Biodiversity in the Argentinean Rolling Pampa Ecoregion: Changes Caused by Agriculture and Urbanisation

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Summary The metropolitan area of Buenos Aires is located in the Rolling Pampa, one of the most productive ecoregions of the world (44, 000 km^2, 33° S − 39° S). This region has undergone deep transformations caused by agricultural, residential, industrial and commercial land-uses. The purpose of this paper is to compare to what exient plant and avian richness is influenced by urban and agricultural uses. To capture the land-use effects a comparison between different sectors was made. Green spaces and farmland, located in areas of contrasting land-use, extending from the La Plata's river shore to semirural and rural areas, were sampled. Vascular plant richness, floristic composition and bird presence were considered. To compare the different sites, biodiversity indexes and Sørensen's coefficient of similarity were calculated and the percentage of forest, grassland, shrubland, wetland and rivers/streams was estimated. All collected data were correlated using Principal Components Analysis (PCA). In general, the decrease of native plants and bird richness towards the city centre is consistent with the studies of other cities. The results of the present study confirm that the actual cultivation practices are extremely more dangerous for conservation of native land than urban sprawl.

Keywords: Biodiversity · Argentina · Buenos Aires · plant species · bird species · species diversity

Introduction

In 1774 Thomas Falkner described the Argentinean Pampa as "One immense sea of grasslands, with scattered forest islands . . ." (Ghersa a. León 2001, 571). With this statement he clearly transmitted the perception of the native inhabitants and the reasons why they named this landscape Pampa – in the natives' language Quechua "Pampa" means "uniform extensive plain". Since then, this landscape has gradually disappeared by high pressure of agriculture and urbanisation.

In general, urban areas are very dynamic and consist of very distinct environmental gradients promoted by anthropogenic effects. This leads, for example, to a fragmentation of native vegetation and to an introduction of alien species.

Agriculture is a threat to biodiversity and may even be greater than the threat of urbanisation. Ricketts and Imhoff (2003) recommended identifying where high levels of human pressure on ecosystems and biodiversity coincide. Nowhere in Argentina does this issue acquire greater prominence than in the urban/rural interface of the Rolling Pampa. Matteucci et al. (1999) and Morello et al. (2003) emphasised that urban sprawl is responsible for the dramatic conversion of land that is

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still going on. The location of settlements on loessial soils of high quality contributes substantially to the destruction of the regional biodiversity.

Living biota depends on the spatial heterogeneity within cities and the surrounding landscapes (Pickett et al. 2001). Rebele (1994) and Kowarik (1990, 2003) proved that the proportion of coloniser and exotic species is characteristically higher in urban vegetation than in near-natural habitats. According to Melles et al. (2003) the variety of bird species decreases as a consequence of an increasing urbanisation. Many authors have suggested that, on the local scale, plants and birds can be used as indicators of environmental changes (Blair 1999; Faggi et al. 2003). Porter et al. (2001, 132) recommended quantifying those changes caused by urbanisation "in order to move beyond simplistic descriptions of urban habitats". Moreover, they pointed out the significance of partially developed landscapes which may serve as an important refuge for many species.

The purpose of the present paper is a) to compare to what extent plant and bird richness in the Rolling Pampa are influenced by urban and agricultural uses; b) to analyse the changes in plant diversity caused by more than 50 years of agriculture, comparing present and historical data.

Rolling Pampa

The Rolling Pampa, as one part of the whole "Pampa" area, is characterized by the presence of low round-topped hills (1–3°) (SAGYP-INTA 1995), which gives the landscape an undulating aspect. Figure 1 locates the Humid Pampa region. Within this area, the Rolling Pampa ($44,000\,\mathrm{km}^2$) is marked and the study locations are pointed out.

The climate of the region is subtropically humid, characterised by long warm summers and mild winters, with an average air temperature of 11 °C in July and 25.5 °C in January and a mean annual precipitation of 1,147 mm (climate station 34°35'S, 58°29'W) (Sträber 1999, 166).

