ORNITOLOGÍA NEOTROPICAL
(2021) 32: 92–96

SHORT NOTE

Sociedad de Ornitología Neotropical

FEEDING HABITS OF THE STYGIAN OWL (*ASIO STYGIUS*) AND THE SHORT-EARED OWL (*A. FLAMMEUS*) IN THE SOUTHWEST OF BOGOTÁ SAVANNA, CUNDINAMARCA, COLOMBIA

Juan Sebastián Restrepo-Cardona[1*], Juan David Ocampo-Velásquez[2], Andrés Delgado[3], Heimo Mikkola[4], David Ricardo Rodríguez-Villamil[5*]

[1] Programa de Maestría en Conservación y Uso de Biodiversidad, Pontificia Universidad Javeriana, Bogotá, Colombia.
[2] Centro de Museos, Museo de Historia Natural, Universidad de Caldas, Manizales, Colombia.
[3] Programa de Ingeniería Ambiental, Universidad ECCI, Bogotá, Colombia.
[4] Department of Biology, University of Eastern Finland, Kuopio Campus, Finland.
[5] Grupo de Ornitología, Universidad Pedagógica Nacional, Bogotá, Colombia.
Email: Juan Sebastián Restrepo-Cardona · jsrestrepoc@gmail.com; David Ricardo Rodríguez-Villamil · bionaturaldavid@gmail.com

Abstract · This study quantitively compares the diets of the Stygian Owl (*Asio stygius*) and the Short-eared Owl (*A. flammeus*) in the southwest of the Bogotá Savanna, Colombia. We identified 130 prey items from 111 *A. stygius* pellets and 579 prey items from 149 *A. flammeus* pellets. In terms of the numbers of preys, the diet of *A. stygius* consisted of the following: 88.1% birds, mainly pigeons, rails and cuckoos; and a smaller proportion of beetles (11.4%). In the diet of *A. flammeus,* insects were the most frequent prey item (59.8%), followed by rodents (39.8%), and birds (0.5%). In terms of biomass contribution, the main preys in the diet of *A. stygius* were Eared Doves (*Zenaida auriculata*) (54%) and Purple Gallinules (*Porphyrio martinica*) (19.3%), while the diet of *A. flammeus* consisted mainly of House Mice (*Mus musculus*) (65.2%). Diet diversity varied between the owl species: *A. flammeus* was more selective in its hunting habits, while *A. stygius* was more of an opportunistic predator. It is important to quantify the ecosystem services these owls provide not only by controlling *M. musculus*, *Z. auriculata,* and Shiny Cowbird (*Molothrus bonariensis*) populations, which can affect human well-being and threatened species populations, but also through secondary seed dispersion and birdwatching opportunities.

Resumen · Hábitos de alimentación del búho orejudo (*Asio stygius*) y del búho campestre (*A. flammeus*) en el suroccidente de la Sabana de Bogotá, Cundinamarca, Colombia
En este estudio comparamos cuantitativamente la dieta de los búhos *Asio stygius* y *A. flammeus* en el suroccidente de la Sabana de Bogotá, Colombia. Identificamos 130 presas recuperadas de 111 egagrópilas de *A. stygius* y 579 presas recuperadas de 149 egagrópilas de *A. flammeus*. En términos del número de presas, la dieta de *A. stygius* estuvo dominada por aves (88,1%), principalmente palomas, rálidos y cucúlidos, y en menor proporción por coleópteros (11,4%). En la dieta de *A. flammeus*, los insectos fueron las presas más frecuentes (59,8%), seguidos de roedores (39,8%) y aves (0,5%). En términos de aportes de biomasa, las principales presas de *A. stygius* fueron la torcaza nagüiblanca (*Zenaida auriculata*) (54%) y la tingua azul (*Porphyrio martinica*) (19,3%), mientras que *A. flammeus* depredó principalmente el ratón doméstico *(Mus musculus*) (65,2%). La diversidad de la dieta de los búhos varió: *A. flammeus* fue más selectivo en su conducta de caza, mientras *A. stygius* fue más oportunista. Es importante cuantificar los servicios ecosistémicos que proveen estos búhos, no solo al controlar las poblaciones de *M. musculus*, *Z. auriculata* y del chamón parásito (*Molothrus bonariensis*), que pueden afectar el bienestar humano y poblaciones de especies amenazadas, sino también mediante la dispersión secundaria de semillas y al brindar oportunidades para la observación de aves.

