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DIET OF BARN OWL (*TYTO ALBA*), SPECTACLED OWL (*PULSATRIX PERSPICILLATA*) AND RUFOUS-BANDED OWL (*STRIX ALBITARSIS*) IN THE WESTERN ANDES OF COLOMBIA

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Abstract · Dietary studies are one of the most developed research areas in biology and ecology studies of Neotropical owls, but most of these studies have focused on few species. Our study describes the diet of Barn Owl (*Tyto alba*), Spectacled Owl (*Pulsatrix perspicillata*), and Rufous-banded Owl (*Strix albitarsis*) in Jardin and Ciudad Bolivar, western Andes of Colombia. The diet of *T. alba,* based on 495 prey items consisted 98.6% of vertebrates, the main food items being rodents (66%) and shrews (21.4%). Out of 142 prey items identified from *P. perspicillata* fractured pellets, the main prey species were *Artibeus lituratus* (23.9%), *Rattus norvegicus* (21.8%), and *Didelphis* sp. (16.1%), species of small and medium-sized mammals that tolerate environmental changes and often live in urban areas. *Pulsatrix perspicillata* preyed also on at least 14 bird species including hummingbirds and migratory birds. Based on 165 prey items *S. albitarsis* consumed more invertebrates (57.7%) than vertebrates (42.3%). Among the insects, the main preys were Coleoptera beetles and Orthoptera crickets. Among the vertebrates, the main prey species included mammals such as *Thomasomys aureus, Marmosops* sp., *Marmosa* sp., and *Reithrodontomys mexicanus*. These scansorial species are likely to be vulnerable to aerial predators such as *S. albitarsis* which hunt from a perchs. According to standardized Levins index values *T. alba* was the most selective in its food habits, *P. perspicillata* had intermediate values, while *S. albitarsis* showed the least selective diet.

RESUMEN · Dieta de la Lechuza Común (*Tyto alba*), el Búho de Anteojos (*Pulsatrix perspicillata*) y el Búho Ocelado (*Strix albitarsis*) en la cordillera Occidental de Colombia Los estudios sobre hábitos tróficos constituyen la línea de investigación más desarrollada dentro de la biología y ecología de los búhos Neotropicales, pero la mayoría de esos estudios se han centrado en pocas especies. El propósito de este estudio es describir la dieta de la Lechuza Común (*Tyto alba*), el Búho de Anteojos (*Pulsatrix perspicillata*) y el Búho Ocelado (*Strix albitarsis*), en Jardín y Ciudad Bolívar, cordillera Occidental de Colombia. Identificamos 495 presas consumidas por *T. alba.* Su dieta estuvo compuesta en un 98.7% de vertebrados, principalmente roedores (66%) y musarañas (21.4%). De 142 presas de *P. perspicillata*, las presas principales, *Artibeus lituratus* (23.9%), *Rattus norvegicus* (21.8%) y *Didelphis sp.* (16.1%), son especies tolerantes a los ambientes intervenidos y hacen parte de los ensamblajes de pequeños mamíferos encontrados en ambientes urbanos. *Pulsatrix perspicillata* consumió también al menos 14 especies de aves incluyendo colibríes y aves migratorias. En base a 165 presas *S. albitarsis* consumió más invertebrados (57.7%) que vertebrados (42.3%). Entre los insectos depredó en mayor porcentaje los ordenes Coleoptera y Orthoptera, mientras que entre los vertebrados predominaron los de hábitos escansoriales (*Thomasomys aureus, Marmosops* sp., *Marmosa* sp. y *Reithrodontomys mexicanus*). Estos vertebrados serían más vulnerables a depredadores aéreos como *S. albitarsis*, la cual caza desde perchas en árboles. De acuerdo a los valores obtenidos para el indice estandarizado de Levins, *T. alba* fue más selectiva en el consumo de las presas, seguida por *P. perspicillata*, mientras que *S. albitarsis* tiene la dieta menos selectiva.