Before the European settlement, this area was presumably a mosaic of dry and riparian forests and other wetlands, which were dominated by grasslands on the eolian terrace. When the Spanish conquerors began to settle down at the end of the 16th century they used the forests as combustible.

In the middle of the 19th century two main transformation processes started: a) the eolian terrace was converted into agriculturally productive land, which led to a loss in biodiversity and

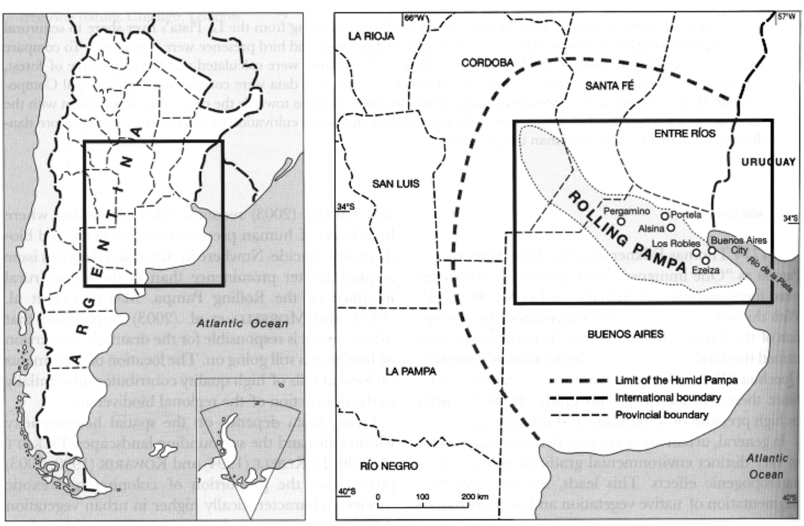

Fig. 1 Location of the study area

b) an important immigration took place and the small settlements were converted into cities. The immigrants brought many of the ornamental exotic plants which today are important elements of the urban vegetation. On the eolian terrace an intensive change from agriculture to residential, industrial and commercial land-use started in the year 1940 (Morello et al. 2003). Under the pressure of a greater need for building space, important parts of the river shore were filled up. In some areas of this land enhancement a recovery of native biodiversity took place.

The Rolling Pampa is one of the most productive ecoregions of the world. Since 1990 intensive agriculture aided by modern technology is being performed (Viglizzo et al. 2002). Today, the dominant land use of the Rolling Pampa is agriculture with soybean, sunflower, maize and wheat as principal crops.

Material and methods

Study area

The study has been conducted in urban, suburban, periurban, semirural and rural sectors in the Rolling Pampa. Every sector includes specific sampled sites (Table 1). The population density ranges from 250–587 hab/ha in the urban area and is $\leq 250\,\mathrm{inh./ha}$ in the suburban area (SECRETARIA DE PLANEAMIENTO URBANO Y MEDIO AMBIENTE, GCBA 1998). Periurban, semirural and rural areas show lower densities between 4 and 5 hab/ha (INDEC 2001).

Characterisation of the sampled areas

1. Urban sector:

   a) The Natural Reserve Costanera Sur with a surface area of 350 ha is located one km away from the Buenos Aires city centre. It is an artificial land enlargement at La Plata's riverside, which was created in the early seventies of the 20th century using remains of the buildings which had to be pulled down for a new high-way construction. The area within the embankments was filled with sand and silt from the river and was partially drained afterwards. Spontaneous natural plant succession took place and many ecosystems developed. Therefore it has been considered as a blind probe for the present study. The diversity of biotopes such as lagoons, wetlands, grasslands and forests guarantees the presence of a rich fauna. In 1986 the City Council, following the demand of many non-governmental environmental organisations, declared this reclaimed land a protected area. Figure 2 shows a photograph of the Costanera Sur with the skyline of Buenos Aires in the background.

