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ORIGINAL ARTICLE

ON THE DIET OF THE MAGELLANIC GREAT HORNED OWL (*BUBO VIRGINIANUS MAGELLANICUS*) IN ANDEAN CENTRAL CHILE

Gabriela Pizarro[1], Alonso Silva[2], Diego Ramírez-Álvarez[3], Guillermo D'Elía[4], Fredy Mondaca[4], Hernan Cañon-Jones[1*]

[1] Núcleo de Investigación Aplicada en Ciencias Veterinarias y Agronómicas, Facultad de Medicina Veterinaria y Agronomía, Universidad de Las Américas, Santiago, Chile.

[2] Parque Safari Chile, Rancagua.

[3] Servicio Agrícola y Ganadero de Chile, Dirección Regional O'Higgins. Rancagua.

[4] Instituto de Ciencias Ambientales y Evolutivas, Universidad Austral de Chile, Valdivia.

E-mail: Hernan Cañon-Jones · hcanon@udla.cl

Abstract · The Magellanic Great Horned Owl,or *tucúquere* (*Bubo virginianus magellanicus*), is a bird of prey of agroecological and environmental importance in Chile. However, there is a gap in what we know about its diet in mountainous regions of central Chile, where its interaction with the human populations is large and anthropic-derived habitat changes are increasing. We collected 91 pellets from two individuals to assess their diet. Analysis of pellet weight, length and width, prey identification to species, as well as absolute and relative abundance, were obtained. From these values, we calculated trophic niche (Levin, Shannon-Wiener, and Smith indexes). The mean weight, length, and width of pellets were 9.84 g, 56.7 mm, and 32.6 mm, respectively. The consumption of 12 different prey species was evidenced, being the most consumed the introduced hare *Lepus capensis* (23.53%), followed by the chinchilla rat *Abrocoma bennetti* (20.59%), and thereafter other species of small rodents, an undetermined bird, and insects. The trophic niche amplitude for normal and standardised Levin, normal and standardised Shannon-Wiener, and Smith (TF) indexes were 6.72, 0.52, 2.11, 0.85, and 0.90, respectively. This is the first evidence of a diet based predominantly on *L. capensis* in central Chile for *B. v. magellanicus*, which seems to be a more generalist predator than previous studies report. Out study contributes to the understanding of food habits and conservation efforts for this raptor species in Chile and the rest of South America.

Resumen · Sobre la dieta del tucúquere (*Bubo virginianus magellanicus*) en la zona central andina de Chile

El búho magallánico, o tucúquere (*Bubo virginianus magellanicus*), es un ave de rapiña de importancia agroecológica y ambiental en Chile. Sin embargo, existe una brecha en el conocimiento sobre la composición de su dieta en regiones montañosas de los Andes en el centro de Chile, donde existe una mayor interacción con la población humana y un aumento de cambios en el hábitat. Se recolectaron 91 egagrópilas de una pareja de *B. v. magellanicus.* Se analizó el peso, longitud y ancho de estas, y se caracterizaron las presas hasta el nivel de especie. Se calculó la abundancia absoluta, relativa y nicho trófico (índices de Levin, Shannon-Wiener y Smith). El promedio del peso, longitud y ancho de las egagrópilas fue de 9,84 g, 56,7 mm y 32,6 mm, respectivamente. Se colectó evidencia de 12 especies diferentes de presas; la más consumida fue *Lepus capensis* (23,53%), seguida de *Abrocoma bennetti* (20,59%), otras especies de pequeños roedores, un ave e insectos indeterminados. La amplitud del nicho trófico para los índices de Levin, Shannon-Wiener y Smith (TF) normales y estandarizados fueron de 6,72, 0,52, 2,11, 0,85 y 0,90, respectivamente. Esta es la primera evidencia de una dieta basada principalmente en *L. capensis* en Chile central para *B. v. magellanicus*, que parece ser un depredador más generalista de lo que evidencian estudios anteriores. Los resultados son de importancia para la comprensión de hábitos de alimentación y los esfuerzos de conservación de esta especie en Chile y Sudamérica.