Key words: Antioquia · Biomass · Food niche · Neotropical owls · Strigiformes

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INTRODUCTION

Dietary studies are one of the most active areas of research in the biology and ecology of Neotropical owls, but most of these studies have focused on a few species, such as Barn Owl (*Tyto alba*), Great Horned Owl (*Bubo virginianus*), Magellanic Horned Owl (*B. magellanicus*), and Burrowing Owl (*Athene cunicularia*) (Enríquez et al. 2006, Bó et al. 2007, Raimilla et al. 2012). In South America, this type of research has been mainly undertaken in Argentina and Chile where studies also have included niche overlap of sympatric species (e.g., Trejo et al. 2005, Donadío et al. 2009). In Colombia, previous research has covered the diet of *T. alba* (Delgado-V & Cataño 2004, Delgado-V & Calderón 2007, Delgado-V & Ramírez 2009), Tropical Screech Owl (*Megascops choliba*) (Delgado 2007), and Striped Owl (*Asio clamator*) (Delgado-V et al. 2005). Here we aim to increase knowledge on the diet of Andean owls in Colombia by presenting new data on the diet of Barn Owl (*T. alba*), Spectacled Owl (*Pulsatrix perspicillata*), and Rufous-banded Owl (*Strix albitarsis*) in Jardin and Ciudad Bolivar, in the western Andes of Colombia.

New World populations of the Barn Owls are often separated from the Common Barn Owl as American Barn Owl *T.* (*alba*) *furcata*, which is widespread from North America to the southern tip of Argentina (Aliabadian et al. 2016). It lives in a variety of habitats, and consumes mainly small rodents but also birds, frogs, reptiles, bats, and insects (König et al. 2008). Food niche and trophic interactions of *T. alba* are more studied than any other owl in Neotropical region (e.g., Bó et al. 2007, Raimilla et al. 2012).

Pulsatrix perspicillata is distributed from South Mexico trough Costa Rica, Panama, Colombia, Ecuador, Venezuela, Guianas, Peru, Brazil, and Bolivia to North Argentina (König et al. 2008). It lives in the humid lowland forests, riverside forests with open areas, flooded forests, forest edges, and urban areas (Lloyd 2003, Rivera-Rivera et al. 2012, Marín-Gómez et al. 2017). It feeds on a variety of prey, including medium sized mammals, birds, bats, insects, lizards, and freshwater crustaceans (Gómez de Silva et al. 1997, Voirin & Kays 2009, Daza et al. 2017).

Strix albitarsis occurs from Venezuela and Colombia south in Andean region through Ecuador and Peru to Bolivia (König et al. 2008). It inhabits humid mountain forests and cloud forests, but is also found in open areas with scattered trees between forested areas (Marks et al. 1999, König et al. 2008). Very little is known of its diet. Greeney (2003) and Cadena-Ortiz et al. (2013) have shown with small samples that it preys on small mammals and insects.

METHODS

Study area. This study was undertaken in Jardin and Ciudad Bolivar, in the southwest of the department of Antioquia, western Andes of Colombia. In Jardin, we found two *T. alba* nest sites, one in the urban area in the church compound (05°35'N, 75°49'W; 1.760 m a.s.l.), and another in an abandoned house in the rural area (05°35'N, 75°47'W; 2.400 m a.s.l.) located in secondary forest in El Clavel nature reserve. *Strix albitarsis* pellets were found in a breeding site in the rural area in La Tebaida site, in a *Pinus patula* (Pinaceae) plantation (05° 34'N, 75° 46'W; 2.430 m a.s.l.), which was planted in 2005 for the timber production. *Tyto alba* and *S. albitarsis* samples were collected in an area of 5.02 km^2. *Pulsatrix perspicillata* fractured pellets were found in Ciudad Bolivar, which is 73.6 km from Jardin. The sampling site was a breeding site in urban area in a remaining riverside forest in 6th Street site (05°50'N, 76°01'W; 1.183 m a.s.l.). Identity of owls was visually confirmed at each collection site. The environment in Jardin and Ciudad Bolivar is composed by a riverside forest mosaic, secondary and primary forest, open areas for the cattle and agriculture, human structures, and planted forests of *P. patula* and *Eucalyptus* sp. (Myrtaceae) (Delgado-V & Ramírez 2009, pers. observ.).