Table 1 Sectors and sites of the study area

Sector		Sites
Urban	Natural Reserve Costanera Sur	
	Urban Parks	Lezama, España, Patricios, Chacabuco
Suburban	Park Indoamericano	
	Park Ribera Sur	
Periurban	Ezeiza	
Semirural	Los Robles	
Rural	sector at the middle of 20^{th} century (rural 1930)	Pergamino
	sectors at the end of the 20^{th} century (rural present)	Ireneo Portela
		Alsina

Fig. 2 Buenos Aires downtown seen from Costanera Sur Reserve

b) Urban Parks: the Lezama (7.36 ha), España (5.78 ha), Patricios (15.41 ha) and Chacabuco (24.41 ha) parks are completely surrounded by densely built-up areas with few green or open spaces. The parks consist of planted tree areas with lawns or flower beds. Figure 3 shows Parque España represented by a photograph and an IKONOS satellite image.

2. Suburban sector:
The Parque Indoamericano with an extension of 55.2 ha and the recreational area Parque Ribera Sur (38.43 ha) were considered. These green areas show planted trees and lawns and are surrounded by open spaces visible in the IKONOS-subsets of the Parks (Fig. 4).
3. Periurban sector:
Ezeiza has a surface area of ca. 708 ha. Isolated buildings are surrounded by parks. Most of the area is covered by afforestations alternating with savannahs, grasslands and wetlands. This area borders on residential settlements, recreational clubs, grazing fields and the infrastructure of the Buenos Aires international airport. In the last decade cattle-breeding stopped and today, the vegetation is left to its own devices. Past and present cartography shows that this area, once used for farming, was converted from mesic and hydrophytic grassland into a mosaic of grassland and forests.
4. Semirural sector:
The reserve Los Robles (568 ha) is located at about 43.5 km North/East of the city centre (34°40'S and 58°52'W). It is used as a recreational area and for environmental education. The reserve is surrounded by agricultural and horticultural fields. Los Robles borders on an artificial lake with a surface area of about 400 ha which was formed by the construction of a dike between 1968 and 1972. The vegetation of the reserve consists of native dry forests, savannahs, forests with exotic species, grasslands, wetlands and crop fields (Burgueño 2004).

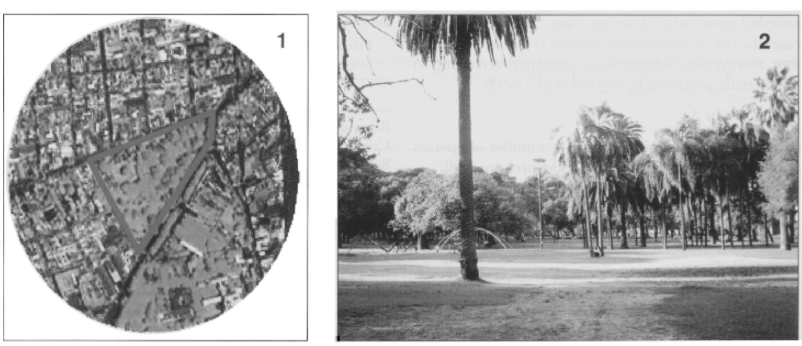

Fig. 3 Urban sector Parque España (+ surroundings)
(1) Satellite image IKONOS (multispectral 4 m resolution, Green-NIR-Red)
(2) Parque España

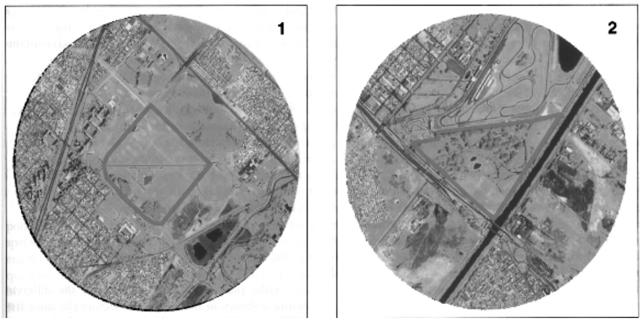

Fig. 4 Suburban sector (1) Parque Indoamericano and (2) Parque Ribera Sur
Satellite image IKONOS (multispectral 4 m resolution, Green-NIR-Red)

5. Rural Sector:
   Two temporal situations were chosen: 1. a rural sector at the end of 20th century and 2. a rural sector at the middle of the 20th century.

