Food habits of the Andean fox *(Pseudalopex culpaeus)* and notes on the moutain cat *(Felis colocolo)* and puma *(Felis concolor)* in the Río Abiseo National Park, Perú

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Summary. – This study presents the diet of the Andean fox *(Pseudalopex culpaeus)* in the Río Abiseo National Park situated in the high Andes of Perú. Results of the 74 scats analyzed showed a total of 180 prey consumed. This consisted primarily of rodents (48 %), followed by berries of *Vaccinium* (Ericaceae, 29 %), birds (12 %), frogs (6 %) and insects (5 %). Eighty two percent of the total vertebrate prey weighted less than 55 g.

A comparison with other studies on Andean fox diet in Argentina, Chile and Perú, confirm its omnivorous opportunistic diet from almost totally carnivorous to highly omnivorous.

Comparisons of the Andean fox diet with that of other large predators present at Río Abiseo N.P. suggest their differences in prey preference.

Résumé. – Cette étude présente des données sur le régime alimentaire du renard des Andes (*Pseudalopex culpaeus*), au Parc national du Río Abiseo, au Pérou. Dans 74 excréments analysés, ont été trouvées 180 proies, principalement des rongeurs (48 %), des baies de *Vaccinium* (Ericacées, 29 %), des oiseaux (12 %), des grenouilles (6 %) et des insectes (5 %). La plupart des vertébrés (80 %) pesaient moins de 55 g.

Cette étude et d'autres portant sur le régime alimentaire du renard des Andes en Argentine, au Chili et au Pérou, confirment son caractère opportuniste, pouvant passer de presqu'entièrement carnivore à très omnivore.

Le renard des Andes diffère des autres grands prédateurs rencontrés au Parc national du Río Abiseo, par le choix de ses proies.

INTRODUCTION

Foxes are omnivorous opportunistic animals that change their feeding habits depending on local and seasonal prey availability. Studies on the diet of the Andean fox, *Pseudalopex culpaeus* (*Pseudalopex* sensu Berta 1987), in several localities including Argentina (Crespo and De Carlo 1963), Chile (Jaksíc *et al.* 1980 ; Durán 1987) and Perú (Fugger 1979 ; Falero 1987) show this opportunistic behavior. This species has a range of diet from almost totally carnivorous, especially in the areas where there are cattle or auquenids, to a more omnivorous diet.

Berta (1987) suggests that the opportunistic feeding behavior of foxes has resulted in a high species diversity and wide distribution in South America. The Andean fox

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lives in particular ranges from the high Andes to lowlands of Ecuador, Perú, Chile and Argentina (Cabrera and Yepes 1960, Langguth 1975, Novak and Paradiso 1983, Redford and Eisenberg 1992). The other species included in this study also show a wide geographic distribution. In Perú, this fox is common along the Andes up to 4500 m and rarely descends lower than 1000 m on the dry western side (see Grimwood 1969, Falero 1987), but it is never found in the wet lowland forest on the eastern side (Brack 1975). The mountain cat *(Felis colocolo)* occurs in Perú, Bolivia, Chile, Paraguay, and Uruguay, mostly in the Andean valleys, but sometimes at altitudes up to 5000 m (Redford and Eisenberg 1992) and occasionally in the lowlands (Grimwood 1969). The puma *(Felis concolor)* is not only a widespread species ranging from North America to Patagonia (Anderson 1983) but also occupies a great variety of habitats from lowland tropical rainforest to elevations up to 4500 m (Grimwood 1969).

Geographic distribution and population density, together with criteria for the level of habitat specialization of a species have been used to classify species into seven levels of rarity (Rabinowitz 1986, Arita *et al.* 1990). Rarity is indeed important to assess the vulnerability of species, when we consider that species with more restricted distributions, more specialized habitat use, and lower population densities should be more prone to environmental and genetic stochastic events (Gilpin and Soulé 1986).

