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Diet of Puma (*Puma concolor*, Carnivora: Felidae) in Coastal and Andean Ranges of Southern Chile

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Abstract

Between 1985 and 1999 we collected a total of 62 puma (*Puma concolor*) feces in two reserves located on the coastal range and on three national parks located in the Andean range, all in the Lake Region of southern Chile. The identification of 79 prey items showed that the puma diet in the southern rainforests was made up mainly of European hares (*Lepus europaeus*; an exotic species), ungulates (chiefly the pudu deer; *Pudu pudu*), rodents, birds and marsupials, in that order of importance. Except for the lowland site San Martín, the trophic ecology of pumas did not differ substantially among sites. At San Martín, in addition to hares, pumas hunted Black-necked swans (*Cygnus melancoryphus*) and coypu (*Myocastor coypus*). Although pumas preyed upon the largest prey available, the mean prey weight was of only 7.7 kg, much smaller than on other previous studies. European hares due to their high abundance, have replaced pudus as the main prey of pumas in the forests of the Lake Region. In order to maintain viable populations of pumas in the biologically most interesting coastal forests, it will be necessary to protect larger native forests that provide enough food and habitat for pumas.

Keywords: *Puma*, *Pudu*, European hare, diet, rainforest, coastal, Andes.

Resumen

Entre 1985 y 1999 colectamos un total de 62 fecas de puma (*Puma concolor*) en dos áreas protegidas del sector costero y en tres del sector andino de la Región de Los Lagos, en el sur de Chile. La cuantificación de las 79 presas detectadas indicó que la dieta del puma en las áreas con bosques lluviosos se compuso principalmente de liebres europeas (*Lepus europaeus*; especie exótica), ungulados (principalmente pudues; *Pudu pudu*), roedores, aves y marsupiales, en ese orden decreciente. La ecología trófica del puma no difirió sustancialmente entre los cinco sitios estudiados, con excepción de uno que incluyó extensos humedales, donde además de liebres el puma cazó cisnes de cuello negro (*Cygnus melancoryphus*) y coipos (*Myocastor coypus*). A pesar que los pumas consumieron las presas más grandes disponibles, el tamaño medio de ellas fue sólo de 7.7 kg, siendo mucho más pequeñas que las de los otros estudios analizados. La gran abundancia de liebres europeas ha reemplazado a los pudues como la presa principal del puma en los ambientes de bosques sureños. Para poder mantener poblaciones viables de pumas en los bosques costeros, los más interesantes biológicamente, es necesario proteger áreas mayores de bosques nativos que provean de suficiente alimento y hábitat a los pumas.

Introduction

Although the puma (*Puma concolor*) is distributed throughout the Americas and its diet is well known, its feeding habits has been little studied on its southern ranges (Currier, 1983). In the Chilean Patagonia, in the protected settings of Torres del Paine National Park, three studies have shown that pumas feed mainly on native guanacos (*Lama guanicoe*) as well as on the exotic European hare (*Lepus europaeus*) (Yáñez et al., 1986; Iriarte et al., 1990; Franklin et al., 1999). In the Lake Region of southern Chile, in three other protected areas, Rau et al. (1991, 1992) have also found that pumas prey heavily upon the native pudu deer (*Pudu pudu*) and exotic hares. At another non-protected area nearby, in Rupanco Lake, Courtin et al. (1980), based on observed kills, reported that pudus

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were the main prey of the puma. However, the studies in the Lake Region were all conducted in Andean areas of the Valdivian rainforest of southern Chile. These are not the most human impacted or biologically most interesting areas. The most diverse areas, considered pleistocene refugia for the fauna and flora of southern Chile, are located in the coastal ranges of the Lake Region and the highly endemic rainforest is one of the least protected ecosystems in Chile (Armesto et al. 1992, 1998).