   For the rural sector at the end of the 20th century two areas in the northern part of the province of Buenos Aires were considered. Due to their mild climate, gentle topography, fertile soils and water supply, these rural localities are representative for agriculturally productive land. The vegetation of Alsina (33°55'S and 59°20'W, 21,909 ha) was described by Faggi (1986) and Ireneo Portela (34°00'S and 59°30'W, 42.550 ha) by Faggi (1996).

   For the rural sector at the middle of 20th century Pergamino district was chosen, because topography, soil and climate conditions of this area are very similar to Ireneo Portela and Alsina (SAGYP-INTA 1995) and scarcely any other studies concerning flora and fauna were made in the past. Pergamino District (312,600 ha, 33°53'S, 60°36'W), devoted to agriculture, was analysed over 20 years by Parodi (1930). At that time the principal crops were maize, flax, wheat, alfalfa, oats and barley. He recorded 488 species, 318 natives, 120 exotics and 50 introduced from other regions of South America. At that time, the abundance of many grasses and herbs in the grasslands was striking.

Data acquisition

To capture the land-use effects on biodiversity (native species losses and exotic species increase) and the existence of thresholds, a comparison of the different sectors was made. Green spaces and farmland, located in areas of contrasting land-use, extending from the La Plata's river shore to semirural and rural areas, were sampled. The Natural Reserve Costanera Sur was analysed as a "blind probe" to contrast the results. To analyse the changes in plant diversity caused by more than 50 years of agriculture and cattle grazing, present and historical data are compared.

It was analysed how urbanisation and agriculture affect species richness and community similarity. In order to compare the different sample areas, the percentage of surface cover of the plant physiognomical units, here defined as wetland, grassland and woodland, was estimated.

Species richness

For each area vascular plant richness, floristic composition and bird presence were considered. In the urban, suburban and periurban areas vascular plants and birds were recorded by an exhaustive walkover of each study area between October and December 2002. In order to compare the selected areas, presence of plants and birds were listed. Richness of plants and birds for the semirural sector came from Burgueño (2004). Values for the richness of birdlife in the rural areas were extracted from Cueto and Lopez de Casenave (1999). Vegetation was studied by Faggi (1986, 1996). As the same methodology was used for all of the studies considered in the present paper, a comparison of the data is possible.

In general, the richness of flora and fauna is expressed as a number of individuals or as a biodiversity index which takes in account the number of individuals per area in a logarithmic way. For the comparison of sampled areas with different sizes, as in the present case, the use of biodiversity indexes is essential. Therefore, biodiversity indexes were calculated according to the formula proposed by Squeo et al. (1998):

$$\mathrm{Bi} = \mathrm{n}/\ln \mathrm{A}$$

where Bi = Biodiversity index; n = number of species and $\ln \mathrm{A}$ = natural logarithms of the area studied.

The biodiversity indexes of planted species, spontaneous exotic plants, spontaneous native plants, spontaneous annual plants and birds were considered.

Similarity

To quantify similarities between the green areas on the basis of self-growing plants (spontaneous species) the Sørensen Similarity Index was calculated (Sørensen 1948). It reflects the number of species two areas have in common. By using the following equation, different areas were compared by pairs:

$$\mathrm{S} = 2 * \mathrm{C}/\mathrm{s1} + \mathrm{s2}$$

where S = Sørensen's coefficient of similarity; C = number of plants common to the two sampled areas; s1 = number of plants in study area1 and s2 = number of plants in study area 2.