Sampling. Pellets of *T. alba* and *S. albitarsis* were collected occasionally between October 2014 and February 2015, but for *P. perspicillata* fractured pellets and other food remains systematic weekly collection took place between June 2015 and April 2017. Pellets and food remains were soaked in a NaOH / H_2O solution separating the bone and exoskeleton material from the fur (Marti et al. 2007). Prey items were identified as far as possible comparing the remains with the Mammalogy Collection in the University of Antioquia (CTUA), and the biological collection of Natural Science Institute of the National University (ICN-UN). Prey items were afterwards deposited at the Natural History Collection in Museum Centre of Caldas University (MHN-UCa).

Data analysis. To study the owls' food niche breadth Levins' indexes (1968) were calculated. Index B = $1/\Sigma\ pi^2$, in which pi is the percentage of each prey category. To estimate the niche breadth we used the standardized Levins index: Bsta = (B - 1) / (n - 1), where n is the number of prey categories (Colwell & Futuyma 1971). Standardized Levins index values range between 0 (minimum niche breadth and, consequently, maximum selectivity) and 1 (maximum niche breadth, minimum selectivity; Krebs 1999). Biomass contribution for each prey type was calculated with the index developed by Marti (1987): Bi = 100[(Spi Ni) / Σ (Spi Ni)], where Spi is the weight of species i and Ni is the number of individuals of the species i. Bi is the total biomass percentage contributed by species i. The average weights of mammal and bird prey species were obtained from CTUA, ICN-UN, and MHN-UCa, and partly from the literature (Tirira 2007, Dunning 2008). In some prey categories, it was not possible to calculate the biomass contribution (frogs and insects) as often it was impossible to identify the prey species to genus and species level.

Table 1. Prey items consumed by two pairs of Barn Owl (*Tyto alba*), one pair of Spectacled Owl (*Pulsatrix perspicillata*), and one pair of Rufous-banded Owl (*Strix albitarsis*) in Jardin and Ciudad Bolivar, western Andes of Colombia. Prey weight (W), number of prey (N), numerical percentage (F%), and biomass percentage (B%). *This category comprises all small Sigmodontinae rats (10–16 g) which were not possible to identify down to genus or species level (average weight 13 g used in biomass calculation). **This term refers to small marsupials belonging to genus *Marmosa*, *Marmosops*, *Micoureus*, or *Gracilinanus* (calculated average weight 54.2 g used).

Prey species	W (g)	*Tyto alba*			*Pulsatrix perspicillata*			*Strix albitarsis*		
		N	F%	B%	N	F%	B%	N	F%	B%
Mammalia		441	89		112	78.8		70	42.3	
Rodentia		327	66		32	22.5		43	26	
Akodon affinis	20	33	6.6	9.21						
Heteromys australis	38	2	0.4	1.06						
Microryzomys sp.	11.3	66	13.3	10.4						
Nephelomys albigularis	58.2	1	0.2	0.81						
Neusticomys sp.	26.4	10	2	3.68						
Rattus sp.	162.1	4	0.8	9.04						
Rattus norvegicus	226				31	21.8	25.49			
Reithrodontomys mexicanus	15.2	16	3.2	3.39				4	2.4	2.77
Thomasomys aureus	81.7							10	6.1	37.24
Thomasomys sp.	36.6							1	0.6	1.66
Sigmodontinae unidentified*	13	177	35.7	32.1	1	0.7	0.04	28	17	16.59
Rodentia unidentified		18	3.6							
Didelphimorphia		7	1.4		29	20.4		25	15.1	
Marmosa sp.	51.1							1	0.6	2.32
Marmosops sp.	27.3	5	1	1.9				17	10.3	21.15
"Marmosa"**	54.2	2	0.4	1.51	6	4.2	0.39	7	4.2	17.29
Didelphis sp.	716.7				23	16.1	59.9			
Soricomorpha		106	21.4					2	1.2	
Cryptotis sp.	10.4	106	21.4	15.3				2	1.2	0.94
Chiroptera		1	0.2		45	31.6				
Artibeus lituratus	59.4				34	23.9	7.35			
Phyllostomus discolor	36.5				7	4.9	0.92			
Phyllostomus hastatus	95.2				1	0.7	0.34			
Sturnira sp.	21.4	1	0.2	0.29						
Phyllostomidae unidentified					1	0.7				
Stenodermatinae unidentified					2	1.4				
Mammalia unidentified					6	4.2				
Aves		10	2		25	17.6				
Columbiformes		2	0.4		2	1.4				
Columba livia	354.5	2	0.4	9.89	2	1.4	2.58			
Passeriformes		8	1.6		18	12.6				
Tyrannus melancholicus	37.4				5	3.5	0.68			
Sayornis nigricans	18.6				1	0.7	0.06			
Pitangus sulphuratus	61				1	0.7	0.22			
Catharus ustulatus	30.3				1	0.7	0.11			
Thraupis episcopus	35				1	0.7	0.12			
Vireo olivaceus	16.8				1	0.7	0.06			
Euphonia laniirostris	15				1	0.7	0.05			
Elaenia frantzii	19.6	2	0.4	0.54	1	0.7	0.07			
Zonotrichia capensis	20.4	2	0.4	0.56						
Myioborus ornatus	11.7	1	0.2	0.16						
Tangara sp.					1	0.7				
Sporophila sp.		1	0.2							
Thraupidae unidentified					1	0.7				