Here, we add new information for five protected areas located in coastal and Andean ranges in southern Chile. Given the high vagility of pumas (Franklin et al., 1999), their main prey (i.e., pudu and European hare), and the similar environmental conditions between the two mountain ranges that are separated by <100 km (Murúa, 1996), we hypothesize that few differences should be found in the diet of pumas from both areas.

Materials and methods

Between 1985 and 1999 we collected puma feces in five protected areas located in the Lake Region of southern Chile. The San Martín Field Station (39°38′S, 73°07′W, 40–80 m elevation, 80 ha, Valdivia Province) and Nahuelbuta National Park (37°47′S, 72°44′W, 900–1100 m elevation, 68.3 km^2, Malleco Province) are located in coastal areas over >30 km away from the seashore. In the Andes mountain range, we obtained puma feces from Conguillío (38°36′S, 71°36′W, 900–1200 m elevation, 608 km^2, Cautín Province), Puyehue (40°45′S, 72°12′W, 420–820 m elevation, 1067 km^2, Osorno Province), and Vicente Pérez Rosales (41°04′S, 71°50′W, 50–600 m elevation, 2537 km^2, Llanquihue Province) National Parks. San Martín differs from the other areas by being at lower elevation and having extensive wetlands.

Puma feces were collected opportunistically along paths and trials and based on their lighter color, cylindrical shape, and larger diameter and length (Yáñez et al., 1986) were easily distinguished from those of other sympatric predators, such as dogs (free ranging dogs are not uncommon in national parks) and foxes. The contents of feces were examined under a dissecting microscope. Prey remains were identified using keys for bones and teeth for local mammals (Reise, 1973; Pearson, 1995). When only hairs were found, we prepared hair cuticles (scale patterns) to be analysed with incident light under the microscope. We also observed hair shaft patterns with transmitted light. Prey species were determined by comparing observed patterns with those in the key provided by Chehébar and Martin (1989). Hair scale patterns were obtained by pressing cleaned hairs on slides painted fresh with transparent nail polish and then observing the negative cast under a microscope (Weingart, 1973). For observing the hair shaft through transmission, when necessary, we cleared dark hairs with commercial hair clearer. To distinguish hairs of hares from those of European rabbits (*Oryctolagus cuniculus*) we followed Wolfe & Long (1997). We did not account for differences in prey digestibility or proportions thereof in the feces and maximum numbers by prey type per feces were reported. We computed the geometric mean weight of prey as described in Iriarte et al. (1990). Prey weight data were obtained from published accounts or from our own field records. Prey composition was expressed as the percent of occurrence of all combined prey found for each locality (Maehr & Brady, 1986).

Results

Perhaps, because of the steady and heavy rainfall (feces disintegrated quickly), we only found a total of 62 puma feces (Table 1), despite making a sizeable effort. Because of the small sample sizes, we pooled the information from the three Andean areas (47 feces) and that from the two coastal areas (15 feces). This also precluded any statistical analysis of the data. We did not differentiate among years or sites within each range.

In the puma diet of the Lake Region we detected a total of 79 prey items corresponding to 13 different species (Table 1). In decreasing order of importance, pumas ate lagomorphs, ungulates, rodents, birds, and marsupials. Aside from puma diet at San Martín, the proportions of the different prey types consumed by pumas were similar among sites. Almost invariable among sites, the most important prey type was the European hare (25–83% by frequency) and then the pudu deer (0–35%). In terms of biomass their contribution was even higher.

The feeding habits of pumas did not differ markedly between coastal and Andean ranges. Predation upon European hares ranged between 25 and 46% for the coastal areas, whereas it was between 32 and 83% for the Andean areas. Predation on ungulates, both native and exotic, was more prevalent in the Andean range than on the coast (Table 1). At San Martín, although hares were still the chief prey, the black-necked swan (*Cygnus melancoryphus*) and the coypu (*Myocastor coypus*) made up a high proportion of the puma diet. The geometric weight of puma prey was quite constant, being 7.6 kg in Andean ranges and 8.3 kg in coastal ranges.