Values of this index vary from 0 to 1. The value 0 indicates that species assemblages differ totally (dissimilarity) and 1 that they are identical. If the Sørensen's coefficient is higher than 0.75, it was considered to reflect very high similarity, values in the range between 0.51–0.75 reflect high similarity, and values between 0.26–0.50 describe moderate similarity. Low similarity is described by values below 0.25 (Ratliff 1993). According to Ellenberg (1956) the vegetation of two sampled areas belongs to the same community if the index is higher than 0.25.

Plant physiognomical units

For each sector the percentage of the surface covered with forest, grassland, shrubland, wetland and rivers/streams was estimated by means of visual aerial photograph and satellite image interpretation (Table 2). The land uses were combined into three plant physionomical units: wetland (including river/ streams), grassland and woodland (which includes forest and shrubland).

Table 2 Percentage of plant physiognomical units

	Wetland	Grassland	Woodland
Reserve	35	50	15
Urban Parks	0	60	40
Suburban sector	20	53	27
Periurban sector	5	25	70
Semirural sector	12	6	82
Rural sector	24	66	10

Data analysis

The software STATISTICA PROGRAM was used to find correlations between the plant physiognomical units (wetlands %, grasslands %, woodlands %) and the richness parameters (biodiversity index of native plants, annual plants, exotic plants and birds) in the eleven study areas (the rural sector of the middle of the 20th century was not included).

To highlight similarities and differences among the studied sectors the plant physiognomical units and the richness parameters were taken in account using Principal Components Analysis (PCA) with the software Pcord 3.0. PCA is well known as a tool to (1) reduce the number of variables and (2) detect structure in the relationships between variables (Glavac 1996). The method involves a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called principal components. In the space it can be viewed as a projection of the observations on to orthogonal axes defined by the original variables. The first axis contains the maximum amount of variation. The second axis accounts the maximum amount of variation orthogonal to the first. Principal components are obtained by projecting the multivariate data vectors on the space spanned by the eigenvectors. The eigenvector associated with the largest eigenvalue has the same direction as the first principal component (axis 1). The eigenvector associated with the second largest eigenvalue determines the direction of the second principal component (axis 2).

Results

Vascular plants and birds richness of the different sectors is shown in table 3. In all sectors the most frequent plants are herbs, which are the typical components of grasslands of the eastern Argentinean pampa. Seven species are natives (*Paspalum dilatatum, Bromus catharticus, Gamochaeta simplicicaulis, Hydrocotyle bonariensis, Hypochaeris microcephala, Stenotaphrum secundatum, Funcus tenuis*), four aliens (*Trifolium repens, Poa annua, Carduus acanthoides, Cirsium vulgare*) and two grow world-wide (*Cynodon dactylon, Sporobolus indicus*). The presence of the exotic self-growing species is considerable in the urban parks (biodiversity index: 14.87) and the semirural area (biodiversity index: 14.22). In contrast to this, rural areas show an important decrease in exotic self-growing species.

In all study areas native birds are the principal component of avian richness. While 250 different bird species were observed in the Natural Reserve Costanera Sur, richness declines to 15 in the urban parks (Parque Lezama, España, Patricios and Chacabuco). Exotic birds like the House Sparrow (*Passer domesticus*) and the Rock Dove (*Columbia livia*) have the highest abundance in the urban parks near the city centre. The avian richness increases little by little towards the semirural sector

