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Feeding habits of Molina's hog-nosed skunk in the Pampas grassland of Argentina

Abstract: We studied the feeding ecology of Molina's hog-nosed skunk (*Conepatus chinga*) in a protected area of the Pampas grassland by comparing the content of scats (140 samples) to prey abundance (estimated by invertebrate capture rates from 38 pitfall trap grids). Fecal analysis supported a largely insectivorous diet, with small vertebrates and carrion representing minor alternative resources. Almost all invertebrate prey was significantly more abundant in the warm period than the cold period, whereas skunk diet did not vary seasonally. Even though Molina's hog-nosed skunks were considered to be opportunistic foragers due to their wide trophic niche, our results indicate that despite their trophic generalism, they consumed several prey items in proportions differing from those expected by their respective availabilities.

Keywords: carnivore; *Conepatus chinga*; diet; fecal analysis; prey selection.

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Introduction

Molina's hog-nosed skunk (*Conepatus chinga*, Molina 1782) is a mammalian carnivore belonging to the family Mephitidae (Dragoo and Honeycutt 1997). Its distribution ranges from Argentina and Chile to Bolivia, Perú,

Paraguay, Uruguay and southern Brazil (Dragoo 2009). Previous dietary studies (Travaini et al. 1998, Donadio et al. 2004, Medina et al. 2009) demonstrated that *C. chinga* represents a generalist, insectivorous predator that consumes mostly beetles.

In general, small carnivores are known to exploit a variety of food resources and may switch between prey types in order to adjust to local fluctuations in food abundance (Hanski et al. 1991, Ray 1998). Despite these varied diets, small carnivores or predators in general can often be categorized as either opportunistic or selective predators. An opportunistic predator consumes prey in a similar proportion to its relative abundance in the patch where it hunts, whereas a selective predator consumes particular prey species disproportionately to their local abundance (Jacksic 1989).

Two additional terms often used to describe the hunting behavior of predators, generalist and specialist, are related to their trophic niche breadth. Typically, a generalist predator (i.e., a predator with a wide trophic niche) relies on opportunistic feeding habits, whereas a specialist predator (i.e., one that has a narrow trophic niche) maintains more selective feeding habits (Jacksic 1989). However, exceptions to this pattern do exist (e.g., opportunistic specialists) (Elmhagen et al. 2000, Zhou et al. 2011), making it necessary to compare diet composition with prey abundance to effectively classify a predatory species according to its hunting behavior.

Here we present the first study comparing the diet composition of Molina's hog-nosed skunk to prey abundance on a seasonal basis. We predicted that if *Conepatus chinga* has developed strategies similar to those of other small carnivores (De Marinis and Masseti 1995, Zapata et al. 2001, Cabral et al. 2010), it would exhibit temporal variation in its diet in accordance to seasonal fluctuations in prey abundance. Also, if Molina's hog-nosed skunks are opportunistic foragers as described by Travaini et al. (1998) and as reported for other skunks (Zapata et al. 2001, Rosatte and Larivière 2003), we expected that on the basis of random encounters, the proportion in the diet of a given available prey should reflect its abundance.

Materials and methods

Study area

We conducted our study at Ernesto Tornquist Provincial Park (ETPP, Figure 1), located in the central part of the Ventania mountain range (38°00'S, 62°00'W), southern Buenos Aires province, Argentina. ETPP covers an area of approximately 6700 ha with a maximum altitude of 1240 m. The climate is temperate with mean annual precipitation of 500–800 mm (Frangi and Bottino 1995). This area is part of the Pampas ecoregion (Olson et al. 2001), and vegetation is mostly characterized by native grassland (Zalba and Villamil 2002). The vegetation in the study area was deeply affected by the presence of a dense population of feral horses that fed on natural grasses (Scorolli et al. 2006).

Diet analysis

We determined the diet composition of *Conepatus chinga* by identifying food remains in scats that were opportunistically collected from November 2003 to February 2005. Scats were identified to species on the basis of morphology, smell, associated footprints and ingested hairs. Most scats were located inside dens where other signs of skunk presence were recorded.



Figure 1 Study area location in Argentina, Ernesto Tornquist Provincial Park (ETPP).

