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Students' familiarity and initial contact with species in the Monte desert (Mendoza, Argentina)

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ABSTRACT

This study investigates how familiarity and initial contact with species can be explained by social-demographic variables in an arid environment of Argentina. Our main objectives were to investigate which species children are familiar with, and analyse the effect of place of residence, sex and age on students' knowledge and initial contact with species. In total, 1746 students between 7 and 18 years old participated in the study, from 25 urban and 19 rural schools. Students were asked to write down ten animals and ten plants, and to indicate where they had seen them for the first time. Children were able to name an important number of species but they were mostly acquainted with exotic ones. Familiarity with species and the use of different sources of information can be explained by interactions between the studied factors, while place of residence was not as significant as we expected. Sex was an important explanatory variable, likely influenced by differences in roles and children activities' preferences. It is necessary to improve the knowledge on native species, particularly those with conservation problems by using information sources close to nature, without neglecting the knowledge of the exotic species that children showed more familiarity from everyday life.

1. Introduction

Conservation of biodiversity not only requires proactive measures, such as the establishment of protected areas, legal regulations for the use of natural resources, and the control of introduced species, but also the dissemination of public information and education about native organisms, their value and the consequences of human activities on local biodiversity (Colton and Alpert, 1998; Pimbert and Pretty, 1995; Trombulak et al., 2004). Achievements of conservation projects could improve if they strongly incorporate communication and biodiversity education components in their design (González Gaudiano, 2002).

Although, in a broad sense, biodiversity education involves not only scientific-ecological aspects but also emotional, ethical and political aspects (Kassas, 2002), there is knowledge that people must have to achieve biodiversity literacy, like knowing native plants and animals (Lindemann-Matthies, 2002; Weilbacher, 1993). Increasing literacy will lead to change in behaviour or action regarding biodiversity and environmental issues (Sudarmadi et al., 2001).

For a long time, accumulated knowledge about species was an important part of people's capacity to manage and conserve the environment. Some studies show that ecological knowledge relative to the names of species and their uses is related to the level of resource dependence and frequency of environmental interactions. For this reason, people from less industrialized countries and from more rural communities gain more ecological knowledge (Chand and Shulka, 2003; Pilgrim et al., 2007; Reyes-García et al., 2005). Then, the place of residence could be an important explanatory factor for predicting environmental perception and concern on a local level but not necessarily on a regional/national level (Vorkinn and Riese, 2001). However, mass communication,

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standardized education, and increasing convergence of lifestyles between rural and urban populations might even out the above shown differences in ecological knowledge (Bogner and Wiseman, 1997; Lowe and Pinhey, 1982).

People's knowledge and perception of local biodiversity and concern for environment could be influenced also by their age and gender. In general, children's perception and knowledge of local plants and animals is poor and they are generally aware of only a few species (Balmford et al., 2002; Lindemann-Matthies, 2002; Lindemann-Matthies, 2006; Lindemann-Matthies and Bose, 2008; Nates et al., 2010). Children are more interested in animals than plants (Flannery, 1991; Hershey, 1996) and, as a consequence, know less about plants and have more difficulties in naming them than in naming animals (Lindemann-Matthies, 2002; Ryman, 1974; Wandersee and Schussler, 1999). Studies have shown that familiarity with organisms increases with increasing age, attitudes regarding animals change during childhood and girls in all age-groups are more aware of and also know more about animals and plants (Kellert, 1985; Lindemann-Matthies, 2002; Nates et al., 2010).

Children currently have their initial contact with species and learn about biodiversity from a wide variety of sources of information including: visits to settings such as protected areas, aquariums, natural centres, zoos, botanic gardens, museums, ecotourism sites, etc.; keeping pets and plants at home; watching films, videos and nature specials on television; seeking out environmental information on the Internet; reading books, newspapers, magazines; and through conversations with teachers, friends and family (Falk, 2005).

Little is known about children's knowledge regarding biodiversity in Argentina, except some studies that analysed the students' preferences and perceptions of animals and plants in Valle Fértil (San Juan Province; Nates et al., 2010), and perception of animals with conservation issues in the Puna (Barbarán, 2004), and in the High Andes (Lucherini and Merino, 2008). The present study is the first to investigate how differences in the familiarity and initial contact with species can be explained by the place of residence (urban or rural), sex and age of students in an arid environment of Argentina. The study provides baseline data for local conservation activities and contributes to international research on children's perception and knowledge of biodiversity (e.g. Balmford et al., 2002; Bebbington, 2005; Lindemann-Matthies, 2002; Woods, 2000).