Key words: Chile · Tucúquere · Pellet · Prey · Trophic niche

INTRODUCTION

The Magellanic Great Horned Owl (*Bubo virginianus magellanicus*), locally known as *tucúquere*, is the largest owl in Chile, with a body length of 45–50 cm, a wingspan of 110–118 cm, and a weight range of 825–975 g (Figueroa 2015). It is widely distributed in Chile, occupying areas up to 4500 m a.s.l. in the Andes (Pavez et al. 2004, Figueroa 2015). Its habitat includes prairies, scrubs, and pine plantations interspersed with native forest (Figueroa 2015).

It is widely accepted that *B. v. magellanicus* plays an important role in trophic chains as a top predator controlling the natural populations of its prey species, contributing to environmental health and providing an important ecosystem service

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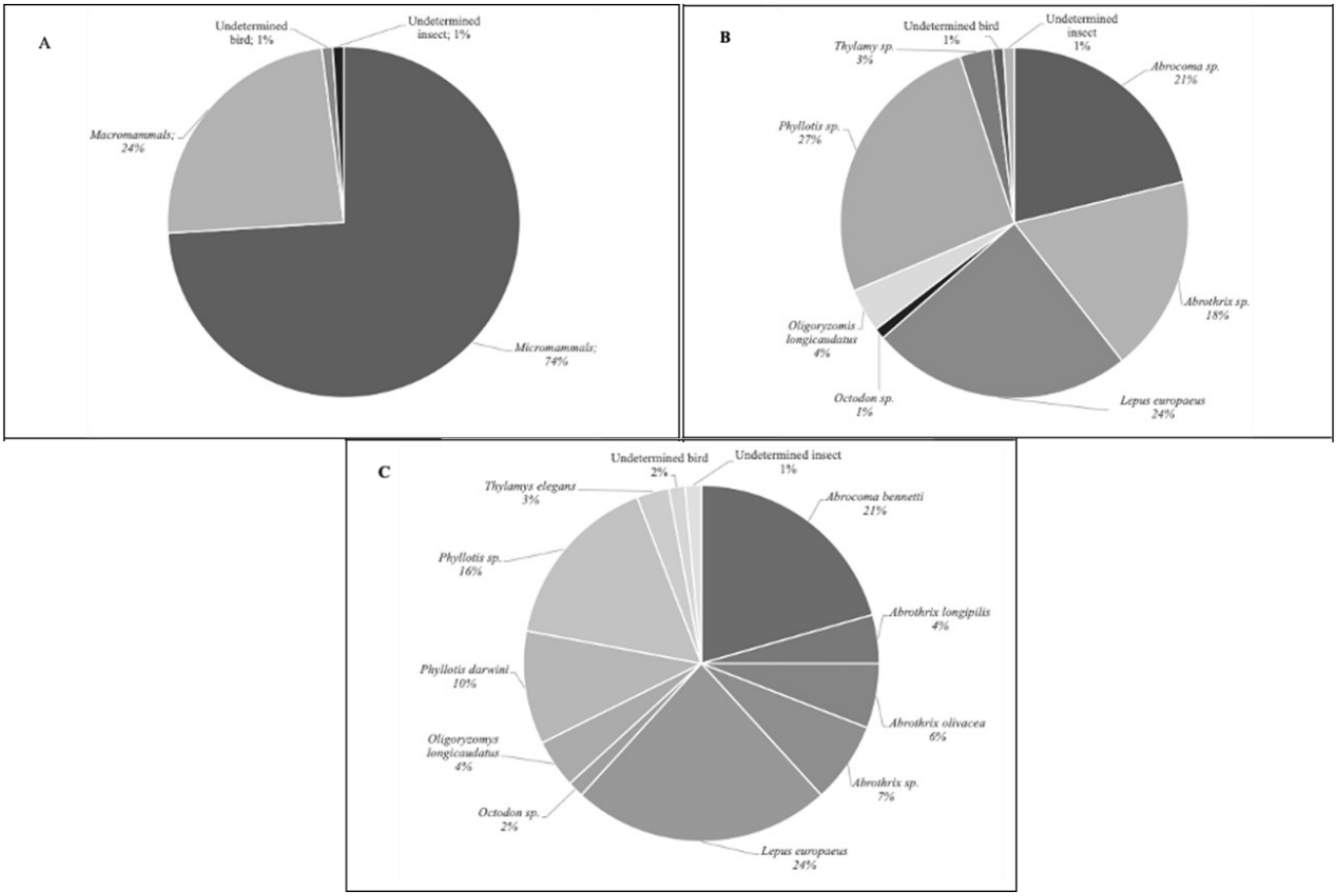

