, the absence of clear statistical models for the other species would be due to the small sample size (Appendix A: Table 1).

The other reproductive variables were estimated for the two years combined. The rate of postpartum estrus (mean ± SE) in organic farm borders was 0.56 ± 0.01 while in conventional farms it was 0.42 ± 0.08. The proportions of reproductive females (mean ± SE) were 0.83 ± 0.07 and

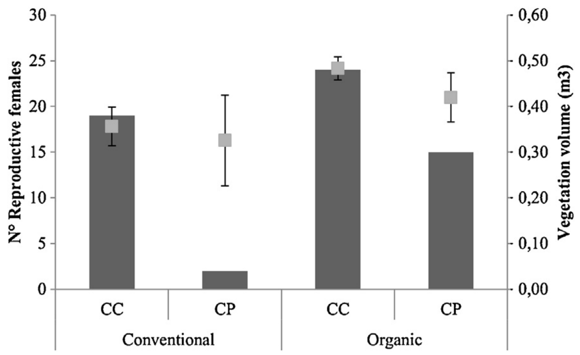

Fig. 2. Total number of reproductive females (dark grey bars) caught in borders neighbouring different fields (CC, crop/crop; CP, crop/pasture); and vegetation volume (mean ± SE) (light grey squares) for organic and conventional managements.

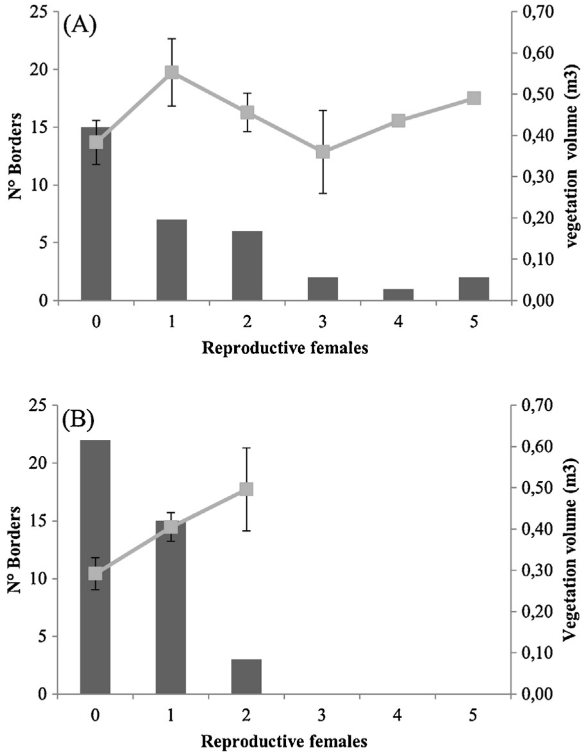

Fig. 3. Number of borders with a given number of reproductive females caught (dark grey bars) and vegetation volumes (mean ± SE, light grey line) associated with those borders for (A) organic and (B) conventional management.

0.71 ± 0.15 for organic and conventional farm borders, respectively.

Discussion

In agricultural systems, border habitats provide potential resources for ecological process as reproduction in rodents and species occurred in these habitats independently of their specialization grade (Gelling et al. 2007; Sommaro et al. 2010; Gomez et al. 2011). Thus, our study design was based on the comparison of the effects of organic and conventional farming practices on reproductive activity in rodent females in border habitats. Besides, considering that females of any rodent species choose habitats with enough food and cover to rear their offspring and that our results showed that the numerically dominant rodent species were the same in both farming practices (*C. musculinus*, *C. laucha* and *A. azarae*), we pooled all the species in a single analysis.