Our main objectives were (1) to investigate which species children are familiar with, (2) to analyse the effect of place of residence, sex and age on students' knowledge and initial contact with species. Derived from literature, we put forward the following hypotheses:

(1) Irrespective of place of residence, sex and age, students will especially know exotic species. Several studies have shown that both children and adults know best (and like most) pets such as cats and dogs, large and charismatic vertebrates such as dolphin, koala or panda (Bell, 1981; Entwistle and Dunstone, 2000; Kellert, 1985; Morris and Morris, 1966; Nates et al., 2010; Woods, 2000), and showy gardens or decorative plants with large, colourful and fragrant flowers such as roses (Lindemann-Matthies, 2005; Paraskevopoulos et al., 1998; Scherf, 1988).

(2) Students from rural areas will know more local native species than those from urban areas, due to more direct interactions with the natural environment (see Chand and Shulka, 2003; Pilgrim et al., 2007). Urban children, who get their information from sources other than nature, will have more familiarity with regional native species.

(3) In rural communities of Argentina, gender roles are strictly defined, with boys helping their fathers with farming and girls helping their mothers with home duties (Nates et al., 2010). We therefore assumed that students from rural areas will know more useful species, with boys focusing on domestic animals and girls on garden plants. Also, rural boys and younger children will be more familiar with birds, reptiles/amphibians/fish, invertebrates and wild plants because boys show more affinity with wild nature (Badarraco, 1973; Kellert and Berry, 1987). Girls were found to show a greater affection for large, attractive pet animals whereas boys showed a greater interest in wildlife (Kellert, 1985; Kellert and Berry, 1987; Lindemann-Matthies, 2005; Nates et al., 2010).

2. Material and methods

2.1. Study site

Mendoza Province is located in the central-west of Argentina, between 32° and 37° 35′S, and 66° 30′ and 70° 35′W, and it is included mainly in the Monte ecoregion. This ecoregion is increasingly affected by an intensive exploitation of natural resources, overgrazing by domestic livestock, overhunting, and the introduction of non-native species (Brown et al., 2006; Bucher, 1987; Novillo and Ojeda, 2008; Ojeda and Mares, 1999; Ojeda et al., 2002). The Monte has been proposed as a priority biome for biodiversity conservation because of the high number of endemisms, the vulnerability of some animal species and the rapid drop in wildlife population, the loss of ecosystem services, and the small extent of land occupied by protected areas (Ojeda et al., 2002; Vilela et al., 2009).

Within this land-use scenario, several native animals should be included in conservation categories and in the Appendices of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), such as guanaco (*Lama guanicoe*), cóndor (*Vultur gryphus*), mara (*Dolichotis patagonum*), vizcacha de la sierra (*Lagidium viscacia*), ratas cola de pincel (*Tympanoctomys barrerae* and *Octomys mimax*), pichiciego (*Chlamyphorus truncatus*), rheas (*Rhea americana* and *Pterocnemia pennata*), lagarto colorado (*Tupinambis rufescens*), boa (*Boa constrictor*) (Barquez et al., 2006; CITES, 2011; Diaz and Ojeda, 2000; García Fernández et al., 1997; Ojeda and Diaz, 1997), some of which are protected by legal regulations (Vilela et al., 2009). Moreover, native plant species which have been traditionally used by rural people as sources for food, timber, firewood, wax, gum, or medicine (Ladio and Lozada, 2009; Vilela et al., 2009) are now threatened by an economic land use mainly based on cultivation of exotic species, and on the husbandry of introduced livestock such as cows, sheep and goats.

In Mendoza Province, the Andes mountains influence river systems, rainfall regime and aridity conditions, namely surface and groundwater supply (Abraham et al., 2009). Since the end of the 19th century important landscape transformation occurred when hydraulic infrastructure constructions were developed, using old ditch networks made by prehistoric dwellers (Bárcena, 2001). These oases cover only 3% of the territory, but harbour almost 99% of the human population. Non-irrigated lands are described as marginal, unproductive, unobserved or integrated into irrigated lands in a condition of subordination (Abraham et al., 2009; Ladio and Lozada, 2009).