Population density is also an indicator of vulnerability. All of the three species of carnivores considered in this study occur at low population densities ; the mountain cat and the Andean fox are more restricted in habitat use and geographic distribution than the puma. This puts them in a separate rarity category. Specific ecological information for a set of species within the same level of rarity is important to better predict aspects of their vulnerability and conservation. A set of species with a narrow geographic distribution, specialized in one habitat and existing at lower population densities can have different degrees of specialization in other aspects of their behavior (i.e., food habits, dwelling requirements), consequently they would be at different levels of risk. Because the feeding habits are one of the most significant aspects of the behavior of species and considering that carnivores might affect (and be affected) their prey populations more dramatic than other trophic groups, it is important to assess the level of specialization or opportunism.

In this paper I describe the dry season diet of the Andean fox, in Río Abiseo National Park and compare it to data reported from other localities and also to the food habits of two other sympatric carnivores, the mountain cat, and puma.

STUDY AREA

This study was conducted in the páramo of the Río Abiseo National Park (3200 m to 3800 m), Department of San Martín, Perú (7°5'S, 76°9'W), from June-August 1987 to July 1988. The preferred habitat of Andean foxes in the area is pluvial páramo, a very muddy habitat covered mainly by grasses of the genera *Calamagostris* and *Festuca*, and shrubs of *Calceolaria*, *Diplostephium*, *Loricaria* and *Lupinus*. Below 3400 m small (0.1 to 5.0 ha) isolated patches of forest appear along the sides of the valleys. Feces of felids but not of foxes were found inside forest patches. A more detailed description of the area and the vegetation is found in Young and León (1988) and Weberbauer (1920).

The climate is cold and humid, with large temperature variations from night to day. The maximum and minimum mean daily temperatures during the study were

17.3°C and 1.8°C respectively, in 1987, and 22.28°C and 0.72°C in 1988 (Leo *et al.* 1988, 1989). The annual rainfall is 1000-2000 mm (Young and León 1988) with a dry season from June to August.

Feces were collected in the following sites : Valle « Laplap » (3800 m), « La Empedrada » Lake (3620 m), the glacial valleys of « Chirimachay », « Cueva Negra » (3600-3750 m), « Manachaqui » (3420 m), « Pampa del Cuy y Paredones » (3380 m and 3600 m), « Los Chochos » (3280 m) and « Puerta de monte » (see Leo *et al.* 1988). These valleys are part of an area of about 25,000 ha (see Leo and Romo 1992) ; however, I scanned only the areas close to the trails crossing the valleys, surrounding or crossing forest patches.

METHODS

Collection and analysis of samples

Fecal samples from foxes and from felids were collected in the above localities. Feces were identified by differences in size and by the tracks associated with them. Fox scats are frequently found beside trails or rocks, felid scats can be found in any place but are very rare. Fox scats measured from 17-22 mm diameter as Falero (1987) also reported (17.6-23.7). Mountain cat scats are much smaller (13-16 mm) and fusiform at the tips. Puma scats are notably larger (> 25 mm).

Scats were dried and stored in plastic bags until they were washed, broken and separated into their components : bones, hairs, feathers, insects and plant material, as described by Korschgen (1987). I identified the bones and hairs by comparing them with a collection made by the Faunal Inventory of the Río Abiseo National Park Project by the Peruvian Association for Conservation. Bones or hairs that could not be identified are labelled as « unidentified big rodent » (RO) or « unidentified small rodent » (ro).

Data analysis

Each identified vertebrate prey from one scat is considered an independent capture following other authors (Crespo and de Carlo 1963, Durán *et al.* 1987, Emmons 1987, Fugger 1979, Jaksíc *et al.* 1980). For the case of insects and plants, I considered a group of them as one prey item.

After identifying the prey and calculating its proportion in the diet, the mean weight of the vertebrate prey (MWVP, Jaksíc *et al.* 1983) was calculated. This index is expressed by :

$$MWVP = \frac{\Sigma F_i(X_i)}{N}$$

where F is the absolute frequency of the prey item i, X is the mean weight of prey i and N is the total of prey.

Weight of the vertebrate species were obtained from the specimens of the Faunal Inventory. Mean weight of rodent was the average weight of all the individuals of a given species in a site, and averaged with values from other sites, to get only one mean for the study area. For the case of birds, the mean weight corresponds to data for individuals of the two genera identified. For frogs, I used 15 g. as the mean weight of the category of larger frogs living in the area because the bones found belong to this group (L. Rodriguez, pers. comm.).