Discussion

Overall, the proportion of prey orders consumed by pumas in three out of the five areas reported here followed the same sequence and similar proportions as those in a previous study conducted by Rau et al. (1991). Courtin et al. (1980) and Rau et al. (1995) also reported pudus and European hares as the main prey of pumas in the Lake Region. Pudus were absent in the puma diet from high-elevation sites such as Conguillío and Nahuelbuta, likely because this deer was rare or absent from these areas (Jiménez, pers. obs.).

The high incidence of prey such as swans and coypus from the San Martín site reflects the opportunistic behavior of the puma. These animals are very abundant in the extended nearby wetlands (Schlatter et al., 1991), which is a particular feature of this lowland site. Puma feeding on native geese

Table 1. Diet composition of puma (percent of total prey) based on feces collected in Coastal and Andean protected areas in southern Chile. Totals by order are shown in boldface and by class in parenthesis.

	Weight (kg)[3]	Coastal			Andean				Total
		Nahuelbuta	San Martin	Total	Conguillio	V Perez R	Puyehue	Total	
MAMMALS		(100)	(69.2)	(76.4)	(83.3)	(100)	(100)	(100)	(94.9)
Rodentia		–	**15.4**	**11.8**	**0.0**	**24.3**	**38.5**	**22.6**	**20.2**
Abrothrix longipilis	0.035[4]	–	–	–	–	–	7.7	1.6	1.3
A. olivaceus	0.024[4]	–	–	–	–	–	7.7	1.6	1.3
Loxodontomys micropus	0.058[4]	–	–	–	–	24.3	15.4	17.7	13.9
Myocastor coypus	4.66[5]	–	15.4	11.8	–	–	–	–	2.5
Oligoryzomys longicaudatus	0.027[4]	–	–	–	–	–	7.7	1.6	1.3
Marsupialia		**25.0**	–	**5.9**	–	–	–	–	**1.3**
Dromiciops gliroides	0.027[6]	25.0	–	5.9	–	–	–	–	1.3
Lagomorpha		**25.0**	**46.1**	**41.1**	**83.3**	**32.4**	**46.2**	**45.2**	**44.3**
Lepus europaeus[1]	3[7]	25.0	46.1	41.1	83.3	32.4	46.2	45.2	44.3
Artiodactyla		**50.0**	**7.7**	**17.7**	**16.6**	**43.3**	**15.4**	**32.3**	**29.1**
Bos taurus[2]	100[6]	–	–	–	8.3	–	–	1.6	1.3
Capra hircus[2]	25[4]	–	–	–	–	8.1	7.7	6.5	5.1
Ovis aries[2]	20[6]	25.0	–	5.9	8.3	–	–	1.6	2.5
Pudu pudu	10[6]	–	7.7	5.9	–	35.1	7.7	22.6	19.0
Sus scrofa[2]	75[6]	25.0	–	5.9	–	–	–	–	1.3
BIRDS		–	(30.8)	(23.6)	–	–	–	–	(5.1)
Anseriformes		–	**30.8**	**23.6**	–	–	–	–	**5.1**
Cygnus melancoryphus	5.15[8]	–	30.8	23.6	–	–	–	–	5.1
PREY ITEMS		4	13	17	12	37	13	62	79
FECES		3	12	15	11	26	10	47	62

[1] Introduced species.
[2] Domestic species.
[3] Sources: [4] = Rau et al., 1991; [5] = Greer, 1966; [6] = our field records; [7] = Dietrich, 1984; [8] = Marín, 1996.

was previously reported for Torres del Paine (Yáñez et al., 1986; Franklin et al., 1999) and on domestic geese for the Lake Region (Courtin et al., 1980; Rau et al., 1991; Muñoz-Pedreros et al., 1995).