2.2. Data collection

Data were collected during 2007 and 2008 in 25 urban schools (39 classes, 1103 students) and 19 rural ones (19 classes, 643

students) with the help of a written questionnaire. In total, 1746 students (915 girls and 831 boys) participated in the study. They were between 7 and 18 years old, and 9 year olds were the largest group (24.4% of total; Table 1). The curriculum of natural sciences and biology in the Province includes some contents related to biodiversity in Argentina and Mendoza, and adaptations of organisms to different environments, but outdoor activities, such as field trips, are rarely developed in schools.

In the questionnaire students were asked to write down ten animals and ten plants. They were then asked to indicate for each animal and plant they had listed, where they had seen it for the first time (initial contact with species). Pre-given answer options for plants were 'garden', 'park', 'television', 'Internet', 'books/magazines', 'field'. Possible answers for animals added 'zoo' (Appendix). Moreover, students were asked about their sex and age. The place of residence (urban or rural) was established by the school location. According to the official list made by the General Direction of Schools of Mendoza Province, rural schools have low number of students and teachers and are placed in small towns with less than 2000 inhabitants.

2.3. Data analysis

The taxa that students had written down were sorted, not mutually exclusive, into categories: native (at local and regional levels), exotic, domestic animals, wild plants, ornamental plants, and food plants. We considered as 'native species at local level' those species originated from Mendoza Province such as guanaco (*L. guanicoe*), puma (*Puma concolor*), foxes (*Pseudalopex griseus*, *Pseudalopex culpaeus*), mesquite (*Prosopis* spp.), jarilla (*Larrea* spp.), and chañar (*Geoffroea decorticans*). The category 'native species at regional level' comprised native species of Mendoza plus species that occur in Argentina (e.g. giant anteater *Myrmecophaga tridactyla*, Magellanic penguin *Spheniscus magellanicus*, Peruvian pepper tree *Schinus molle*). The category 'exotic species' included species non-native to Argentina, such as pets, animals living in zoos (lion, tiger, etc.), feral species (e.g. hare *Lepus europaeus,* wild boar *Sus scrofa*), or plants cultivated by man. Included in the category 'domestic animals' were species that live in close relationship with man and depend on him for their survival, such as pets and livestock. The plants were grouped as 'wild' (species not cultivated by man), 'ornamental plants' (species cultivated in gardens or parks), and 'food plants'.

Additionally, animals named were divided, by using a scientific identification key, into 'invertebrates', 'fish, amphibians and reptiles', 'birds', and 'mammals'. The category 'undetermined species' included taxa that were not further specified at the family, genus or species level, such as 'birds', 'trees', 'flowers'.

Analyses were conducted with R statistical software version 2.11.1 (R Development Core Team, 2010; http://www.r-project.org/). The response variables (number of native species mentioned, number of mammals, number of times each source of information is cited, etc.) were proportion data (e. g. number of native animals named in relation to the total animals mentioned by each child, number of times that the source garden is mentioned for native animals in relation to the total sources cited for native animals). We used generalized linear mixed models (GLMM) with a binomial error structure because the data were strictly bounded proportions, the variance was not constant and the errors were non-normal (Crawley, 2007). Models were fitted by Laplace approximation and a log-link function was applied, using the lmer function of R's lme4 package. The significance of fixed factors was tested using Wald statistical test. The sign of parameters having significant effects was used to interpret the results (Bolker et al., 2008; McCulloch and Searle, 2001).

We assessed whether the explanatory variables 'place of residence' (urban or rural; categorical variable), 'sex' (male and female; categorical variable), and 'age' (from 7 to 18 years old; numerical variable) affected each response variable. For each response variable, we fitted generalized linear mixed models with place of residence, sex (with two levels each) and age as fixed factors, considering also the interaction between place of residence and sex. Students within classes and classes within schools were considered random factors. In cases where the interaction of place of residence with sex had an influence, new models were included for each level of place of residence (rural and urban), now using the factor sex as fixed factor.

