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FOOD HABITS OF PUMAS (*Puma concolor*) IN A SEMIARID REGION OF CENTRAL MEXICO

J. Antonio de la Torre[1]* and Gilfredo de la Riva[2]

[1] Instituto de Ecología, UNAM, Laboratorio de Ecología y Conservación de Vertebrados Terrestres, Ap. Postal 70-275, 04510 Ciudad Universitaria, México D. F. *[Corresponding author: <adelatorre@miranda.ecologia.unam.mx>]. [2] Departamento de Biología, Centro de Ciencias Básicas. Universidad Autónoma de Aguascalientes. Blvd. Universidad No. 940, 20100 Aguascalientes, Mexico.

ABSTRACT: The puma's diet in a semi-arid region of central Mexico was determined by scat analyses. The study was conducted at two sites in the state of Aguascalientes: the Natural Protected Area of Sierra Fría and the El Muerto and Laurel ranges. Fifty-five prey items were found in thirty-eight scat samples. The white-tailed deer was the main prey item, followed by the collared peccary and raccoon. Livestock was an important prey item in terms of biomass, with a greater incidence of livestock remains in the scats from the El Muerto and Laurel ranges, possibly due to a reduced native prey base caused by human activities.

RESUMEN: Hábitos alimentarios del puma (*Puma concolor*) en una región semiárida de México central. Se determinó la dieta del puma en una región semi-árida en el centro de México mediante el análisis de excrementos. El estudio se llevó al cabo en dos zonas: el Área Natural Protegida Sierra Fría y en las serranías El Muerto y Laurel. Se identificaron un total de 55 individuos presa en 38 excretas analizadas. El venado cola blanca fue el principal componente de dieta, seguido por el pecarí de collar y el mapache. El ganado representó un importante componente de dieta en términos de biomasa consumida, presentándose una mayor incidencia de ganado en las excretas colectadas en el área que cubre las serranías El Muerto y Laurel, probablemente ocasionado por la baja abundancia de las presas naturales en esta área debido a las actividades humanas.

Key words. Aguascalientes. Cougar. Diet. Mexico.

Palabras clave. Aguascalientes. Dieta. México. Puma.

The puma is the mammal in the American continent with the largest distribution, ranging from Alaska to southern Argentina and Chile (Anderson, 1983; Wilson and Reeder, 1993). The current distribution of pumas in Mexico is unknown, but it has been sharply reduced by hunting and habitat loss (López-González and González-Romero, 1998).

The puma is an opportunistic predator which bases its diet on ungulates, but can feed on any available prey (Iriarte et al., 1990). The diet of the puma is well studied in North America, and generally consists of mule-deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*), supplemented by locally abundant small mammals (Iriarte et al., 1990). Dietary studies conducted in Mexico reported white-tailed deer, peccary (*Tayassu tajacu*), desert bighorn sheep (*Ovis canadensis*) and cattle (*Bos taurus*), as main prey items (López-González and González-Romero, 1998; Nuñez et al., 2000; Rosas-Rosas et al., 2003), but no studies have been published for central Mexico. The presence of the puma in the Mexican state of Aguascalientes, in central Mexico, is well established, but basic aspects of its biology and ecology necessary to determine management and conservation measures are unknown

in the region. Thus, the objective of this study was to determine the components of the diet of the puma in Aguascalientes, as basic information for the creation of a management plan for the species in this region.

The study area was located in western Aguascalientes, between 21º 44'N and 22º 18'N latitude and between 102º 24'W and 102º 46'W longitude. This area is part of the Sierra Madre Occidental and is formed by several mountain ranges with an altitude that ranges from 2000 to 3050 m. The region has a semiarid climate, with summer rains (June-October) and occasional rains during the winter. A small area (less than 5%) in the southwestern part of the state has a temperate climate. Mean annual temperature is 17ºC, and annual rainfall varies from 500 to 700 mm (Secretaria de Programación y Presupuesto, 1981). The dominant vegetation classes between 2000 to 2650 m are chaparral, oak forests, and grasslands. The chaparral is characterized by oaks (*Quercus* spp.), Mexican manzanita (*Arctostaphylos pungens*), yucca (*Yucca filifera*), sotol (*Dasylirion acrotriche*) and nopal (*Opuntia* spp.); oak forests are dominated by oaks, Mexican manzanita, catclaw (*Mimosa monancistra*) and jarilla (*Dodonaea viscosa*); and natural grasslands include *Eragostis* spp., *Mulhenbergia* spp., *Aristida* spp., and *Stipa* spp. Pine-oak forests occur at elevations higher than 2650 m, and consist primarily of juniper (*Juniperus* spp.), oaks, madrone (*Arbutus* spp.) and pine (*Pinus* spp.) (Secretaria de Programación y Presupuesto, 1981; García et al., 1993).