Scats were washed in a 0.5-mm sieve under hot water and all remains were separated and identified (Reynolds and Aebischer 1991). For dietary analysis, we grouped trophic items into 14 categories: large mammals (horse carrion and hares), small mammals (rodents), Coleoptera, Orthoptera, Isopoda, Araneae, Scorpiones, Hymenoptera, Miriapoda, Mollusca, Coleoptera larvae, Lepidoptera larvae, non-identified invertebrates and plant material.

Results were expressed as frequency of occurrence (FO, percentage of the total number of scats), numerical frequency (NF, percentage of the total number of occurrences of all food items) (Reynolds and Aebischer 1991, Paltridge 2002) and percent volume (PV, visual estimation of the percent dry volume of each prey item in each scat) (Angerbjörn et al. 1999, Elmhagen et al. 2000). In order to minimize the individual biases of the three methods used to estimate diet composition, we used the index of relative importance (IRI) (Paltridge 2002, Home and Jhala 2009), where $IRI = (NF + PV) \times FO$. To test if the diet was influenced by seasons, we split the study period into a warm (January–March and October–December) and a cold season (April–September). IRI scores for the different prey items obtained in each season were resampled with 1000 iterations using R 2.7.1 (R Development Core Team 2008) to generate means and bias-corrected 95% confidence intervals in order to compare seasonal diets. Additionally, we calculated dietary overlap between the two seasons (O) as $O = \sum p_i q_i / (\sum p_i^2 \sum q_i^2)^{1/2}$, where p_i is the NF of food item i in the warm season and q_i is the NF of food item i in the cold season (Pianka 1975). O ranges from 0 (no overlap) to 1 (total overlap).

Prey abundance

On the basis of foraging habits of other skunk species and previous information available for *Conepatus chinga* (Travaini et al. 1998, Donadio et al. 2004, Medina et al. 2009), we used pitfall traps to assess the availability of invertebrates at ground level. The traps were placed in 20 m×20 m grids, each one consisting of nine plastic containers of 10 cm in diameter and 7 cm deep, filled with salt water solution and placed in pits deep enough to bury the cups up to the rim. We deployed a total of 38 grids (warm season=18, cold season=20) and distributed them randomly as to sample all the main habitats of the study area. Grids were active for three consecutive nights. Captured invertebrates were collected and identified on the basis of morphological characteristics using Birochio (2008) as a reference. Prey abundance was calculated as the average number of individuals captured per grid.

Prey selection

Consumption of prey by skunks and the availability of each prey category were compared seasonally by Ivlev's electivity index (D) modified by Jacobs (1974). The index is calculated as follows: $D=(n-p)/(n+p-2np)$, where n and p are the respective proportions of each prey in the hog-nosed skunk diet (NF) and in the environment. D values range from -1 (total avoidance of a food item) to 0 (use proportional to its availability), and 1 (maximum selection). Additionally, we calculated Bonferroni's simultaneous confidence intervals (Byers et al. 1984). For statistical procedures (Mann-Whitney and t-test), values of $p \leq 0.05$ were considered significant.

Results

Diet composition

We collected and analyzed 140 scats. The mean (\pm SD) number of food items per scat was 3.41 ± 1.31 (minimum=1 and maximum=8). Only 5.7% of the scats contained a single prey item. Invertebrates were found in all scats and were also the main food resource in terms of volume. Plant remains and vertebrate prey (rodents, hares and horse carrion) occurred in 25% and 18.6% of the scats, respectively, but were less important when results were expressed as PV (Table 1).

Among insects, coleopterans predominated the diet of *Conepatus chinga* (Table 1), followed by Coleoptera and Lepidoptera larvae and plant material. Scorpions were present in 41.4% of the feces, but their volume contribution was small (Table 1). IRI scores were the highest for Coleoptera followed by both types of larvae (Coleoptera and Lepidoptera) and scorpions (Table 1).

Seasonal diet composition

The mean (\pm SD) number of food items per scat was higher in the cold season vs. the warm season (cold season= 3.76 ± 1.34 , $n=76$; warm season= 3 ± 1.17 ; t-test=-3.56, $p < 0.001$, $n=64$).

The dietary composition of *Conepatus chinga* showed a large degree of seasonal overlap ($O=0.96$). In both seasons, IRI scores were the highest for Coleoptera followed by both types of larvae (Coleoptera and Lepidoptera) (Table 1). Only scorpions varied significantly between seasons (Figure 2).