The Akaike Information Criterion (AIC) was used to assist in model selection (i.e. those being more parsimonious and with a better fit, minimizing the AIC values). Models were derived using backward selection. We started with a full model and at each step the most non-significant variable, i.e. the variable with the highest *P*-value on the basis of the results of Wald tests ($P < 0.05$), was removed. This procedure was reiterated until obtaining the model with the lowest AIC (Burnham and Anderson, 2010).

3. Results

3.1. Familiarity with species

Overall, less than half of the participating students could name ten animals (47%) and ten plants (32%), as requested. However, only 26 students could name no animal or plant at all. Children were able to give 13,731 responses about animals and 11,916 responses for plants, in which 477 different taxa (220 animals and 257 plants) were named, with dogs and roses being the most common (Table 1).

Only two of the ten most frequently named animals could be considered native (4.9% of all responses included 'monkey' and 'birds', the latter a not further specified taxon). Children were able to name 104 local native animals, 133 regional native and 87 exotic animals. Considering the general taxonomic groups, students named

Table 1
The ten most frequently taxa of animals and plants mentioned by 1746 students from Mendoza Province. Ten answers for animals and 10 for plants were requested. Overall, 13,731 responses for animals and 11,916 responses for plants were given. *denotes taxa that were not further specified.

Animals	Frequency (%)	Plants	Frequency (%)
1) Dog (*Canis familiaris*)	1287 (7.4)	1) Rose (*Rosa* spp.)	1290 (7.4)
2) Cat (*Felis silvestris*)	1040 (6.0)	2) Cactus (Cactaceae)	947 (5.4)
3) Lion (*Panthera leo*)	756 (4.3)	3) Jasmine (*Jasminus* spp.)	699 (4.0)
4) Horse (*Equus caballus*)	737 (4.2)	4) Daisy (*Bellis perennis*)	590 (3.4)
5) Monkey (Primates)	465 (2.7)	5) Jarilla (*Larrea* spp.)	537 (3.1)
6) Cow (*Bos taurus*)	403 (2.3)	6) Sunflower (*Helianthus annuus*)	477 (2.7)
7) Bird*	387 (2.2)	7) Pine (*Pinus* spp.)	370 (2.1)
8) Tiger (*Panthera tigris*)	385 (2.2)	8) Willow (*Salix* spp.)	319 (1.8)
9) Elephant (*Elephas maximus* and *Loxodonta africana*)	340 (1.9)	9) Poplar (*Populus* spp.)	294 (1.7)
10) Rabbit (*Oryctolagus cuniculus*)	326 (1.9)	10) Mesquite (*Prosopis* spp.)	280 (1.6)

95 mammals, 61 birds, 29 fish/amphibians/reptiles, and 33 invertebrate species (Table 2). They named also undefined taxa, such as 'bird' or 'bugs' (3.34% of total responses). Native species included in conservation categories and CITES Appendices were mentioned with low frequency, for example guanaco (0.5% of total responses), rheas (0.5), cóndor (0.6), mara (0.1), and rata cola de pincel (0.04).

Three out of the ten most frequently named plants were native (10% of all responses included cactus, jarilla *Larrea* spp., mesquite *Prosopis* spp.). Children were able to name 47 local native plants, 64 regional native plants, and 193 exotic plants. They mentioned 162 ornamental plants (such as rose, jasmine, daisy), 67 food plants (orange, apple tree, lemon) and 64 wild plants (acacia *Acacia* spp., clavel del aire *Thylandsia* spp., coirón *Stipa* spp.) (Table 2).