Key words: Andes · Biomass · Diet · Ecosystem services · Raptors

INTRODUCTION

In the Neotropical region, the diets of owls have been studied mainly in Mexico, southern Brazil, Argentina, and Chile (e.g., Aragón et al. 2002, Trejo et al. 2005, Arruda & Motta-Junior 2008, Figueroa et al. 2009). In Colombia, the knowledge of owl diets is very limited, hindering the development of successful conservation strategies (e.g., Delgado-V et al. 2005, Delgado-V 2007, Restrepo-Cardona et al. 2018, Restrepo-Cardona et al. 2019). To fill this gap of knowledge in the Andean region of Colombia, this study intended to compare the diets of Stygian and Short-eared Owls in the southwest of the Bogotá Savanna. Our results, based on owl pellet analysis, have important implications for understanding the feeding habits of these species and highlights the ecosystem services that these owls provide.

Submitted 11 April 2020 · First decision 25 January 2021 · Acceptance 31 March 2021 · Online publication 10 September 2021
Communicated by María Andreína Pacheco & Carlos Bosque

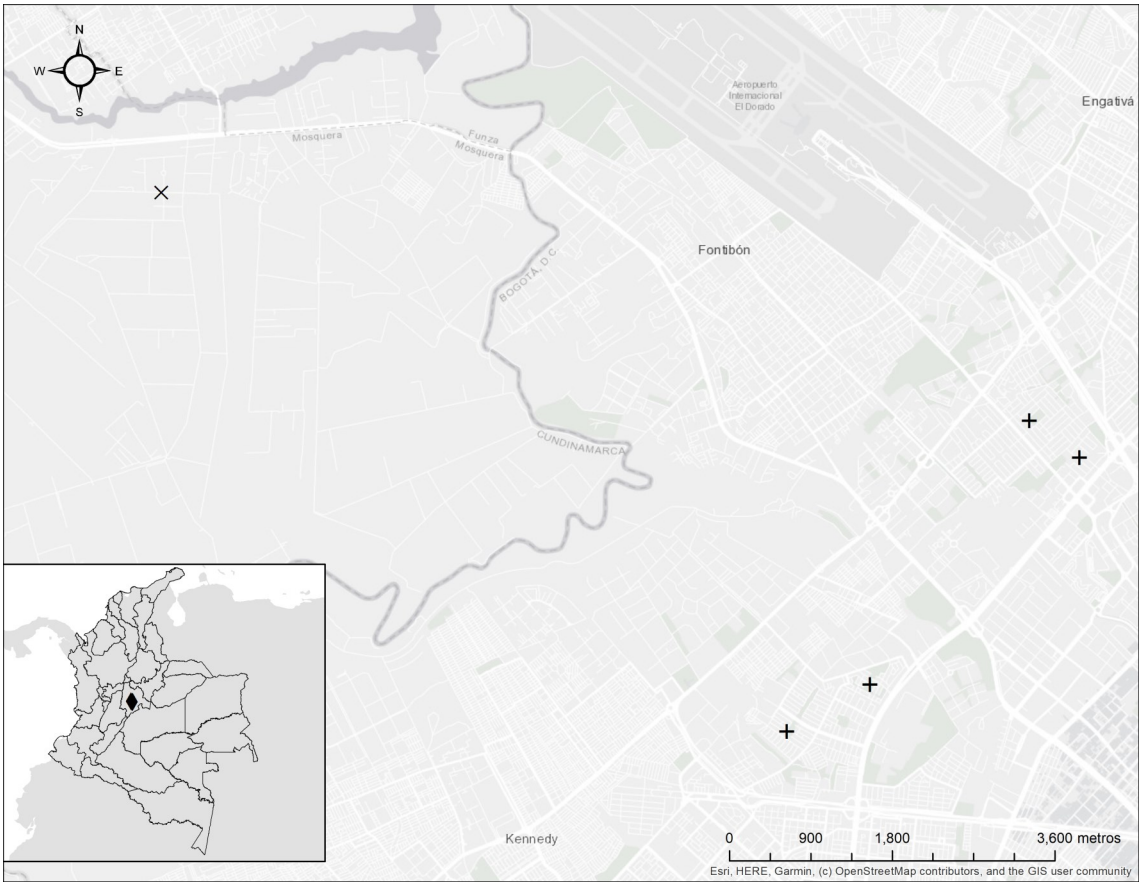

Figure 1. Four roosts of Stygian Owls (*Asio stygius*) (+) and a roost of the Short-eared (Owl *A. flammeus*) (x) in the southwest of the Bogotá Savanna, department of Cundinamarca, eastern Andes of Colombia.