RESULTS

Food habits of Andean fox

A total of 180 prey consisting of vertebrates (119), insects (9) and plants (52) were found in the 74 scats collected (Table 1). Of the 119 vertebrate prey 87 were rodents, 22 birds and 10 frogs (corresponding to 1.6 vertebrate prey/scat). The insects found were principally coleoptera and the plants were leaves and seeds of *Vaccinium* (Ericaceae), the only plant species found in the scats.

The most numerous prey were rodents (48.3%) followed by *Vaccinium* (28.9 %), birds (12.2 %), frogs (5.6 %) and insects (5.0 %). Although *Akodon* and *Thomasomys* are the rodents most commonly found in all habitats and localities when using Sherman and snap traps (Leo and Romo 1992), *Auliscomys pictus*, a species that typically inhabits rocky areas, was the most numerous prey found in the fox scats. The results show some degree of prey selection for this species. Other terrestrial mammals present in the area (Leo *et al.* 1989) but not represented in diet are : *Hippocamelus antisensis*, *Pudu mephistopheles*, *Mazama* sp., *Mustela frenata*, *Thylamys* spp., *Thomasomys apeco* (Leo and Gardner 1993), *Thomasomys macrotis* (Gardner and Romo 1993) and *Rhipidomys* spp. Calves, that inhabit neighboring valleys (pers. obs.), were another possible prey.

Two bird remains were identified to the generic level : *Scytalopus* « Tapaculo » (Fam. Thynocriptidae), probably *S. unicolor* or *S. magallanicus* and *Diglossa* (Fam. Coerebidae), probably *D. lafresnayii*, « Glossy flower-piercer », or *D. carbonaria*, « Carbonated flower-piercer ». The former occurs in the lower strata of the forest or close to the ground in the páramo ; the latter is the most common species in bushes and edge habitats (E. Ortiz, pers. comm.).

The high representation of *Vaccinium* (in 70.3 % of the feces) might be explained by the coincidence between *Vaccinium* fruiting period (May-July) and our sample collection. The fruit and leaves of this plant are very small (5-10 mm) and relatively thick, and they were found almost intact in the scats. *P. culpaeus* could thus be an important disperser of this plant.

Food habits of the mountain cat and puma

Although the number of scats and prey found for these species was small, the results give an idea of the major prey itemps of these felids. The results of the eighteen scats collected are also shown in Table 1.

The mountain paca, *Agouti taczanowskii*, the biggest rodent of the area (4.9 Kg) was found four times in puma scats (31 %). Although puma hide large prey and come back for several days to feed on it (Hornocker 1970, Yáñez *et al.* 1986), I believe this is not the case with the mountain paca since this prey is not big enough. Furthermore, I found the scats on distant dates, so they almost certainly represent separate kills.

Mean weight of vertebrate prey of Andean fox, mountain cat and puma

The MWVP is 264.9 g. for the Andean fox, 628.9 g. for the mountain cat and 1557.8 g. for puma. The Andean fox feeds mainly (82.4 % of prey items) on preys that weight less than 55 g. (Fig. 1) which are mostly small rodents. The mountain cat and puma also take prey of that weight but in lower percentages (63.6 % and 61.6 % res-

TABLE 1. – Prey in the diet of the Andean fox, mountain cat and puma in the Río Abiseo National Park.

Prey species		Andean fox		Mountain cat	Puma
	weight (g)	N	(% prey)	N	N
Mammals		87	(48.3)		
Marmosa sp.				1	
Agouti taczanowski	4950	4	(2.2)	1	4
Lagidium peruanum	1200	2	(1.1)		
Cavia tshudii	355	13	(7.2)	1	
Auliscomys pictus	51	27	(15.0)	1	2
Thomasomys sp.[a]	42	4	(2.2)	2	1
Thomasomys apeco	242				1
Akodon sp.	24	16	(8.9)	2	1
Oryzomys sp.	12	17	(9.4)	2	1
RO. unidentified[b]	>1000	2	(1.1)		
ro. unidentified[c]	<50	2	(1.1)	2	
Birds					
Scytalopus spp.[d]	15	1	(0.5)		
Diglossa spp.[e]	15	1	(0.5)		
unident. birds		20	(11.1)		1
Frogs	15	10	(5.5)		1
Insects		9	(5.0)		
Plants					
Vaccinium sp.		52	(28.9)	6	3
Total vertebrate prey		119		11	13
Total prey items		180		17	16
Total feces		74		9	9