Figure 1. Relative abundance of distinct groups, genera, and species preyed by *B. v. magellanicus* in an Andean location of central Chile. (A) Group level; B) Genus level; C) Species level.

(Monserrat et al. 2005). Over half of its known diet consists of rodents (Marti 1987, Reise & Venegas 1974, Murphy 1997), some of which have been recognised as reservoirs of zoonotic diseases (e.g. hantavirus), and other prey considered agricultural pests (Muñoz-Pedreros et al. 2010). In Chile, *B. v. magellanicus* is currently regarded as a beneficial species for forestry and agriculture, helping maintain the functionality of natural ecosystems, and is legally protected by the Hunting Law (Ministerio de Agricultura de Chile 1996) and the Protection of Animals Law (Ministerio de Salud de Chile 2017).

The study of owl pellets allows to characterise the diet of prey birds and predatory behavior (Errington 1930). One to two pellets are normally regurgitated each day, and their shape may vary according to the species of owl and the number of prey items consumed (Marti 1987). *B. v. magellanicus* regurgitates a single pellet, at dusk, which contains rests of preys ingested the night before (Muñoz & Rau 2004). Most studies on the diet of *B. v. magellanicus* using pellets have been carried out in North America and have enabled the description of its nocturnal foraging habits and opportunistic behaviour (Johnsgard 1988, Morrell & Yahner 1994, Murphy 1997, Rohner & Krebs 1996, Cromrich et al. 2002, Aragón et al. 2002). These findings coincide with the few available studies in South American populations of this raptor characterising it as a generalist-opportunistic species with a tendency to a specialised consumption of small mammals (Massoia 1994, Trejo & Grigera 1998, Tomazzoni et al. 2004, Nabte et al. 2006, Donadio et al. 2009, Teta et al. 2010).

In Chile, studies of feeding habits of *B. v. magellanicus* have been limited to the Patagonian grasslands (Aysén and Magallanes regions), habitats where the owls have little or no human interaction (Mella 2002). These earlier studies showed that this owl tends to specialise in small rodents (up to 70%), consuming items according to the prey availability, size, and their period of activity (Jaksic et al. 1980, Tala & Mussa 1995, Mella 2002). These results coincide with a more recent study in the Chilean Patagonia, confirming a high consumption of micromammals, but also larger prey such as lagomorphs (Figueroa 2015). Only a few studies have been carried out in central Chile, showing that its diet is composed of small rodents (62%) and invertebrates (38%; Mella 2002). The most commonly described rodent species consumed in central Chile are Darwin's Leaf-eared Mouse (*Phyllotis darwini*), the Long-haired Mouse (*Abrothrix longipilis*), the Olive Mouse (*Abrothrix olivaceus*), the Silky Noah's Mouse (*Euneomys noei*), the Chinchilla Rat *(Abrocoma bennetti)*, and the invasive Black Rat (*Rattus rattus)* (Jaksic et al. 1980, Jaksic & Marti 1984, Mella 2002).