The Stygian Owl (*Asio stygius*) occurs from northwestern Mexico to Central America and the Caribbean. In South America, it occurs patchily from Colombia and Ecuador to northern and northeastern Argentina, as well as southeastern Brazil (König et al. 2008). Its total length is 43 cm and its weight 565 g, making it the largest of the two studied species (ABO 2000, Dunning 2008). In the Bogotá Savanna, it is common but often overlooked (ABO 2000, Leguizamón 2008). It is strictly nocturnal and its behavior is poorly known; it lives in humid and semi-arid forests in montane landscapes, semi-open areas, pine and oak plantations, agricultural areas, and wooded urban parklands (ABO 2000, Motta-Junior 2006, König et al. 2008, Phillips 2011). The diet of *A. stygius* is mainly made up of birds (Lopes et al. 2004), bats (Motta-Junior & Taddei 1992), lizards, frogs (Motta-Junior 2006, Phillips 2011, Cadena et al. 2018), and insects (Borrero 1967). In Colombia, its diet includes the Eared Dove (*Zenaida auriculata*) in Popayán (department of Cauca), the Purple Gallinule (*Porphyrio martinica*), the Eastern Meadowlark (*Sturnella magna*) and the Vermillion Flycatcher (*Pyrocephalus rubinus*) in Bogotá (department of Cundinamarca), and the Great Fruit-eating Bat (*Artibeus lituratus*) and beetles in Medellín (department of Antioquia) (Borrero 1967).

The Short-eared Owl (*Asio flammeus*) occurs worldwide: in South America, it is resident from Venezuela to Argentina (König et al. 2008). *A. flammeus* is smaller than *A. stygius*, with a total length of 36 cm and a weight of 282 g (ABO 2000, Dunning 2008). It is not very common in the Bogotá Savanna and it is locally considered vulnerable because of the indiscriminate use of pesticides and the substitution of the native grasslands (Molina-Prieto & Osorio 1999, ABO 2000, Leguizamón 2008). It is largely diurnal, but most active at dusk, and lives in a variety of open areas that include pastures, savannas, and moorlands (Borrero 1962, Hilty & Brown 2001, König et al. 2008). It feeds mostly on small mammals, mainly rodents, but also other small vertebrates and insects (König et al. 2008). In North America, Europe, Asia, and Africa, its dietary habits have been widely studied (Marks et al. 1999, König et al. 2008), but to a much lesser degree in South America, with the exception of Ecuador, Chile and Paraguay (Rau et al. 1992, Figueroa et al. 2009, Torres et al. 2014, Pozo-Zamora et al. 2017). In urban environments in Colombia, Borrero (1962) observed that in two *A. flammeus* nests, the diet included Black Rats (*Rattus rattus*), Brown Rats (*R. norvegicus*), and Hispid Cotton Rats (*Sigmodon hispidus*).

METHODS

Study area. The study was carried out in the southwest of the Bogotá Savanna, Cundinamarca, Colombia (Figure 1). Four roosts of *A. stygius* were found, two of them in Argyle Apple trees (*Eucalyptus cinerea*) located within wooded parks in urban areas of the districts of Castilla (04°38′17.5″N-74°08′41.3″W; 2.543 m a.s.l.) and Modelia (4°40′09.8″N-74° 07′14.3″W; 2.542 m a.s.l.). The other two were located in river forest relicts of the Boyacá Canal in the Fucha River (4° 39′56.5″N-74°06′56.5″W; 2.542 m a.s.l.). The roost of a pair of *A. flammeus* was found in the rural landscape of the municipality of Mosquera (4°41'31.9"N- 74°12'26.2"W; 2.540 m a.s.l.), at a distance of 9.95 km from Bogotá's urban area. It was located in an open pastureland consisting of shrubs and

Table 1. Composition of pellets of four Stygian Owls (*Asio stygius*; N= 111) and a pair of Short-eared Owls (*A. flammeus*; N= 149) in the southwest of the Bogotá Savanna, department of Cundinamarca, eastern Andes of Colombia. Prey mass (W), number of preys (N), numerical percentage (F%) and biomass percentage (B%). *The seeds recovered from the pellets were not included in the total of prey items.