Among the different size classes of prey locally available, pumas generally took the largest prey consistent with their killing power (Sunquist & Sunquist, 1989). Thus, small mammals were rarely consumed and birds, aside from large waterfowl, were not consumed at all. The average weight of prey for the Lake Region was 7.7 kg, and thus very similar to that for pumas in Paraguay. With the exception for the puma population studied in central Argentina (Branch et al., 1996), puma prey in the Lake Region were much smaller than of that reported for North America (>17 kg) and for those with large sample size reported from South America (Iriarte et al., 1990). The relatively low prey weight we found appears to reflect the small size of the puma prey available in the rainforest habitat of southern Chile. For instance, the pudu deer is the largest natural prey and weighs a little over 10 kg, whereas the largest wild bird available (in wetlands) is the black-necked swan, which weighs only 5 kg (Marín, 1996). The small prey size might also result from the fact that pumas of this regional population are some of the smallest reported for the species throughout its distribution (i.e., 22–31.2 kg; Greer, 1966; Courtin et al., 1980).

Interestingly, we found the European hare almost always as the most abundant prey in the puma diet. This species was released in the Lake Region at the beginning of the 1900s, and quickly became a successful invader of the new clearings and livestock pastures (Grigera & Rapoport, 1983; Dietrich, 1984). Our findings support Rau et al.'s (1992) hypothesis that by being abundant, the European hare became an apparently easy alternative prey for pumas, displacing the pudu as its main prey. Given this, the trophic ecology of pumas might have changed substantially from what it was originally.

The high incidence of the hare in the puma diet appears to be a widespread phenomenon in southern South America. Puma feeding largely on European hares has been documented in the Lake Region (Rau et al., 1991, 1992, 1995), in Torres del Paine National Park (Yáñez et al., 1986; Iriarte et al., 1991; Franklin et al., 1999), and in the Argentinean steppe (Novaro et al., 2000). It is likely that either an increase in hare abundance or the almost complete extinction of pudus, the main native prey of pumas in the Lake Region, due to direct human impact and deforestation, might have

contributed to the increase in hare consumption as an alternative prey by the puma (Rau et al., 1992; see also Novaro et al., 2000). It is puzzling to explain the lack of rabbit predation by pumas, given that this lagomorph was abundant in areas such as Nahuelbuta (Jiménez, pers. obs.). Perhaps the small size (about 1 kg), the escape behavior and/or the particular habitat use by rabbits accounted for this lack of predation.

Unlike in studies from Patagonia, we did not detect a high incidence of domestic animals in puma diet in the Lake Region (Table 1). Ungulates such as sheep (*Ovis aries*) and goats (*Capra hircus*) are repeatedly detected as preyed upon by puma in other studies in protected habitats, as pumas also hunt in the surroundings. Under private holdings in the Lake Region, Courtin et al. (1980) described pumas killing sheep in Rupanco Lake, and in Lastarria, at least 30% of the owners of small farms perceived that pumas preyed on their livestock (Muñoz-Pedreros et al., 1995).

Our findings of the low consumption of domestic stock by pumas may be explained by the fact that most of our study areas were largely forested with native plants on their surroundings and thus perhaps still held enough native prey for pumas. Even though the number of exotic prey consumed we found was moderate, when computed on a biomass base, exotic prey still constitute the bulk of puma diet in many areas of southern Chile.

The results of studies from austral Chile that pumas commute to private ranches to hunt domestic animals and use the protected areas as a refuge (Yáñez et al., 1986; Franklin et al., 1999), support the claim that national parks are too small to provide this large carnivore with a sustainable prey base (Simonetti & Mella, 1997) and that protected wildlife uses non-protected areas extensively (Simonetti, 1995). Furthermore, because the only national park on the coastal range (i.e., Nahuelbuta) has an extension of 68.3 km^2 and is an isolated forest, it can hardly sustain a couple of pumas, the largest native carnivore in Chile. This is an argument for protecting larger undisturbed areas in the coastal range to maintain native biodiversity (Armesto et al., 1992, 1998; Simonetti & Mella, 1997).

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