Abundance and selection of food resources

We captured 4950 invertebrates, mostly Hymenoptera (68.1%, Table 2). Subsequent analysis of prey selection did not include the following items: Diptera, Hemiptera, Formicidae (because they were not present in any of the

Table 1 General and seasonal diet composition of *Conepatus chinga* in the Pampas grassland of Argentina.

	General, n=140				Warm season, n=64				Cold season, n=76			
	FO	NF	PV	IRI	FO	NF	PV	IRI	FO	NF	PV	IRI
Vertebrates	18.6	12.9	1.6		20.3	14.1	1.6		17.1	11.9	1.6	
Large mammals	15.7	4.6	1	88.6	17.2	5.7	0.8	112.6	14.5	3.7	1.2	73.2
Small mammals	3.6	1.1	0.6	5.8	4.7	1.6	0.8	11	2.6	0.7	0.4	2.9
Plant material	25	17.4	4.5	546.8	23.4	16.3	3.6	267.3	26.3	18.3	5.2	320.6
Invertebrates	100	69.6	93.9		100	69.6	94.8		100	69.7	93.2	
Coleoptera	90	26.4	39.8	5955.3	92.2	30.7	44.5	6940.2	88.2	22.9	35.8	5222.7
Orthoptera	22.1	6.5	6.1	277.9	21.9	7.3	7.5	323.2	22.4	5.8	4.9	241.9
Scorpiones	41.4	12.1	3.2	634.1	21.9	7.3	1.7	195.7	57.9	15	4.4	1148.2
Araneae	10	2.9	0.5	34.5	9.4	3.1	0.5	34.1	10.5	2.7	0.5	34.9
Hymenoptera	1.4	0.4	0.2	0.8	1.6	0.5	0.1	0.9	1.3	0.3	0.3	0.8
Miriapoda	2.9	0.8	0.4	3.5	1.56	0.5	0.1	0.9	3.9	1	0.7	6.7
Isopoda	5.71	1.7	0.4	11.8	3.1	1.04	0.1	3.6	7.9	2	0.6	21.5
Mollusca	12.86	3.8	1.36	65.9	9.4	3.1	0.7	35.9	15.8	4.1	1.9	96.4
Lepidoptera larvae	53.57	15.7	18.38	1825.1	46.9	15.6	16.9	1525.3	59.2	15.4	19.6	2092.9
Coleoptera larvae	53.57	15.7	23.02	2073.7	46.9	15.6	22.7	1796.3	59.2	15.4	23.2	2310.6
Non-identified invertebrates	3.57	1.1	0.64	6.1	-	-	-	-	6.6	1.7	1.2	19.3

FO, frequency of occurrence; NF, numerical frequency; PV, percent volume; IRI, index of relative importance; n, number of fecal samples.