We conducted fieldwork in two different areas, the Natural Protected Area of Sierra Fría and the mountain ranges of El Laurel and El Muerto. The Natural Protected Area of Sierra Fría is located on the northwest side of the state and covers approximately 600 km², including El Pinal, San Blás de Pabellón, Sierra Guajolotes and Sierra Fría ranges. The ranges of El Laurel and El Muerto are in an unprotected area located in the southwestern part of the state, covering approximately 200 km². The white tailed deer is the largest native ungulate in the region and occurs in the two areas. Other animals that occur in both areas are the peccary (*Tayassu tajacu*), the wild turkey (*Mellagris gallopavo*), the raccoon (*Procyon lotor*), the coatí (*Nasua narica*), and the gray fox (*Urocyon cinereoargenteus*). The prey base for pumas is very similar in both areas, but the ranges of El Laurel and El Muerto present a more fragmented habitat than Sierra Fría, due to agriculture and forestry. In addition, the incidence of poaching is greater at El Laurel and El Muerto ranges than in the Natural Protected Area of Sierra Fría. There are no data on prey availability; however, factors mentioned above may influence the densities of natural prey of puma in the study area. Livestock occurs and is widespread in both areas.

We evaluated the puma's diet through the analysis of scats collected from January 2003 to February 2005. Scats were collected opportunistically along dirt roads, trails, and paths. Puma scats were identified on the basis of size (diameter >30 mm), form, color, shape, smell (Shaw, 1990; McKinney, 1996; Aranda, 2000), and by the presence of other puma signs (i.e., tracks, scrapes). We stored the scats in paper bags labeled with date, location and associated sign. Each scat was soaked in soapy water, and washed manually through 1 mm sieves to separate the undigested components (i.e., hair, hooves, claws, teeth and bones). We dried the samples in paper bags for 24-48 hr under 100-watt lights. Sample components were separated into hair, bones, teeth, claws, hooves and plant matter, then stored in individual plastic bags. Prey identification was accomplished by analyzing hair macro- and microscopically, and comparing skeletal material recovered from the scats (i.e., teeth, claws and bones) with area-specific material from the reference mammal collection at Universidad Autónoma of Aguascalientes. For the hair identification we prepared a reference collection to compare microscopic characteristics (cuticular scales and medulla pattern), using the techniques suggested by Moore et al. (1974) and Arita and Aranda (1987). Prey identified from different scats were assumed to represent different individuals unless we found evidence that

the same individual was represented in separate scats, for instance: a) some scats were found on latrines or near each other on the same trail, b) some of these scats clearly had been deposited at the same time, and, c) when we analyzed these scats, we realized that some of the items found obviously were represented in more than one scat, based on the color of hair or the size of hooves and claws. Plant matter and puma hair were excluded from the analysis because they did not represent prey items.

The results of the analysis were expressed in frequency of occurrence (F.O.), which is the percentage of scats in which an item was found. We used the correction factor developed by Ackerman et al. (1984): $Y=1.98+0.035X$; where Y is the mass of prey consumed per scat, and X is prey body mass. This regression was used to convert the prey occurrence to an estimate of the relative biomass and relative number of prey consumed. Estimated mass of wild prey was based on the weights of specimens in the reference mammal collection and published literature (Leopold, 1959; Hall, 1981; Ceballos and Miranda, 2000; Hesselbach and Pérez, 2001; Villa and Cervantes, 2003). For livestock, we assumed that young individuals are preyed on by pumas more frequently than other age classes (Shaw, 1990), and the estimated mass was 100 kg for horses and cattle. G-test analysis was used to test the difference in prey frequency distribution between the Natural Protected Area of Sierra Fría and the mountain ranges El Muerto and Laurel. We grouped the data of prey items in six categories (*O. virginianus*, *T. pecari*, Livestock, Carnivores, Small mammals and Birds) before analyzing it with the G-test.

Diet of pumas in central Mexico was determined from thirty-eight analyzed scats from both study areas in Aguascalientes. Fifty-five prey items were found belonging to 14 different prey, with 11 of these identified to species level (**Table 1**). Frequency of occurrence indicated that white-tailed deer was the main prey item, followed by the peccary and the raccoon. The white-tailed deer accounted for the greatest biomass consumed and the lago-

Table 1

Frequency of occurrence, estimated biomass consumed, and estimated numbers of individuals consumed by pumas in Aguascalientes Mexico, based on the contents of scats collected from January 2003 to February 2005 (n = 38).