However, there is a gap in what we know of the diet of *B. v. magellanicus* in the central Andean region of Chile, where interaction with human settlements is now greater than in other regions, and habitat changes by humans are severe. There is no data available on the diet of *B. v. magellanicus* in the O'Higgins region, where agriculture is the main activity. Consequently, this study was carried out to help characterise the diet of *B. v. magellanicus* in Andean areas of the O'Higgins region in central Chile. The information presented here may be relevant for the design of strategies to ensure stable populations of *B. v. magellanicus* in this area.

Table 1. Weight, length, width and area (mean ± SD) of pellets of *B. v. magellanicus* found in central Chile according to prey type. Letters [a] and [b] represent statistical differences between species at $P < 0.05$. SD = standard deviation .

Group	Species	Weight (g)	Length (mm)	Width (mm)	Area (cm^2)	N
Mammals	*Abrocoma bennetti*	7.2 ± 3.8[ab]	56.0 ± 14.8[a]	32.6 ± 7.8[ab]	1.7 ± 0.8[ab]	14
	Abrothrix longipilis	8.2 ± 4.1[ab]	67.3 ± 14.1[a]	50.3 ± 16.7[b]	3.5 ± 1.6[b]	3
	Abrothrix olivacea	7.0 ± 3.3[ab]	61.2 ± 21.7[a]	38.0 ± 16.4[ab]	2.5 ± 1.7[ab]	4
	Abrothrix sp.	6.3 ± 3.3[ab]	56.0 ± 10.8[a]	35.0 ± 14.5[ab]	2.0 ± 1.2[ab]	5
	Lepus capensis	21.3 ± 17.7[a]	57.1 ± 9.5[a]	30.0 ± 6.4[ab]	0.7 ± 0.9[ab]	16
	Octodon sp.	10.4 ± 0.0[ab]	80.0 ± 0.0[a]	40.0 ± 0.0[ab]	3.2 ± 0.0[ab]	1
	Oligoryzomys longicaudatus	5.0 ± 0.5[ab]	53.3 ± 10.4[a]	26.6 ± 2.8[ab]	1.4 ± 0.1[ab]	3
	Phyllotis darwini	5.6 ± 2.2[b]	57.9 ± 11.8[a]	30.0 ± 5.7[ab]	1.7 ± 0.6[ab]	7
	Phyllotis sp.	3.9 ± 1.0[b]	47.6 ± 8.6[a]	26.8 ± 4.6[a]	1.2 ± 0.3[a]	11
	Thylamys elegans	8.7 ± 2.3[ab]	71.0 ± 12.7[a]	33.5 ± 9.1[ab]	2.4 ± 1.0[ab]	2
Birds	Not determined	11.6 ± 0.0[ab]	70.0 ± 0.0[a]	60.0 ± 0.0[b]	4.2 ± 0.0[ab]	1
Insects	Not determined	3.6 ± 0.0[ab]	52.0 ± 0.0[a]	31.0 ± 0.0[a]	1.6 ± 0.0[ab]	1
Total mean ± SD		9,8 ± 10.9	56.7 ± 13.2	32.6 ± 10.4	1.9 ± 1.0	

Table 2. Absolute and relative abundance (%) of group and species preyed by *B. v. magellanicus* at an Andean zone of central Chile.

Group	Species	Absolute abundance (N)	Relative abundance (%)
Mammals	*Abrocoma bennetti*	14	20.59
	Abrothrix longipilis	3	4.41
	Abrothrix olivacea	4	5.88
	Abrothrix sp.	5	7.35
	Lepus capensis	16	23.53
	Octodon sp.	1	1.47
	Oligoryzomys longicaudatus	3	4.41
	Phyllotis darwini	7	10.29
	Phyllotis sp.	11	16.18
	Thylamys elegans	2	2.94
Birds	Not determined	1	1.47
Insects	Not determined	1	1.47
Total		68	100

METHODS

Pellets of *B. v. magellanicus* were collected at La Buitrera, an Andean plateau located in the O'Higgins Region, central Chile (33°56´14”S, 70°34´49”W). A total of 91 pellets from two *B. v. magellanicus* individuals (one female and one male) were collected during March 2017 and authorized by the staff of the Agricultural and Livestock Service, Ministry of Agriculture of Chile. The procedure for collecting the samples consisted on the initial identification of the sites, perches, or places for feeding and hunting through the direct observation of the owl and using camera traps one week before pellet collection. Pellets were placed in paper bags, labeled, and sent for analysis to the Universidad Austral de Chile, Valdivia. No direct interaction or manipulation of *B. v. magellanicus* individuals were conducted.