Prey	Common name	W (g)	*Asio stygius*			*Asio flammeus*		
			N	F%	B%	N	F%	B%
Class Mammalia						231	39.8	82.3
Order Rodentia						231	39.8	82.3
Mus musculus	House Mouse	11.3				205	35.4	65.2
Microryzomys sp.		11.3				10	1.7	3.1
Rattus sp.		162.1				3	0.5	14
Rodentia unidentified						13	2.2	
Class Aves			115	88.1	98.1	3	0.5	8
Order Columbiformes			54	41.7	57	2	0.3	7.6
Zenaida auriculata	Eared Dove	136	53	41	54	2	0.3	7.6
Columba livia	Rock Dove	354.5	1	0.7	3			
Order Cuculiformes			21	16.3	13.1			
Coccyzus americanus	Yellow-billed Cuckoo	64	16	12.3	7.6			
Crotophaga major	Greater Ani	148.5	5	4	5.5			
Order Caprimulgiformes			1	0.7	0.5			
Chordeiles minor	Common Nighthawk	79.3	1	0.7	0.5			
Order Gruiformes			12	9.1	20.2			
Porphyrio martinica	Purple Gallinule	236	11	8.4	19.3			
Mustelirallus erythrops	Paint-billed Crake	121	1	0.7	0.9			
Order Passeriformes			27	20.3	7.3	1	0.2	0.4
Tyrannus melancholicus	Tropical Kingbird	37.4	4	3	1.1			
Vireo olivaceus	Red-eyed Vireo	16.8	2	1.5	0.2			
Catharus ustulatus	Swainson's Thrush	30.3	1	0.7	0.2			
Turdus fuscater	Great Trush	143	1	0.7	1.1			
Thraupis episcopus	Blue-grey Tanager	35	9	7	2.3			
Zonotrichia capensis	Rufous-collared Sparrow	20.4	2	1.5	0.3			
Piranga rubra	Summer Tanager	29.1	1	0.7	0.2			
Conirostrum rufum	Rufous-browed Conebill	11	2	1.5	0.2			
Icterus chrysater	Yellow-backed Oriole	53.4	3	2.3	0.4			
Molothrus bonariensis	Shiny Cowbirds	40	1	0.7	0.3			
Sturnella magna	Eastern Meadowlark	87	1	0.7	1			
Sicalis luteola	Grassland Yellow-Finch	15.9				1	0.2	0.4
Class Insecta			15	11.4	1.6	345	59.8	9.7
Order Coleoptera			15	11.4	1.6	343	59.5	9.6
Ancognatha vulgaris		1	4	3	0.4	343	59.5	9.6
Coleoptera unidentified			11	8.4	1.2			
Order Odonata						2	0.3	0.1
Rhionaeschna marchali	Blue-eyed Darner	1				2	0.3	0.1
Seeds unidentified*			398			43		
Total number of prey			130			579		
Number of pellets			111			149		
B (orders)			3.8			1.96		
Bsta (orders)			0.56			0.24		

scattered trees, including French Broom (*Genista monspessulana*), Humboldt's Willow (*Salix humboldtiana*), Elder (*Sambucus nigra*), Australian Blackwood (*Acacia melanoxylon*), Hopbush (*Dodonaea viscosa*), 'dicots' (*Myrcianthes leucoxyla*), and Southern Bulrush (*Schoenoplectus californicus*), found within partly marshy areas. The southwest of the Bogotá Savanna landscape is a matrix of open agriculture and livestock lands, industrial buildings, secondary river forest relicts, swamplands, and urban and rural settlements (ABO 2000, Chaparro-Herrera & Ochoa 2015, pers. observ.).

Sampling. Pellets of *A. stygius* were collected every 15 days between April and September 2015 to 2018. Pellets of *A. flammeus* were collected weekly between September 2017 and July 2018. The collected material was processed in the Museo de Historia Natural de la Universidad de Caldas *(*MHN -UCa) and in the Museo de Historia Natural de la Universidad Pedagógica Nacional (MHN-UPN). Pellets were processed dry, separating the bone and exoskeletal material from feathers and fur (Marti et al. 2007). All prey items were identified as accurately as possible by using the available museum specimens for comparison in the mammal collection of MHN-UCa, the entomological collection of MHN-UPN and the ornithological collection of the Instituto de Ciencias Naturales de la Universidad Nacional de Colombia (ICN-UN).