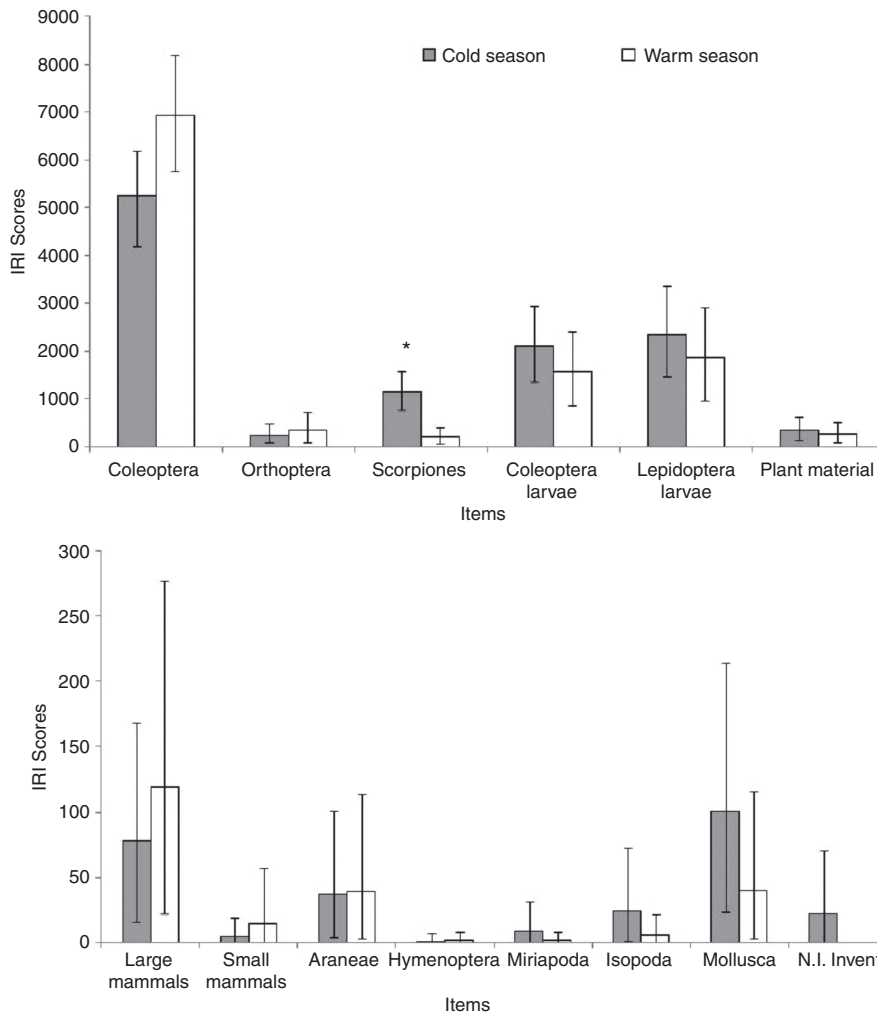


Figure 2 Seasonal variation in the diet of *C. chinga* in the Pampas grasslands of Argentina based on the IRI scores. Error bars show 95 bootstrap confidence intervals. * indicates significant differences between pairs.

analyzed scats), and Mollusca (which were not recorded in our prey abundance sampling).

Seasonal variations in mean abundance were found for Coleoptera, Orthoptera, Araneae, Isopoda, Hymenoptera and Coleoptera larvae. All these invertebrates, with the exception of the last group, showed the highest mean numbers in the warm season (Table 2). Seasonal variation in the percent composition of the invertebrate community (number of individuals of each prey item $\times 100$ / total number of captures) showed that in the warm season Coleoptera, Isopoda and Orthoptera were the most abundant groups, whereas the cold period was dominated by Coleoptera and Araneae (Table 2).

Scorpions, Coleoptera larvae, Lepidoptera larvae and Orthoptera (in the cold season only) were positively selected (Figure 3), whereas Molina's hog-nosed skunks used Araneae less than expected in both seasons. Selection was also negative for Orthoptera, Isopoda and

Hymenoptera in the warm season and for Coleoptera in the cold season (Figure 3).

Discussion

Our results demonstrate that Molina's hog-nosed skunks in the Pampas grassland were generalist feeders with a largely insectivorous diet. These conclusions are in accordance with information available for this species (Travaini et al. 1998, Novaro et al. 2000, Donadio et al. 2004, Medina et al. 2009, Peters et al. 2011) and for other mephitids (Greenwood et al. 1999, Zapata et al. 2001, Rosatte and Larivière 2003, Cantú-Salazar et al. 2005). The finding that Coleoptera was the most important item in the diet is also consistent with previous studies (Travaini et al. 1998, Donadio et al. 2004, Medina et al. 2009, Kasper

Table 2 Prey abundance (number of invertebrates captured by pitfall traps) for *C. chinga* in the Pampas grasslands of Argentina in two seasons (warm and cold).

Prey	General	Warm season, n=18	Cold season, n=20
Coleoptera	496 (13.1)	297 (16.5) ^a	199 (9.9) ^b
Orthoptera	140 (3.7)	136 (7.6) ^a	4 (0.2) ^b
Hemiptera	25 (0.7)	12 (0.7) ^a	13 (0.6) ^a
Hymenoptera, Formicidae	3370 (88.7)	3049 (169.4) ^a	321 (16.05) ^b
Other Hymenoptera	17 (0.4)	17(0.9) ^a	0 ^b
Diptera	371 (9.8)	321 (17.8) ^a	50 (2.5) ^b
Scorpiones	14 (0.4)	9 (0.5) ^a	5 (0.25) ^a
Araneae	191 (5)	127 (7.1) ^a	64 (3.2) ^b
Isopoda	246 (6.5)	232 (12.9) ^a	14 (0.7) ^b
Miriapoda	1	0 ^a	1 (0.05) ^a
Lepidoptera larvae	58 (1.5)	23 (1.3) ^a	35 (1.75) ^a
Coleoptera larvae	21 (0.6)	5 (0.3) ^a	16 (0.8) ^b

Mean number of individuals per grid are depicted in parentheses. Seasonal means followed by the same letter are not significantly different (Mann-Whitney test, $p > 0.05$). n, number of trap grids.