Table 3 Richness of vascular plants and birds

	Urban (n:5)					
	Reserve (n:1)	Parks (n:4)	Suburban (n:2)	Periurban (n:1)	Semirural (n:1)	Rural actual (n:2)
Number of plant species	245	124	102	237	334	156
Number of bird species	250	15	30	65	189	75
Exotic sps. %	29	60	51	41	45	22
Spontaneous sps. %	98	41	73	83	77	98
Exotic spontaneous sps. %	27	17	39	15	27	21
Native spontaneous sps. %	71	24	34	68	50	77
Annual spontaneous sps. %	15	14	25	22	15	23

n = number of sampled areas

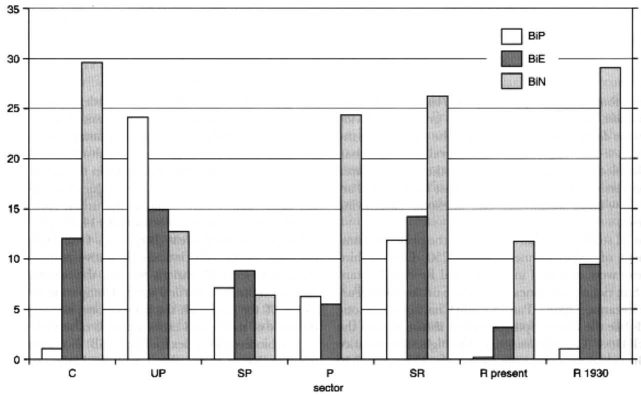

Fig. 5 Biodiversity indices of vascular plants

(Parque Indoamericano, Ribera Sur, Ezeiza and Los Robles) to decline again in the rural sector (Portela and Alsina).

Figure 5 shows the biodiversity indexes of vascular plants for each sector, comparing planted (BiP), exotic spontaneous (BiE) and native spontaneous species (BiN). Planted species are, as a result of afforestation practices on public land, significant in the urban parks and semirural areas. The highest values for self-growing exotic plants were found in the urban parks (BiE: 14.87) and the semirural sector (BiE: 14.22), the lowest in the present rural areas (BiE: 3.17). Outstanding are the high biodiversity indexes of native plants in the Natural Reserve Costanera Sur and the relatively low indexes in the present rural sector. Comparing the rural sector of the past with the present one, an important decrease of native and exotic plants is observed today.

The biodiversity index for birds (BiB) shows the same trend as that of native plants, with the highest value in the urban reserve (BiB: 42.67), a minimum in the urban parks (BiB: 3.89) and values increasing towards the semirural areas (BiB: 29.8). The index drops abruptly in the rural sector (BiB: 4.61–10).

This tendency reveals that agricultural practices have also altered birds' natural habitats.

In the eleven study areas along the urban-to-rural gradient, a strong positive correlation (0.84) between the biodiversity indexes of birds and native plants is recognised (Table 4). A negative correlation (−0.71) between woodlands (F) and grasslands (G) can be inferred, indicating the replacement of herbs and grasses by trees and shrubs.

In table 5 the similarity values for floristic composition between the defined sectors are presented. These values range from 0.2 to 0.46, which represents low and moderate similarity. Highest

Table 4 *Correlation coefficients between site and richness parameters (software STATISTICA PROGRAM)*

	W	G	F	BiN	BiA	BiE
Wetlands (W)	1.00					
Grasslands (G)	−0.39	1.00				
Woodlands (F)	−0.37	0.71	1.00			
Biodiversity index of native plants (BiN)	0.28	−0.57	0.36	1.00		
Biodiversity index of annual plants (BiA)	0.24	0.09	0.09	0.26	1.00	
Biodiversity index of exotic plants (BiE)	−0.24	0.27	0.08	0.03	0.19	1.00
Biodiversity index of birds (BiB)	0.54	−0.52	0.12	0.84	−0.10	0.01

Marked correlations are significant at $p < 0.05$

Table 5 *Similarity Index between areas considering vascular plants (spontaneous species)*

	Reserve	Urban Parks	Suburban sector	Periurban sector	Semirural sector	Rural present
Urban Parks	0.26					
Suburban sector	0.38	0.45				
Periurban sector	0.33	0.46	0.46			
Semirural sector	0.38	0.36	0.38	0.42		
Rural present	0.36	0.22	0.38	0.35	0.36	
Rural 1930	0.24	0.20	0.22	0.30	0.20	0.34