3.2. Influence of social-demographic variables on students' knowledge and initial contact with species

Overall, gardens, and in the case of animals also zoos, were most often indicated as the initial settings where students become acquainted with animals and plants at least the ones they had recorded (Table 3). Place of residence, sex and age explained differences in sources of knowledge of animals mentioned by students. In the rural study population, the countryside was an important place where students became acquainted with animals (GLMM: $\chi^2 = 4.75$; $P < 0.001$). In the urban study population, the focus was more on zoos in case of animals (GLMM: $\chi^2 = 2.00$; $P = 0.045$) and books in case of animals (GLMM: $\chi^2 = 2.74$; $P = 0.006$) and plants (GLMM: $\chi^2 = 3.34$; $P < 0.001$). Male students more often associated the countryside with the species they were familiar with (GLMM animals: $\chi^2 = 4.64$; $P < 0.001$; GLMM plants: $\chi^2 = 5.22$; $P < 0.001$), whereas female students more often indicated the garden (GLMM animals: $\chi^2 = 2.61$; $P = 0.008$; GLMM plants: $\chi^2 = 3.17$; $P < 0.001$). The younger the students were, the more likely to be acquainted with animals and plants through TV (GLMM animals: $\chi^2 = 3.71$; $P < 0.001$; GLMM plants: $\chi^2 = 6.48$; $P < 0.001$) or Internet (GLMM animals: $\chi^2 = 3.83$; $P < 0.001$), and the less likely to be acquainted with species through direct experience in the countryside (GLMM animals: $\chi^2 = 3.51$; $P < 0.001$; GLMM plants: $\chi^2 = 2.08$; $P = 0.037$) or gardens (GLMM animals: $\chi^2 = 2.27$; $P = 0.022$; GLMM plants: $\chi^2 = 2.31$; $P = 0.021$).

Rural and urban boys were more familiar than girls with local native species, and while boys named the countryside as a place where they first met with local animals, girls cited gardens (Table 4). Rural boys was the group that more often mentioned regional native species, and girls named exotic animals and plants significantly more often than boys, especially in rural places. With increasing age, boys cited the countryside as a source of knowledge about exotic species, and girls used the garden as source of knowledge of exotic plants. The park, books, TV and the Internet were the sources of knowledge about exotic species more used by younger children (Table 4).

Neither place of residence, nor sex nor age explained the children's familiarity with mammals. Birds were more familiar to rural children (GLMM: $\chi^2 = 3.39$; $P < 0.001$) and boys (GLMM: $\chi^2 = 2.15$; $P = 0.031$), particularly rural boys (GLMM: $\chi^2 = 3.39$; $P < 0.001$), and increasingly with age (GLMM: $\chi^2 = 2.47$; $P = 0.013$). Fish, amphibians and reptiles were named more times by boys than girls (GLMM: $\chi^2 = 2.67$; $P = 0.007$), and by younger children (GLMM: $\chi^2 = 2.30$; $P = 0.021$), whereas invertebrates were more frequently mentioned by urban children (GLMM: $\chi^2 = 2.58$; $P = 0.009$). The children's place of residence and sex affected the number of domestic animals mentioned. Rural children (GLMM: $\chi^2 = 2.34$; $P = 0.019$) and girls (GLMM: $\chi^2 = 4.99$; $P < 0.001$) were more familiar with domestic animals.

Finally, sex affected the familiarity of children with ornamental plants and wild plants. Girls mentioned more ornamental plants (GLMM: $\chi^2 = 6.43$; $P < 0.001$), whereas boys were more familiar with wild plants (GLMM: $\chi^2 = 4.51$; $P < 0.001$).

Table 2
Species named by 1746 students from Mendoza Province. Students were asked to write down ten animals and ten plants. Overall, 220 different taxa of animals and 257 different taxa of plants were recorded. The taxa were grouped into broad categories, and the three most frequently named organisms among 'native' and 'exotic' categories are shown. *denotes taxa that were not further specified.

Group of taxa	Proportion of responses (%)
Animals	
Local native: birds*, snakes*, fox (*Pseudalopex griseus*)	32.83
Regional native: monkey*, bat*, tucán (*Ramphastos* spp.)	39.03
Exotic: dog, cat, lion	60.97
Domestic animal	34.29
Invertebrate	4.89
Fish, amphibian and reptile	9.13
Bird	17.64
Mammal	68.3
Plants	
Local native: cactus*, jarilla (*Larrea* spp.), mesquite (*Prosopis* spp.)	23.98
Regional native: Peruvian pepper tree (*Schinus molle*), araucaria (*Araucaria* spp.), Chilean myrtle (*Luma apiculata*)	32.8
Exotic: rose, jasmine, daisy	67.2
Wild plant	25.99
Ornamental plant	78.65
Food plant	20.26

Table 3
Initial contact with species. Students in Mendoza Province ($N = 1746$) were asked to write down ten animals and ten plants and to indicate where they had seen each organism for the first time. Overall 11,478 responses for animals and 10,148 responses for plants were given.