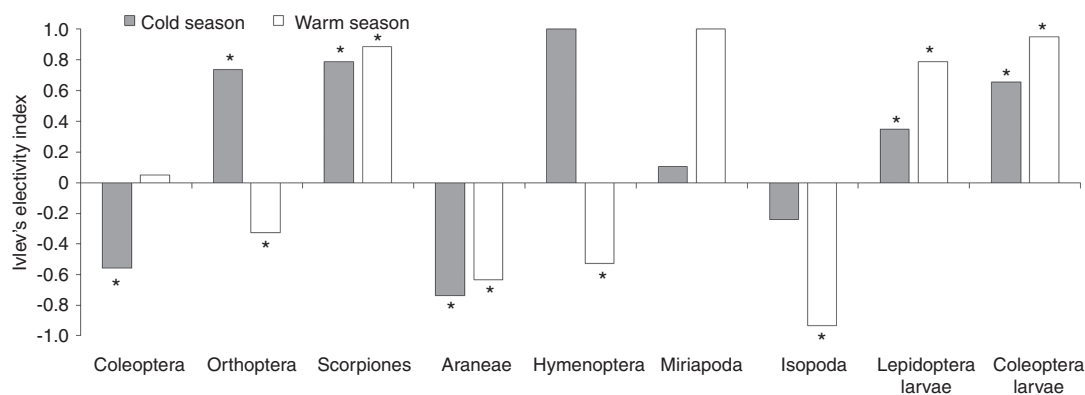
et al. 2011, Peters et al. 2011). However, unlike previous studies, we did not find reptile and bird remains in any of the analyzed samples. Although coleopteran larvae were cited as an important component in the diet of *Conepatus chinga* (Donadio et al. 2004, Medina et al. 2009), lepidopteran larvae were only occasionally consumed by animals monitored during these studies. The compositional variation observed between our study and previous investigations into the diet of *C. chinga* (Donadio et al. 2004, Medina et al. 2009) may be related to differences in prey availability between study areas.

Similar to other skunk species (Rosatte and Larivière 2003), *Conepatus chinga* has been described as an opportunistic predator (Travaini et al. 1998, Zeballos et al. 1998) capable of switching its staple food depending on prey availability. In our study, however, although the

abundance of most prey items showed a seasonal variation, we did not observe large variations in diet composition across seasons.

The selective foraging behavior of *Conepatus chinga* was supported by the fact that it consumed several prey items in different proportions than expected based on their abundance (e.g., Orthoptera were positively selected in the cold season, whereas they were consumed less than expected in the warm season when they were very abundant). Interestingly, although Coleoptera were the most important food item recorded in the diet of *C. chinga*, our data indicate that they were used less than expected, at least in the cold season.

The positive selection of insect larvae may be related to their comparatively high fat content and smaller amounts of chitin than adults of the same species (Redford

**Figure 3** Seasonal prey selection by *C. chinga*, as shown by Ivlev's electivity index. * $p \leq 0.05$, indicates significant positive or negative selection according to Bonferroni's simultaneous confidence intervals.

and Dorea 1984). Additionally, larvae are probably easier to capture than other arthropods (Cantú-Salazar et al. 2005). It is clear that these results may be affected by the sampling techniques we used. This is especially true for the abundance of Coleoptera larvae. Most of these larvae have subterranean habits and this may have produced an underestimation of their abundance. However, we believe that the avoidance of isopods, spiders and Hymenoptera is a reliably robust conclusion given our sampling methodology.

This is the first study on the foraging ecology of *Conepatus chinga* that simultaneously compared prey abundance and consumption. This approach enabled us to understand the feeding preferences of Molina's hog-nosed skunk, further supporting the hypothesis by Donadio et al. (2004) and Medina et al. (2009) that this species has a certain degree of trophic selectivity. Because the primary prey of *C. chinga* in the Pampas is most abundant in grassland patches (Castillo et al. 2012), these conclusions are also in agreement with the recent finding that this mephitid shows a clear preference for seminatural

grasslands, suggesting that the preservation of remnant patches of this habitat type are of great relevance for conservation of the Molina's hog-nosed skunk in the Pampas ecoregion (Castillo et al. 2011, 2012).