Values in grey represent moderate similarity (0.26–0.50), in white low similarity (0–0.25)

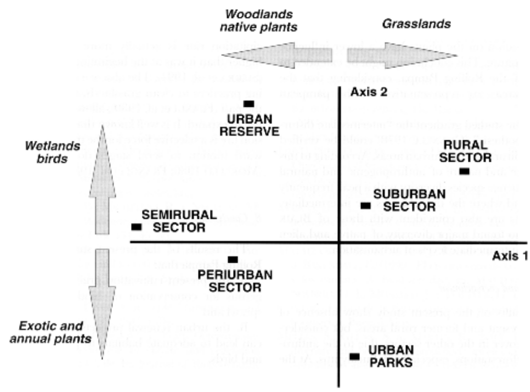

Fig. 6 Ordination of the sampled sectors produced by Principal Component Analysis (PCA)

similarity values were observed between the periurban area and the urban parks and between the periurban and the suburban areas. Dissimilarity is found between the rural area of the middle of the 20th century and urban, suburban and semirural sectors. The similarity index between past and present rural areas is moderate (0.34). The similarities of both rural sectors compared with the periurban sector are also moderate.

Figure 6 shows the Principal Component Analysis ordination of the eleven study areas. Axis 1 explains 42.71% of the variance and grasslands, woodlands and the biodiversity index of native plants are the principal components. They allow the separation of the studied sectors along this axis. The rural and the suburban sectors as well as the urban parks are characterised by the dominance of grassland. On the other hand the urban reserve and the semirural and periurban sectors show a high percentage of woodland and high biodiversity indexes of native plants.

The principal components of the axis 2 are “wetlands” and “the biodiversity index of birds”, “the bio-diversity index of exotic” and “the biodiversity index of annual plants”. This axis displays 29.16% of the variance. The urban reserve as well as the rural, surburban and semirural sectors show high values of “wetlands and the biodiversity index of birds”. Urban parks and periurban sectors are characterised by high values of the “biodiversity index of exotic” and “biodiversity of annual plants”.

Discussion

Species richness

In urban biodiversity gradient studies an increase of native plants from the city centre towards the periurban areas is generally recognized (Pickett et al. 2001; Sukopp 1998; Zipperer et al. 1991; Grapow a. Blasi 1998). In the present case the biodiversity indexes of native plants do not conform to these analyses. The Natural Reserve Costanera Sur, situated in the city centre, shows very high values of biodiversity of native plants and birds because its environment, due to its conservation state, is not altered. Therefore, it is suitable to be used as a reference for the comparison with the other sectors.

The high presence of birds in the reserve coincides with the results of Clergeau et al. (2001) who concluded that at regional and local scales, urban bird communities are independent of the bird diversity of adjacent landscapes. In the study conservation area bird richness depends very strongly on local and temporal features like the presence of lagoons, water level and habitat heterogeneity. Excepting the Natural Reserve Costanera Sur, the variation of bird richness from the city centre towards rural areas is consistent with the results of studies conducted in other cities, which also show a decrease towards the city centre (Melles et al. 2003).

On the other hand, all of the calculated biodiversity indexes in the suburban sector are very low. They can be related to the soil conditions of the Parque Indoamericano, which shows poor structure and presence of heavy metal (Hg/Pb) contamination (Kaplanski a. Gonzalez 1997).

Comparing the rural development over the years, today there is an outstanding plant impoverishment of native and also exotic species. Parodi (1930) found eight grasses and four herbs, which had been abundant in the Rolling Pampa in the first decades of the last century; today only two of them (*Bromus catharticus* and *Lolium multiflorum*) are frequent. Many endemic plants have also disappeared. In this sector of the pampa an adverse effect of intensive agriculture – particularly since 1970 – is described by many authors (Senigalesi 1991; Bertonatti a. Corcuera 2000; Casas et al. 2000). They observed that habitat fragmentation, soil erosion and changes in the water balance of the soils led to a decline in the abundance and diversity of native species and the invasion of exotic plants.