Several studies have shown positive effects of organic farming on abundance and diversity of species (Hole et al. 2005). However, there are scarce studies that analyze the effect of farming practices on demographic parameters such as reproduction. To our knowledge, this is the first study to investigate the effect of farming practices on small mammal reproductive parameters. This study was conducted in the summer as this is the season with the peak of reproductive activity of rodents in the Argentina Pampa region (Mills et al. 1992), and it was conducted at a wide scale, since farm sizes varied from 1000 to 2000 ha with an average plot size of 54 ha. The majority of captured females belonged to *C. musculinus* and *C. laucha*, while those of *A. azarae* and *M. musculus* were less abundant (Table 3). Even though the involved species have different mating systems: *C. musculinus* is promiscuous (Steinmann et al. 2009), *C. laucha* is monogamous (Laconi, Jahn, & Castro-Vazquez 2000), and *M. musculus* and *A. azarae* are polygynous (Wolff 1985; Bonatto, Gomez, Steinmann, & Priotto 2012), the general pattern is that females choose habitats that guarantee food and cover to rear their offspring (Trivers 1972). Thus, in this study we used reproductive parameters of rodent females as an indicator of habitat quality. Considering that sympathetic management of border habitats increases availability of food and shelter to mammalian species in farmlands (Brown 1999), we predicted that border habitats of organic farms would hold a higher abundance of reproductive females than those of conventional farms. Our results showed that in borders under organic management there were higher rates of post-partum estrus and number of reproductive females than in conventional ones.

The number of reproductive females in borders was mainly determined by agriculture management, field and vegetation volume (Table 4). Macdonald et al. (2007), in a small spatial scale study, registered a higher number of *Apodemus sylvaticus* breeding females in organic than in conventional farms. In Argentina the exclusion of synthetic pesticides and fertilizers from organic farms would be the fundamental difference between the management systems. The reduction of agrochemical application increases the diversity of plants and invertebrates in field borders (Tew, Macdonald, & Rands 1992). Fields under organic management record higher weed abundance and species richness, regardless of the arable crop being grown (Hole et al. 2005). Frieben and Kopke (1995) recorded that the mean number of weed species in both margins and crop fields was more than twice as high under organic than under conventional management; similarly Hald (1999) observed that density of non-crop vegetation in conventional crop fields was about one-third of that in organic fields. Consequently, the crops themself are less dense and invertebrate communities are more abundant and diverse in the latter (Macdonald, Tew, Tod, Garner, & Jhohnson 2000). Although these results were obtained in European habitats, they also may apply to organic farms in Argentina. Thus all characteristics described above, make the organic farms in general, and in particular their border habitats more suitable habitats for reproductive females of small mammals since they provide the highest availability of shelter and food. Our results clearly support that borders of organic farms with higher percentage of green cover (Fig. 1A), registered the highest female reproductive activity.

Another noticeable result is the relationship between the number of reproductive females in borders and vegetation volume. Borders in conventional farms hold a low number of reproductive females which are restricted to borders with high vegetation volume (Fig. 3B). Most of the vegetation volume in conventional farms is constituted by plant litter, making these borders less suitable habitats for reproductive females. Vegetation volume in borders of organic farms is mainly composed of green vegetation cover, constituting a higher quality habitat for reproductive females, thus holding a greater number of them than borders in conventional farms (Fig. 3A).

We observed the lowest numbers of reproductive females in borders with pasture fields regardless of management (Fig. 2). This result could be due to the fact that cattle grazing influences the quality and quantity of vegetation modifying habitat use of small rodents (Arsenault & Owen-Smith 2002). Grazing activity removes both live and dead vegetation (Altesor et al. 2006) and produces soil compaction, erosion and soil nutrient modification (Steffens, Kolbl, Totsche, & Kogel-Knabner 2008). A negative impact of cattle grazing on diversity and abundance of small mammals has been reported previously (Moser & Witmer 2000). Keesing (1998) observed a higher recruitment rate of small mammals, as a result of a higher number of females in non-grazed habitats than in grazed habitats.

Conclusions

We confirm that reproductive activity of rodent females is higher in border habitats of organic than of conventional farms. Borders of organic farms are quality habitats that provide resources for reproduction and persistence of rodent populations. This finding has many implications, among which we can mention the potential benefit to the breeding success of predators given that small mammals represent an important prey source. Thus, organic farms could be key to the conservation of the complexity of food webs. However, it is now widely recognized that wildlife friendly farmland practices need to consider landscape context (Batáry et al. 2010). Therefore an increase of the area under organic management would be important to the conservation of biodiversity in simple landscapes (Tscharntke et al. 2005) such as Argentine farmland under intensive agriculture.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.baae.2014.06.005.

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