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References

- Angerbjörn, A., M. Tannerfeldt and S. Erlinge. 1999. Predator prey relationships: arctic foxes and lemmings. *J. Anim. Ecol.* 68: 34–49.
- Birochio, D.E. 2008. Ecología trófica de *Lycalopex gymnocercus* en la región pampeana: Un acercamiento inferencial al uso de los recursos. PhD thesis, Universidad Nacional del Sur, Bahía Blanca.
- Byers, C.R., R.K. Steinhorst and P.R. Krausman. 1984. Clarification of a technique for analysis of utilization-availability data. *J. Wildlife Manage.* 48: 1050–1053.
- Cabral, M.M.M., J. Zuanon, G.E. de Mattos and F.C.W. Rosas. 2010. Feeding habits of giant otters *Pteronura brasiliensis* (Carnivora: Mustelidae) in the Balbina hydroelectric reservoir, Central Brazilian Amazon. *Zoologia (Curitiba, Impr.)* 27: 47–53.
- Cantú-Salazar, L., M.G. Hidalgo-Mihart, C.A. López-González and A. González-Romero. 2005. Diet and food resource use by the pygmy skunk (*Spilogale pygmaea*) in the tropical dry forest of Chamela, Mexico. *J. Zool.* 267: 283–289.
- Castillo, D.F., M. Lucherini and E.B. Casanave. 2011. Denning ecology of Molina's hog-nosed skunk in a farmland area in the Pampas grassland of Argentina. *Ecol. Res.* 26: 845–850.
- Castillo, D.F., E.M. Luengos Vidal, E.B. Casanave and M. Lucherini. 2012. Habitat selection of Molina's hog-nosed skunk in relation to prey abundance in the Pampas grassland of Argentina. *J. Mammal.* 93: 716–721.
- De Marinis, A.M. and M. Masseti. 1995. Feeding habits of the pine marten *Martes martes* L., 1758, in Europe: a review. *Hystrix* 7: 143–150.
- Donadio, E., S.D. Di Martino, M. Aubone and A.J. Novaro. 2004. Feeding ecology of the Andean hog-nosed skunk (*Conepatus chinga*) in areas under different land use in north-western Patagonia. *J. Arid Environ.* 56: 709–718.
- Dragoo, J.W. 2009. Family Mephitidae (skunks). In: (D.E. Wilson and R.A. Mittermeier, eds.) *Handbook of the mammals of the world*, vol. 1 Carnivores. Lynx Edicions, Barcelona. pp. 532–563.
- Dragoo, J.W. and R.L. Honeycutt. 1997. Systematics of mustelid-like carnivores. *J. Mammal.* 78: 426–443.
- Elmhagen, B., M. Tannerfeldt, P. Verucci and A. Angerbjörn. 2000. The arctic fox (*Alopex lagopus*): an opportunistic specialist. *J. Zool.* 25: 139–149.
- Frangi, J.L. and O.J. Bottino. 1995. Comunidades vegetales de la Sierra de la Ventana, provincia de Buenos Aires, Argentina. *Revista de la Facultad Agraria de La Plata* 71: 93–133.
- Greenwood, R.J., A.B. Sargeant, J.L. Piehl, D.A. Buhl and B.A. Hanson. 1999. Foods and foraging of prairie striped skunks during the avian nesting season. *Wildlife Soc. B.* 27: 823–832.
- Hanski, I.L., L. Hansson and H. Henttonen. 1991. Specialist predators, generalist predators, and the microtine rodent cycle. *J. Anim. Ecol.* 60: 353–367.
- Home, C. and Y.V. Jhala. 2009. Food habits of the Indian fox (*Vulpes bengalensis*) in Kutch, Gujarat, India. *Mamm. Biol.* 74: 403–411.
- Jacksic, F.M. 1989. What do carnivorous predators cue in on: size or abundance of mammalian prey? A crucial test in California, Chile, and Spain. *Rev. Chil. Hist. Nat.* 62: 237–249.
- Jacobs, J. 1974. Quantitative measurement of food selection. A modification of the forage ratio and Ivlev's electivity index. *Oecologia* 14: 413–417.
- Kasper, C.B., F.B. Peters, A.U. Christoff, A. Bager and T.R.O. Freitas. 2011. Trophic relations of sympatric small carnivores in fragmented landscapes of southern Brazil: niche overlap and