Sources of knowledge	Proportion of responses (%)
Animals	
Garden	25.19
Park	7.38
Television	10.58
Internet	5.73
Books/magazines	8.18
Countryside	17.32
Zoo	25.62
Plants	
Garden	40.03
Park	16.04
Television	9.72
Internet	6.74
Books/magazines	8.43
Countryside	19.03

4. Discussion

Knowledge of biodiversity, expressed through the naming of species with which the students are familiar, provides an indication of the people's connectivity to the local environment (Pilgrim et al., 2007). Children may only have learnt and remembered the names of species they found attractive, or had direct experience with (Lindemann-Matthies, 2005), and the sources of ecological knowledge used can involve more or less direct contact of students with nature. In general, children were able to name an important number of species (almost 500 species) but their familiarity was mostly with exotic animals and plants. The species most familiar to children were the same as in the rest of the world: pets, ornamental

Table 4
Effect of place of residence (P; U: urban, R: rural), sex (S; M: male, F: female) and age (A) of children on proportion of native species (at local and regional levels) and sources of knowledge mentioned. GLMM included P, G and A as fixed factors, and school/grade as random factor. Non-significant effects were not included. Akaike's Information Criterion (AIC) values and significance for the overall models; value, S.E. and significance ($P < 0.05$; Wald test) for effect coefficients are shown.

	Whole model		Factors				
	AIC	*P*	Effect	Coefficient	S.E.	Wald's	*P*
Local native animals	2570	0.000	S (M > F)	0.33	0.06	5.17	0.000
Countryside	1523	0.000	S (M > F)	0.64	0.14	4.65	0.000
			A (+)	0.07	0.02	3.30	0.000
			P*G	0.40	0.17	2.32	0.020
Garden	1650	0.000	S (M < F)	−0.71	0.14	−5.02	0.000
			P*G	0.59	0.17	3.47	0.000
Local native plants	2096	0.000	S (M > F)	0.36	0.07	4.86	0.000
			P*S	0.23	0.09	2.42	0.015
Countryside	1623	0.045	P (U < R)	−0.63	0.13	−4.77	0.000
			A (+)	0.07	0.02	3.55	0.000
Garden	1235	0.000	P (U > R)	0.59	0.15	4.02	0.000
Regional native animals	2367	0.000	S (M > F)	0.27	0.06	4.38	0.000
			P*S	0.24	0.08	3.15	0.001
Books	1389	0.006	P (U > R)	0.40	0.12	3.44	0.000
TV	1332	0.000	A (−)	−0.08	0.02	−3.90	0.000
Internet	1074	0.000	A (−)	−0.09	0.02	−3.49	0.000
Regional native plants	2095	0.000	S (M > F)	0.27	0.07	4.00	0.000
			P*S	0.20	0.08	2.33	0.019
TV	1035	0.000	A (−)	−0.10	0.03	3.60	0.000
Exotic animals	2367	0.000	S (M < F)	−0.27	0.06	−4.39	0.000
			P*S	0.24	0.08	3.15	0.001
Countryside	1523	0.000	S (M > F)	0.64	0.14	4.65	0.000
			A (+)	0.07	0.02	3.30	0.000
			P*S	0.40	0.17	2.32	0.020
Garden	1601	0.000	A (+)	0.05	0.01	3.47	0.000
Park	1253	0.000	A (−)	−0.07	0.02	−3.56	0.000
Exotic plants	2095	0.000	S (M < F)	−0.27	0.07	−4.00	0.000
			P*S	0.20	0.08	2.33	0.019
Countryside	1661	0.000	S (M > F)	0.31	0.08	4.06	0.000
Garden	2017	0.000	S (M < F)	−0.14	0.05	−2.83	0.005
			A (+)	0.06	0.01	4.19	0.000
Books	1239	0.000	P (U > R)	0.45	0.12	3.69	0.000
			A (−)	−0.05	0.02	−2.41	0.015
TV	1344	0.000	A (−)	−0.09	0.02	−4.56	0.000
Internet	1210	0.001	A (−)	−0.05	0.02	−1.99	0.046