a=either *T. ischyurus* or *T. incanus*. b= RO:big rodent. c=ro:small rodent. d=probably *S. unicolor* or *S. magallanicus*. e=probably *D. lafresnayii* or *D. carbonaria*.

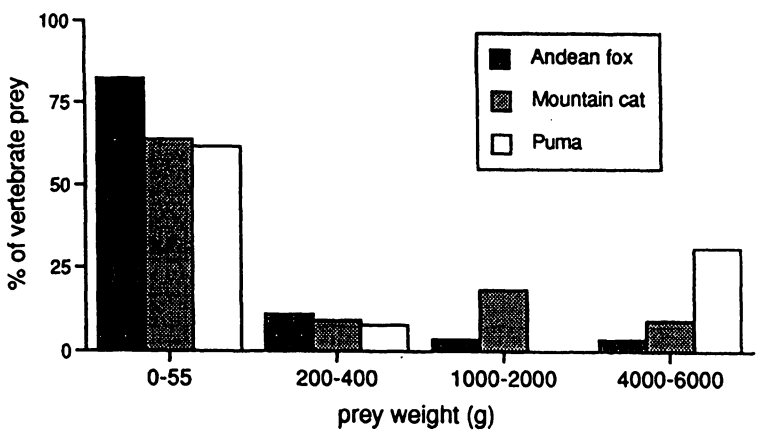

Fig. 1. – Distribution of vertebrate prey weight consumed by the Andean fox, mountain cat and puma in the Río Abiseo National Park.

pectively). A major difference is that the puma preys more upon the biggest rodent of the area *(A. taczanowskii*, 30.8 %) in contrast to the mountain cat that only feeds 9.1 % on this species. In general the mountain cat feeds mostly on smaller rodents (Table 1).

DISCUSSION

Diet of Andean fox in South America

Other studies on the food habits of the Andean fox in Argentina, Chile and Perú (Crespo and De Carlo 1963 ; Jaksíc *et al.* 1980 ; Jaksíc *et al.* 1983 ; Durán 1987 ; Iriarte *et al.* 1989 ; Fugger 1979 ; Falero 1987) show opportunistic feeding behavior, although in some cases some degree of selectivity is reported (Iriarte *et al.* 1989) (Table 2). In Neuquén Province (Argentina), Crespo and De Carlo (1963) reported an almost totally carnivorous diet (96.9 %), with stronger preference for exotic mammals (63 %) than natives ones (37 %). In central Chile, Jaksić *et al.* (1980) found variation in percentages of vertebrates and increase in the percentage of berries from spring to fall. Another study in central Chile, showed some selectivity in Andean fox diets (Iriarte *et al.* 1989). Durán (1982) did not find significant variation in the proportion of vertebrates throughout the year but did find a significantly higher number of young rabbits eaten during the spring in the Chinchilla National Reserve, Chile. In two Peruvian Andes sites in Ayacucho and Cuzco, Fugger (1979) characterized the fox as carnivore (95 and 97 % animal consumption rates), feeding on a great proportion of auquenids. Falero (1987) who studied a population in Lima desert (Lachay « lomas »), reported a population increase in foxes in response to increased rodent densities. These

TABLE 2. – Percentage of prey of the Andean fox in six localities.