- potential for competition. PhD thesis, Universidade Federal do Rio Grande do Sul, Porto Alegre. pp. 71–100.
- Medina, C.E., C.V. Díaz, F.A. Delgado, G.A. Ynga and H.F. Zela. 2009. Dieta de *Conepatus chinga* (Carnívora: Mephitidae) en un bosque de Polylepis del departamento de Arequipa, Perú. *Rev. Peru. Biol.* 16: 183–186.
- Novaro, A.J., M.C. Funes and R.S. Walker. 2000. Ecological extinction of native prey of a carnivore assemblage in Argentine Patagonia. *Biol. Conserv.* 92: 25–33.
- Olson, D.M., E. Dinerstein, E.D. Wikramanayake, N.D. Burgess, G.V.N. Powell, E.C. Underwood, J.A. D'Amico, I. Itoua, H.E. Strand, J.C. Morrison, C.J. Loucks, T.F. Allnutt, T.H. Ricketts, Y. Kura, J.F. Lamoreux, W.W. Wettengel, P. Hedao and K.R. Kassem. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. *Bioscience* 51: 933–938.
- Paltridge, R. 2002. The diets of cats, foxes and dingoes in relation to prey availability in the Tanami Desert, Northern Territory. *Wildlife Res.* 29: 389–403.
- Peters, F.B., P.R.O. Roth and A.U. Christoff. 2011. Feeding habits of Molina's hog-nosed skunk, *Conepatus chinga* (Carnivora: Mephitidae) in the extreme south of Brazil. *Zoologia (Curitiba, Impr.)* 28: 193–198.
- Pianka, E.R. 1975. Chapter 12: Niche relations of desert lizards. In: (M.L. Cody and J. Diamond, eds.) *Ecology and evolution of communities*. Harvard University Press, London. pp. 292–314.
- R Development Core Team. 2008. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available at <http://www.R-project.org>. Accessed 12 October 2012.
- Ray, J.C. 1998. Temporal variation of predation on rodents and shrews by small African forest carnivores. *J. Zool.* 244: 363–370.
- Redford, K.H. and J.G. Dorea. 1984. The nutritional value of invertebrates with emphasis on ants and termites as food for mammals. *J. Zool.* 203: 385–395.
- Reynolds, J.C. and N.J. Aebischer. 1991. Comparison and quantification of carnivore diet by faecal analysis: a critique, with recommendations, based on a study of the fox *Vulpes vulpes*. *Mamm. Rev.* 21: 97–122.
- Rosatte, R. and S. Larivière. 2003. Skunks. In: (G. Fledhamer G, B.C. Thompson and J.A. Chapman, eds.) *Wild mammals of North America: biology, management and conservation*. Johns Hopkins University Press, Baltimore. pp. 692–707.
- Scorolli, A.L., A.C. Lopez Cazorla and L.A. Tejera. 2006. Unusual mass mortality of feral horses during a violent rainstorm in Parque Provincial Tornquist, Argentina. *Mastozoología Neotropical* 13: 255–258.
- Travaini, A., M. Delibes and O. Ceballos. 1998. Summer foods of the Andean hog-nosed skunk (*Conepatus chinga*) in Patagonia. *J. Zool.* 246: 457–460.
- Zalba, S.M. and C.B. Villamil. 2002. Woody plant invasion in relictual grasslands. *Biol. Invasion.* 4: 55–72.
- Zapata, S.C., A. Travaini and R. Martínez-Peck. 2001. Seasonal feeding habits of the Patagonian hog-nosed skunk *Conepatus humboldtii* in southern Patagonia. *Acta Theriol.* 46: 97–102.
- Zeballos, H., E. López and A. Morales. 1998. Mamíferos de Chiguata, hábitat y hábitos. *Revista del Departamento Académico de Biología (BIOS)* 2: 101–114.
- Zhou, Y.-B., C. Newman, C.D. Buesching, A. Zalewski, Y. Kaneko, D.W. Macdonald, Z.-Q. Xie. 2011. Diet of an opportunistically frugivorous carnivore, *Martes flavigula*, in subtropical forest. *J. Mammal.* 92: 611–619.

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