Data analysis. Trophic-niche breadth was calculated using Levins' (1968) index, where pi is the percentage of each prey category:

$$B = 1/\Sigma\ pi^2$$

To compare our results with other studies and with owls with a different number of prey categories, we calculated Levins' standardized trophic niche breadth index, where n is the number of prey categories (Colwell & Futuyma 1971):

$$Bsta = (B - 1) / (n - 1)$$

Standardized Levins' index values range from 0 (minimum niche breadth and, consequently, maximum selectivity) to 1 (maximum niche breadth, minimum selectivity; Krebs 1999). To evaluate whether there were significant differences in the

frequency of preys consumed between owls, we performed chi-squared tests of independence in R, version 2.1 (R Core Team, 2013).

The biomass contribution of prey species was calculated using Marti's (1987) index:

$$Bi = 100 [(Spi\ Ni) / \Sigma (Spi\ Ni)]$$

Spi is the weight of species i, Ni is the number of individuals of species i, and Bi is the total biomass percentage contributed by species i. We obtained mean prey mass from specimens in the mammal collection of the Universidad de Antioquia and the biological collection of ICN-UN, and complemented this information with data published by Dunning (2008). For insect preys, 1 g mass was used in biomass calculations, as suggested Bó et al. (1996).

RESULTS AND DISCUSSION

We identified 130 prey items from 111 *A. stygius* pellets and 579 prey items from 149 *A. flammeus* pellets. In terms of the number of preys, *A. stygius* consumed more vertebrates than insects ($X^2 = 59.12$, $P < 0.01$): 88.1% of its diet consisted of birds, mostly *Z. auriculata* (41%), followed by Yellow-billed Cuckoos (*Coccyzus americanus*) (12.3%), *P. martinica* (8.4%), Blue-grey Tanagers (*Thraupis episcopus*) (7%), and 14 additional species (collectively 19.4%). A smaller part of its diet was made up of beetles (11.4%) (Table 1). Similar reports were found in Brazil (Motta-Junior 2006), where *A. stygius* was reported to have consumed birds (91.2%), bats (4.4%), insects, and rodents. In Ecuador and Belize, birds were also the most frequent prey items of *A. stygius (*73.9% and 61.9%, respectively), with the remaining prey items being bats, insects, reptiles, and frogs (Phillips 2011, Cadena-Ortíz et al. 2018). In the southwest of the Bogotá Savanna, *Z. auriculata* and *P. martinica* contributed the greatest biomass to the diet of *A. stygius* (54% and 19.3%, respectively; Table 1). The most important preys of *A. stygius*, both in number and biomass (*Z. auriculata*, *P. martinica*, and *C. americanus*), are species tolerant to habitat transformation and live in the urban areas of Bogotá (ABO 2000, Rosselli et al. 2017, Stiles et al. 2017).

The diet of *A. flammeus* consisted of Rhinoceros Beetles (*Ancognatha vulgaris*) (59.5%) and House Mice (*Mus musculus*) (35.4%). A smaller proportion of preys included *Microryzomys* sp. (1.7%), *Rattus* sp. (0.5%), *Z. auriculata* (0.3%), Blue-eyed Darners (*Rhionaeschna marchali*) (0.3%), and Grassland Yellow-Finches (*Sicalis luteola*) (0.2%). Insects were more common preys in numbers ($X^2 = 3.79$, $P = 0.05$), but rodents made the greatest contribution of biomass (82.3%), followed by insects and birds (Table 1). Similar results were found in the Pichincha Province and Antisana *páramo* in Ecuador. Rodents provided the highest percentage of total prey biomass *(*40.4% and 22%, respectively) but were not the most frequent prey items in the diet of *A. flammeus* (Pozo-Zamora et al. 2017, Cadena-Ortíz et al. 2018).

Diet diversity varied between both owl species. The value of Levins' standardized trophic niche breadth was greater for *A. stygius* than for *A. flammeus* (Bsta = 0.56 and 0.24, respectively). In Brazil, Motta-Junior (2006) identified in *A. stygius* a standardized trophic niche breadth value of 0.03 and in Ecuador, index values for *A. flammeus* were between 0.27 and 0.34 (Pozo-Zamora et al. 2017, Cadena-Ortíz et al. 2019). Our results showed a clear difference in the trophic niche of these two owl species in the southwest of the Bogotá Savanna, but also less prey selectivity in *A. stygius*, which regularly prey upon abundant and frequent birds that inhabit the urban parklands of Bogotá (Amaya et al. 2009; Rosselli et al. 2017, Stiles et al. 2017). It also preyed upon the following migratory birds: Common Nighthawk (*Chordeiles minor*), Paint-billed Crake (*Mustelirallus erythrops*), *C. americanus* and Swainson's Thrush (*Catharus ustulatus*) (Table 1), which indicates opportunistic hunting habits (see Jaksic & Marone 2006).