The analysis of pellets was carried out following a modified wet method described by Marti (1987). Briefly, the length, width, and weight of pellets were measured and then moistened for 12–24 hours with distilled water to break them down, avoiding damage to bone remains. Each component was separated and classified by food item (prey) using a stereoscopic microscope. Bone, chitinous material, hairs, and feathers were stored in coded bags. Prey items were sorted into three main groups: mammals (bones and hairs), birds (pneumatic bones and feathers), and insects (exoskeleton). Mammals, which constituted the most abundant group, were further identified to the species level using a key (Reise & Venegas 1974) and comparative material housed at the Colección de Mamíferos de la Universidad Austral de Chile.

Absolute abundance was determined for each group, expressed as the number of species occurring in the pellets. Relative abundance was also determined, expressed as the relationship between the number of species observed in pellets as a function of their absolute abundance. Trophic niche amplitude was calculated using the Levin niche amplitude index (*B*), the standardized Levin index, the normal and standardized Shannon-Wiener indexes (*H’ and H’* standardized), and the Smith index (*TF*) described by Colwell and Futuyma (1971) and Krebs (1999). All analyses were carried out using the free statistical software R (R Development Core Team 2014).

RESULTS

Species-level identification of prey items was possible in 73.7% (N = 67) of the samples. Eight mammal species were identified, including six native rodents, one native marsupial, and an invasive lagomorph. Some remains were identified only to genus level (Figure 1, Table 1). *B. v. magellanicus* consumed at least 10 species of prey, mostly *Lepus capensis* and *Abrocoma bennetti,* and other species, as shown in Table 2 and Figure 1. Mammal prey accounted for 83% of the identified items. In fact, there were significant differences between the prey species consumed ($\chi 2 = 53.41$, df = 11, $P < 0.001$). Normal and standardized Levins (*B*) index, normal and standardized Shannon-Wiener (*H’*) and standardized Smith (*TF*) were 6.72, 0.52, 2.11, 0.85 and 0.90, respectively, at the species level (Table 3).

All pellets contained a single prey species, except for one pellet that contained two rodents (*Abrothrix longipilis* and *Phyllotis darwini*). The average weight, length, width, and areas of the pellets were 9.84 g, 56.7 mm, 32.6 mm and 1.9 cm^2, respectively. We found that pellets were significantly different in their dry weight ($F_{11,56} = 2.935$, $P = 0.01$), width ($F_{11,46} = 2.76$, $P < 0.01$), and area ($F_{11,47} = 2.47$, $P = 0.02$), depending on the prey species they contained. Pellets containing *L. capensis* were significantly heavier ($P < 0.05$) than

Table 3. Levin, Shannon-Wiener, and Smith indexes calculated from pellets of *B. v. magellanicus* in central Chile.

Index	Species	Genus	Group
Levin B	6.72	4.94	1.68
Levin B (standardised)	0.52	0.44	0.17
Shannon-Wiener H'	2.12	1.75	0.69
Shannon-Wiener H' (standardised)	0.85	0.80	0,50
Smith TF	0.9	0.87	7.93

those containing *A. bennetti*, *Phyllotis darwini*, and *Phyllotis* sp., but similar in weight to those containing other prey species (Table 1). Pellets containing *Phyllotis* sp. had significantly smaller areas ($P < 0.05$) than those of *A. longipilis* and the pellet that contained an undetermined bird (Table 1). Finally, pellets containing *A. longipilis* had a significantly larger area ($P < 0.05$) than those containing *Phyllotis* sp. (Table 1).

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