Prey category	Frequency of occurrence	Prey weight (kg.)	Correction factor	Relative biomass consumed	Relative number of individuals consumed
Odocoileus virginianus	42.11	38	3.310	36.4	6.8
Tayassu tajacu	15.79	20	2.680	11.1	3.9
Procyon lotor	15.79	6	2.190	9.0	10.8
Lagomorph	10.53	2	2.050	5.6	20.1
Mephitis macroura	10.53	2	2.050	5.6	20.1
Didelphis virginiana	7.89	1.5*	1.500	3.1	14.7
Equus caballus	7.89	100	5.480	11.3	0.8
Bos taurus	5.26	100	5.480	7.5	0.5
Canis latrans	5.26	13	2.435	3.4	1.8
Mellagris gallopavo	5.26	4	2.120	2.9	5.2
Urocyon cinereoargenteus	5.26	4	2.120	2.9	5.2
Bassariscus astutus	2.63	1*	1.000	0.7	4.9
Squirrels	2.63	0.5*	0.500	0.3	4.9
Unknown bird	7.89	-	-	-	-

*No correction factor, see Ackerman et al. (1984).

morphs and skunks were the highest estimated number of consumed prey (**Table 1**). These results are similar to other studies of food habits in Mexico and North America (Ackerman et al., 1984; Iriarte et al., 1990; Nuñez et al., 2000), where large ungulates, in particular deer, represent the main prey item. We observed that an important proportion of the puma's diet in Aguascalientes is conformed by fawns because 18.42% of the scat samples contained hooves from young deer. Dominance of young deer in the diet of pumas has been reported, reflecting the greater vulnerability of the younger age class (Hornocker, 1970; Pierce et al., 2000; Husseman et al., 2003).

In this region, livestock seems to be an important dietary resource as well. In terms of biomass, horses represent the second most important food item, and cattle, the fifth. However, horses and cattle represent the last items in terms of relative number of individuals consumed, suggesting that the actual number of livestock preyed on by puma in the region could be low (Ackerman et al., 1984). Even though livestock appears to be widespread and abundant in the study area, puma predation upon livestock is incidental, and in some cases reports of predation are exaggerated because it results in economic losses (pers. observ). An important cause of predation of puma upon livestock in the region is poor management of the cattle. They graze freely, with no control of the place and time of birth, and often calves and colts are left unattended in puma habitat (Shaw, 1982; Shaw, 1990).

The main prey item in Sierra Fría was the white-tailed deer followed by the peccary. In the mountain ranges of El Muerto and Laurel the main prey items were livestock and white tailed deer (**Table 2**). We detected a significant variation in the occurrence of prey items between the two study areas ($G = 13.73$, $d.f. = 5$, $P < 0.05$). However, the sample size of this study is small and comparisons between the two areas must be considered with caution.

In the Natural Protected Area of Sierra Fría the peccary is an important prey item, but it was absent in the scat samples analyzed for the mountain ranges of El Muerto and Laurel, despite being present in the area. We speculate that the densities of peccaries are low at the ranges of El Muerto and Laurel in contrast with Sierra Fría. Other studies have documented the peccary as part of the puma's diet, which has been used in proportion to its avail-

Table 2

Components of puma's diet based on scat contents, expressed in frequency of occurrence (percentage in parentheses), for the two areas in the state of Aguascalientes, Mexico.

Prey item	Natural Protected Area Sierra Fría (n = 24)	Mountains ranges El Muerto y Laurel (n = 14)
Odocoileus virginianus	12 (50)	4 (28.6)
Livestock	1[a] (4.1)	4[b] (28.6)
Tayassu tajacu	6 (25)	-
Procyon lotor	4 (16.6)	2 (14.3)
Lagomorphs	2 (8.3)	2 (14.3)
Mephitis macroura	2 (8.3)	2 (14.3)
Unknown bird	1 (4.1)	2 (14.3)
Didelphis virginiana	-	3 (21.4)
Canis latrans	1 (4.1)	1 (7.1)
Mellagris gallopavo	1 (4.1)	1 (7.1)
Urocyon cinereoargenteus	2 (8.3)	-
Bassariscus astutus	1 (4.1)	-
Squirrels	1 (4.1)	-

[a] 1 cow; [b] 3 horses, 1 cow

ability (Cunningham et al., 1995; Harveson et al., 2000). Higher occurrence of livestock in the puma's diet in the ranges of El Muerto and Laurel can be explained in terms of prey availability. Native prey densities at the ranges of El Muerto and Laurel could be declining because of human activities such as agriculture and poaching. Low abundance of native prey combined with a greater availability and bad management of livestock could favor the greater incidence of livestock predation in this area (Shaw, 1990). Illegal puma control has been reported in Aguascalientes, because ranchers see the puma as a pest. Predation on livestock is the greatest conflict between humans and pumas, so the reduction of livestock loss is essential to improve the conservation of this species in the region.

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