Table 1. Continuation.

Prey species	W (g)	*Tyto alba*			*Pulsatrix perspicillata*			*Strix albitarsis*		
		N	F%	B%	N	F%	B%	N	F%	B%
Passeriformes unidentified		2	0.4		4	2.8				
Psittaciformes					1	0.7				
Forpus conspicillatus	26.4				1	0.7	0.09			
Cuculiformes					1	0.7				
Crotophaga ani	101.8				1	0.7	0.37			
Piciformes					1	0.7				
Melanerpes rubricapillus	52.4				1	0.7	0.19			
Apodiformes					2	1.4				
Amazilia tzacatl	4.6				1	0.7	0.01			
Trochilidae unidentified					1	0.7				
Amphibia		37	7.4							
Anura unidentified		37	7.4							
Insecta		7	1.4		5	3.5		95	57.7	
Coleoptera		4	0.8		2	1.4		48	29	
Ancognatha vulgaris								11	6.6	
Pucaya sp.								1	0.6	
Cyclocephalinae unidentified		1	0.2							
Dynastine unidentified		2	0.4		1	0.7		5	3	
Cerambicidae unidentified								3	1.8	
Scarabeidae unidentified					1	0.7		13	7.8	
Curculionidae unidentified								2	1.2	
Coleoptera unidentified		1	0.2					13	7.8	
Orthoptera		3	0.6		1	0.7		47	28.4	
Phaneropteridae unidentified								18	11	
Orthoptera unidentified		3	0.6		1	0.7		29	17.5	
Mantodea unidentified					1	0.7				
Lepidoptera unidentified					1	0.7				
Total number of prey		495			142			165		

RESULTS AND DISCUSSION

We recovered 495 prey items from 143 pellets for *T. alba*, 142 prey items from 149 g of prey remains for *P. perspicillata*, and 165 prey items from 62 pellets for *S. albitarsis*. The diet of *T. alba* consisted 98.6% of vertebrates, the main food items being rodents (66%) and shrews (21.4%). Other vertebrate prey items included frogs, birds, marsupials, and bats. All non-vertebrates were insects (Table 1). The diet of *T. alba* was dominated by terrestrial prey species like Colombian grass mouse (*Akodon affinis*), southern spiny pocket mouse (*Heteromys australis*), Tomes's rice rat (*Nephelomys albigularis*), and an unidentified shrew (*Cryptotis* sp.), also taking scansorial prey like rice rats (*Microryzomys* sp.), Mexican harvest mice (*Reithrodontomys mexicanus*), slender opossums (*Marmosops* sp.) and mouse opossums (*Marmosa* sp.), semiaquatic species like fish-eating rats *Neusticomys* sp., and flying species like yellow-shouldered bats *Sturnira* sp. (Table 1). These findings correspond well with the earlier results from other Neotropical regions (e.g., Bó et al. 2007, Raimilla et al. 2012), where *T. alba* is preying variety of prey species but mainly rats and mice (Sigmodontinae).