plants and charismatic mammals (as predicted; see hypothesis 1). Other studies have also shown that children, but also adults, are most familiar with 'loveable animals', i.e. large mammals similar to humans in appearance and behaviour, with considerable intelligence and capacity for social bonding (e.g. Kellert, 1985; Lindemann-Matthies, 2005; Morris and Morris, 1966; Nates et al., 2010; Paraskevopoulos et al., 1998; Patrick and Tunnicliffe, 2011; Woods, 2000) and attractive plants, i.e. garden or decorative plants with large and colourful flowers, conspicuous fruits, nice scents, and overall beauty (Lindemann-Matthies, 2005; Scherf, 1988; Tunnicliffe, 2001). From a phylogenetic point of view it has been assumed that brightly coloured flowers, fruits or leaves might have signalled 'food' for people in ancient times (Heerwagen and Orians, 1993).

Students could list more plant than animal taxa. This is an interesting result because previous studies have shown that students know less about plants than animals and have more difficulties in naming them (Lindemann-Matthies, 2002; Ryman, 1974; Wandersee, 1986). Rural children from Mendoza were familiar with almost 200 plant species, in comparison with the 116 plant species named by rural children from the neighbouring province of San Juan. But rural children from San Juan knew more native plants (56 species; Nates et al., 2010) than did rural children from Mendoza (34 species). Among the ten most frequently named plant taxa were three local native ones. These taxa are typical for the Monte region and children might have learnt about them in school. Moreover, the jarilla (*Larrea divaricata*) was declared Provincial Flower in 2006 (Law 7618; http://www.tribunet.com.ar/tribunet/ley/7618.htm). Almost 80% of the plants listed were ornamental ones.

In a broad sense, the initial contact with all species occurred in the countryside in the case of rural students, and through the zoo and books in the case of urban students. But we had expected (see hypothesis 2) a strong effect of the children's place of residence not only on the initial contact but also on their familiarity with native and exotic species: rural children more familiar with local native species using sources closer to nature (such as countryside, garden), and urban children more familiar with regional native and exotic species getting information from sources other than nature (urban park, zoological garden, books, TV, Internet). However, we could find no such direct correlation. The children's place of residence did not by itself affect the familiarity with native species, but its interaction with sex and sex alone were the most important explanatory factors: boys were more familiar than girls with native plants and animals, particularly in rural places. The observed affinity of boys towards native and wild species is supplemented with mention of countryside as the place of initial contact. On the other hand, girls were familiar with exotic species and used the garden as a source of knowledge.

Although it has been argued that rural inhabitants of the Monte desert preserve their traditional ecological knowledge because they are familiar with native species and have used them since before the European colonization (Abraham et al., 2009; Ladio and Lozada, 2009; Vilela et al., 2009), we did not find a strong influence of place

of residence in the familiarity of children with native biodiversity. It could be that traditional ecological knowledge is only preserved in small and isolated places in the most arid sites of Mendoza Province, i.e. places that were not included in our study sample. But currently the economy is based on production of exotic crops of Mediterranean origin, and on livestock husbandry (Vilela et al., 2009), and most of the communities might have lost their ancestral knowledge, acquired over hundreds of years of cultural learning, or practical experimentation (Ladio and Lozada, 2009). In addition, rural and urban populations are highly concentrated in oases where native habitats were transformed and native biodiversity was replaced by species that thrive in human-dominated landscapes. As a result, the people live increasingly disconnected from wild nature (Miller, 2005) and native animals and plants. Contradictory results or a trend towards the disappearance of rural-urban discrepancies were also observed in different environmental issues, such as environmental concern, attitudes, perception, values, and behaviours (e.g. Berenger et al., 2005; Bogner and Wiseman, 1997; Huddart-Kennedy et al., 2009).

With regards to age, young children more often than older ones indicated mass media and books as their source of knowledge. This might reflect an increasing lack of opportunities for children to become familiar with animals and plants through outdoor experiences and direct observation of plants and animals (Lindemann-Matthies, 2006). Moreover, family lifestyles might have changed: more time is currently spent by both children and adults in front of TV and computer, and fewer hours are spent outdoors (Louv, 2005). Nevertheless, the use of mass media as a source of knowledge could also reflect the increasing production in recent times of educational television programs about regional topics in Argentina. Mass media play a pivotal role in shaping public opinion through TV, radio, and the press, and they are powerful instruments for changing public attitudes (Sudarmadi et al., 2001).