All biodiversity indexes of plants in the present rural areas are lower than the values observed in the urban parks. This indicates for the study area, that the effects of urbanisation on the plants have a lower influence than agriculture. This conclusion might be extended to the rest of the Rolling Pampa, considering that the analysed areas are representative for the pampean ecoregion.

Along the studied gradient the "intermediate disturbance hypothesis" (Connell 1978) could be verified for the semirural and periurban areas. According to this author, size and nature of anthropogenic and natural events influence species diversity, with a peak frequently being found where the disturbances are intermediate. The results are also coincident with those of Blair (1996), who found major diversity of native and alien species at intermediate levels of urbanisation.

Woodland encroachment

The results of the present study show absence of trees in present and former rural areas, but considerable tree cover in the other sectors, due to the anthropogenic afforestations, especially of Eucalyptus. At the end of the 19th century, the Eucalyptus was brought from Australia to Argentina.

Today, in the periurban areas of the Rolling Pampa, a spontaneous increase in the number of shrubs and trees can also be observed. Woodland encroachment is a process which is taking place in many prairie-savannah regions (Nowak et al. 1996). An aggressive North American tree, *Gleditsia triacanthos* (Honey locust), covers about 40% (277.52 ha) of the sampled periurban sector. This information was taken from the supervised classification of the Landsat ETM+-Image of this area. In North America the honey locust shows a wide natural range and its distribution increased through anthropogenic changes in land-use like pasture clearance and road construction (Blair 1990).

In the periurban areas of Buenos Aires this tree grows rapidly as a dense thicket at the beginning. Finally it forms a monophytic forest. Once planted as an ornamental element, it has invaded the pampa and other regions along streams since the second half of the 20th century (Morello a. Matteucci 2001; Marco a. Paez 2000). Over the years it has displaced the previous native grasslands. The honey locust tree is also an invader in Queensland (Australia) and was declared a plant that has to be eliminated (LAND PROTECTION 2006).

It is possible that climate and land-use changes influence invasion of the honey locust. Murphy et al. (1999) described a decrease of the winter chilling occurring in central Buenos Aires and its suburbs for the period 1911–1998. This trend was also observed by Damario a. Pascale (1995) for the rest of the country. The precipitation rate is actually more than 200–250 mm higher than it was at the beginning of the 20th century (Sierra et al. 1994). The absence or decrease of burning practices to clean grasslands, as were practiced in the past (Frangi et al. 1980), allows the *Gleditsia triacanthos* to expand, it is well known that in the plant succession fire is a selective force for the maintenance or backward motion to seral stages dominated by grasses (Morello 1980; Frangi et al. 1980).

Conclusions

The results of the present study confirm for the Rolling Pampa that:

A. the present cultivation practices are more dangerous for conservation of biodiversity than urban sprawl and

B. the urban renewal projects designed for nature can lead to adequate habitats to protect native plants and birds.

The implementation of further conservation areas in the Rolling Pampa together with more adequate agricultural practices could improve the current situation, rehabilitating and restoring native communities.

A reduction of mowing in urban to periurban areas, especially along the highways, could allow native plants to re-establish themselves and could help to prevent a further decline in richness. Also a policy of invasive plants control, as practised in Australia, has to be considered.

To increase the presence of birds in the urban and suburban parks it is advisable to enhance the presence of small lakes and ponds and to create a diversity of vegetation structure with tree and shrub layers within the grasslands. A good example is the urban Natural Reserve Costanera Sur, which contains 250 taxa of plants and birds respectively, most of them are native species. Compared to a range of urban, suburban and periurban areas this man-made wetland, covering only about 0.45 % of Buenos Aires and its surroundings, contains more than twice the amount of plants than the urban parks and suburbs, protecting a great part of the pampas diversity.

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