Taxon	Argentina Neuquén [a]	Chile Central [b]	Chile T. del Paine[c]	Perú Ayacucho [d]	Perú Cuzco [d]	Perú Abiseo [e]
Mammals	88.8[f]	81.6[g]	48.1	60.4	70.2	48.3
Birds	6.1	4.7	31.5	18.3	14.5	12.2
Amphibians	2.0	3.9		6.2	8.1	
Reptiles						5.6
Total vertebrates	96.9	90.3	79.6	84.9	92.8	66.1
Insects & aracnids	2.7		8.3	10.5	4.0	5.0
Plants		9.7	12.0	4.6	3.2	28.9
N. of vertebrate prey		343	86	329	345	119
Total number of prey		380	108	388	372	180
Total number of scats		318	116	160	160	74

a=Crespo and De Carlo, 1963. b=Jaksic *et al.*, 1980. c=Jaksic *et al.*, 1983. d=Fugger, 1979. e=this work. f=including exotic species. g=percentage corrected to include plants.

studies illustrate the opportunistic nature of the diet of the Andean fox from almost totally carnivorous to highly omnivorous.

Berta (1987) suggests that the high diversity of South American foxes is a consequence of a great availability of small and medium prey, fruits, and grains, but particularly of their opportunistic behavior. Not only diet, but also hunting strategy and solitary behavior contribute to the success of foxes compared to the big South American social or social-solitary canids of the Pleistocene *(Canis, Theriodictes, Protocyon)* that may have been affected by the extinction of their prey, large herbivorous ungulates. At the present there remain only two big carnivores in South America (puma *F. concolor*, and jaguar *P. onca*) ; the reason for their persistence beyond that of big canids is unknown. Diet and behavior of these big felids suggest that their persistence is probably due to their ability to hunt inside the forest (L. Emmons pers. comm.).

Comparison of the diet of the Andean fox, mountain cat and puma

The distribution of the prey weights in the diet of the three big mammal predators at the highest altitudes of the Río Abiseo National Park show clear differences. This prey distribution, besides being the result of physiological restrictions, might have being shaped as the result of competition ; however it is always hard to suggest it without experimentation. The population of puma living in a lowland forest at Cocha Cashu (Madre de Dios, Perú) (Emmons 1987) feeds twice as much (60 %) on prey of more than 4000 g., than in Abiseo. This percentage correspond to *Agouti paca*, « paca » (27 %) and *Dasyprocta variegata*, « agouti » (33 %). Also, the MWVP in Manu is 3400 g. (calculated from data in Emmons 1987), while MWVP in Abiseo is 1558 g. In the same way, the mean biomass per scat in Manu is 4.4 kg while in Abiseo is 2.2 kg. According to these data, we might suggest that pumas in the páramo at Abiseo would have to kill prey more often. These differences in puma prey in the two habitats might be due to differences in faunal composition ; at Cocha Cashu, a lowland rainforest should be not only more diversity and biomass but also more larger prey species than in Abiseo. In the same way, differences in prey/km^2 might imply differences in home range of the two populations of pumas.

Another study of the food habits of pumas in Chile (Yáñez *et al.* 1986) showed percentages of big mammals such artiodactyla (Wild animals and cattle), carnivora and perissodactyla from 13.9 to 46.5 %, and a gross percentage (38.1 to 73.0 %) of the exotic middle sized mammal *Lepus capensis*.

Conservation

According to the rarity classification of Rabinowitz (1986), the Andean fox and the mountain cat can be considered rare species (type E) because they can be found in a widespread geographic range, they are habitat specialists and then occur at low population densities. The puma as a habitat generalist is also considered a rare species but of a different type (type D). Emmons and Feer (1990) cite the pumas as « the most adaptable of the worlds cats ». Arita *et al.* (1990) classified neotropical mammals according to distribution and abundance, and found that the carnivores as a trophic group are in general widespread and locally rare. Robinson and Redford (1986) found that bigger mammals tend to have lower population densities ; and this negative correlation declines faster for carnivores. Arita *et al.* (1990) went further to demonstrate that as the body mass of a species increases, its area of distribution tends to increase and its

local density tends to decrease. As a consequence, species that are widespread but locally rare – the case of the species studied – are the largest. However they also noted that the ultimate causes of rarity are difficult to discern because of the multiple variables (diet, home range and territory size, individual and population growth rate, and carrying capacity) affecting population densities. This diet study is thus a contribution to understanding one aspect of the behavior of these carnivores and its possible implications for populations.

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