As predicted (hypothesis 3) for rural schools, differences between genders in perception of and preferences for species could be explained by the strict definition of roles: boys help their fathers with farm work and girls stay at home helping their mothers with home duties (Nates et al., 2010). Then, girls get to know species using the vicinity of their homes as source (i.e. garden) and boys become familiar with species from the countryside. Young girls, through an aesthetic and anthropomorphic orientation, are familiar with domestic pets, charismatic mammals and plants with flowers (Badarraco, 1973). The same humanistic attitude was manifested by adult women, who also presented fear and low interest towards wildlife (Kellert and Berry, 1987).

Regarding the children's familiarity with different taxa, some of our results were in line with our predictions (hypothesis 3). Almost 70% of the animals named were mammals, and all groups of children were familiar with mammals. It has been shown that familiarity and preferences tend towards organisms closer to humans, animals able to make eye contact, communicate by sound and interact with humans (Morris and Morris, 1966). Birds were the second most mentioned group in accord with Badarraco (1973). As we expected, rural children, particularly boys, were more familiar with birds, and familiarity increased with age. In the countryside, the hunting of songbirds for commercial purposes is a frequent activity, although illegal, and it is carried out mainly by boys.

Vertebrates such as reptiles, amphibians and fish, but also invertebrates were only rarely listed, and these taxa were familiar to young boys. Possible reasons are that invertebrates, despite their ecological importance, are hardly known to the public, and that people express aversion, dislike, or fear towards certain reptiles, insects and spiders (Kellert, 1993). In consequence, they might not want to list them on paper. Snakes, for instance, are considered slimy, slippery, dirty, poisonous and dangerous, and invertebrates are disliked in general (Morris and Morris, 1966; Nates et al., 2010). It has been argued that humans have an innate fear and avoidance of potentially dangerous or harmful animals related to human disease and crop predation (Kellert, 1993). The present study showed an overall low familiarity with invertebrates, particularly in rural children. Rural children were familiar with birds and domestic animals, probably because of a more utilitarian attitude towards species (Nates et al., 2010). For urban children, instead, invertebrates may represent the animal group easiest to observe in the garden, or in the park.

Biodiversity and conservation need to be linked in different settings, such as schools, museums, and educational programs in the mass media (radio, TV, cinema, internet). In schools, for example, the science curriculum should contemplate the knowledge and appreciation for threatened species and not be confined only to the exotic and well known animals, but also include both plants, small organisms as well as large obvious ones (Gayford, 2000; Lindemann-Matthies, 2002.), and native species affected by local environmental issues. Also the mass media are effective tools for education with great potential to bring the environmental message to homes and schools.

5. Conclusion

In conclusion, familiarity with species and the use of different sources of information can be explained by interactions between the studied factors. More familiar species included exotic plants and animals, although children were able to name almost the same number of native and exotic animals. Place of residence was not as important as we expected probably because both the rural and urban populations are concentrated in oases where exotic species prevail. Differences in familiarity because of sex were important in some cases and explained by differences in roles and in activity preferences. The use reported by young children of sources of knowledge that are far from nature is an important 'warning sign' because children's knowledge on biodiversity improves when the amount of time spent on the investigation of species outside the classroom increases. The near vicinity of the school and the school yard are valuable settings for investigation and enquiry in nature, both in urban and rural areas, and children become familiar with the natural history of their local environment (Feisinger et al., 1997; Patrick and Tunnicliffe, 2011). Repeated visits to a site were found to produce the best learning results at all ages, but particularly for young people (Lindemann-Matthies, 2006).

Faced with this situation, we consider it important to enhance the efforts of the school, the family, environmental organizations, etc. to improve the knowledge on native species, particularly those with conservation problems, using as sources of information those closest to natural settings, without neglecting the knowledge of the urban species that children live with on a daily basis.

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Appendix. Questions asked to 1746 students from Mendoza Province.

- School/Class.
- How old are you?
- Are you a girl or a boy?
- Write down 10 plants you know.
- Indicate the place where you saw each plant for the first time ('garden', 'park', 'television', 'Internet', 'books/magazines', 'field').
- Write down 10 animals you know.
- Indicate the place where you saw each animal for the first time ('garden', 'park', 'television', 'Internet', 'books/magazines', 'field', 'zoo').

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