Pulsatrix perspicillata also consumed a high percentage of vertebrates (96.5%). Insects taken belonged to the orders Coleoptera, Lepidoptera, Mantodea, and Orthoptera (Table 1). In Ciudad Bolivar, this owl was nesting in urban area with remnants of riverside forest. The area was frequently used as a waste dump including used construction materials. In this environment, the main prey species of *P. perspicillata* were great fruit-eating bat (*Artibeus lituratus*) (23.9%), brown rat (*Rattus norvegicus*) (21.8%), and opossums *Didelphis* sp. (16.1%), all small and medium-sized mammals which tolerate environmental changes and often live in urban areas (see Sánchez-Londoño et al. 2014). At our study site, medium-sized mammals (*Didelphis* sp. and *R. norvegicus*) formed 86.5% of the total prey biomass of *P. perspicillata*. In Oaxaca, Mexico, *P. perspicillata* consumed mainly nocturnal Peter's climbing rats (*Tylomys nudicaudus*) which weighs on average 326 g and is the heaviest small mammal in the study area (Gómez de Silva et al. 1997). In Ciudad Bolivar, *P. perspicillata* also captured at least 14 bird species belonging to six orders, but all avian prey species formed only minor percentages of the diet (12.6%). If we consider the smallest bird captured, the Rufous-

tailed Hummingbird (*Amazilia tzacatl*), *P. perspicillata* is preying on a very broad range of differently sized vertebrates from 4.6 to 716.7 g making it clearly a food generalist (Table 1). Likewise, predation on migratory birds such as the Swainson's Thrush (*Catharus ustulatus*) suggests a certain degree of opportunism in their hunting behavior. Owls are not often reported capturing hummingbirds. So far only *Glaucidium* species have been reported consuming hummingbirds in Chile (Jiménez & Jaksic 1989), Brazil (Sazima 2015), and USA (Rashid 1999).

Strix albitarsis consumed more invertebrates (57.7%) than vertebrates (42.3%). Among the insects, the main groups eaten were Coleoptera beetles (29%) and Orthoptera crickets (28.4%), and the main vertebrate prey were Sigmodontinae rats and opossums belonging to *Marmosops* genus. In the biomass terms, the most important prey was the golden old-field mouse (*Thomasomys aureus*) (Table 1). The little we know before this study on the diet of *S. albitarsis* comes from small-scale studies in Ecuador by Greeney (2003) and Cadena-Ortiz et al. (2013). They examined three pellets and four stomach contents and identified 12 prey items including 10 insects and two small mammals. Our study therefore adds new detailed information on the diet of *S. albitarsis* in the Neotropics. Among the vertebrates, scansorial species such as *T. aureus, Marmosops* sp., *Marmosa* sp., and *R. mexicanus* (see Sánchez-Londoño et al. 2014) were the main prey (Table 1). These species are more vulnerable to aerial predators like *S. albitarsis*, which hunt from a perch of a tree (König et al. 2008).

Levins' index values B and Bsta were 2.05 and 0.13, respectively, for *T. alba*, 4.38 and 0.28 for *P. perspicillata*, and 3.91 and 0.72 for *S. albitarsis*. According to standardized Levins index values, *T. alba* was the most selective of all three owls in its food habits, *P. perspicillata* had intermediate values, while *S. albitarsis* showed the least selective diet. Unfortunately, our material is very limited and based only on a few owls in one or two sites, so larger samples are needed to confirm these results. However, our results contribute towards better knowledge of the ecology of owls in Colombia. Better planning of conservation strategies for many rare owl species requires more studies about their food habits. It is necessary to study spatial and temporal variation of the diet of different species, including also the availability of prey species.

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