A. flammeus was more selective in its hunting habits by feeding upon one main species, *M. musculus*, which contributed 65.2% of the biomass of all the prey eaten (Table 1). *M. musculus* is an invasive, alien species that causes losses in agriculture and competes with the native species (Ramírez-Chaves et al. 2011). Similarly, the main prey of *A. stygius*, *Z. auriculata,* is a carrier and transmitter of diseases that can affect the well-being of humans (Diaz et al. 2008). Another prey eaten by *A. stygius,* the Shiny Cowbird (*Molothrus bonariensis*), is a brood parasite that affects the population of Apolinar's Wren (*Cistothorus apolinari*) in the Bogotá Savanna, an endemic and critically endangered species (Velásquez-Tibatá et al. 2000, BirdLife International 2020). Since 2017, these owls have been frequently visited by birdwatchers (O. Cortes pers. com.). For these reasons, *A. stygius* and *A. flammeus* could provide important ecosystem services, not only by controlling *M. musculus*, *Z. auriculata* and *M. bonariensis* populations, but also through birdwatching opportunities and secondary seed dispersion, based on seeds found in our pellet analyses (Table 1). Secondary seed dispersal occurs when a primary seed disperser (e.g., frugivorous animals) or seed predator is hunted and transported from foraging areas to consumption or deposition seed locations (Pérez-Méndez & Rodríguez 2018). Further research is needed on the feeding habits of owls and on the ecosystem services these raptors can provide in human-dominated landscapes in Colombia.

ACKNOWLEDGEMENTS

We are grateful to F. Gary Stiles, Andrés Cuervo and Héctor Ramírez for their permission to use the biological collections of the Instituto de Ciencias Naturales de la Universidad Nacional de Colombia and the Museo de Historia Natural de la Universidad de Caldas, and also for their help in the identification of mammal and bird prey bones and other remains. We also thank Rodrigo Torres and Martha García, from the Museo de Historia Natural de la Universidad Pedagógica Nacional, and Juan C. Caicedo for their assistance in the identification of insect prey remains, Alan Sieradzki and John A. Gray, who revised the text, and two anonymous reviewers for their valuable comments on the manuscript. Pedro A. Camargo and Nathalia Franco kindly participated in the collection and processing of the *A. flammeus* pellets.

REFERENCES

ABO (2000) *Aves de la Sabana de Bogotá, guía de campo.* Asociación Bogotana de Ornitología y Corporación Autónoma Regional de Cundinamarca, Bogotá, Colombia.

Amaya, J, D Agudelo, L Melo, A Morales, & P. Terán (2009) Formulación de criterios técnicos de conectividad ecológica con énfasis en la conservación de la avifauna y la consolidación de procesos de restauración en la estructura ecológica principal del distrito capital. Convenio 046/07. Asociación Bogotana de Ornitología y Secretaria Distrital de Ambiente, Bogotá, Colombia.

Aragón, EE, B Castillo, & A Garza (2002) Roedores en la dieta de dos aves rapaces nocturnas (*Bubo virginianus* y *Tyto alba*) en el noreste de Durango, México. *Acta Zoológica Mexicana* 86: 29–50.

BirdLife International (2020) *Cistothorus apolinari*. *In*: *IUCN Red list of threatened species*. Version 2012.1. Available at http://www.iucnredlist.org [Accessed 29 March 2020].

Borrero, JI (1962) Notas varias sobre *Asio flammeus bogotensis* en Colombia. *Revista Biología Tropical* 10: 45–59.

Borrero, JI (1967) Notas sobre hábitos alimentarios de *Asio stygius robustus*. *El Hornero* 10*:* 445–447.

Bó, MS, SM Cicchino, & MM Martínez(1996) Diet of Long-winged Harrier (*Circus buffoni*) in southeastern Buenos Aires Province, Argentina. *Journal of Raptor Research* 30*:* 237–239.

Cadena-Ortíz, H, J Bedoya, GM Pozo-Zamora, J Watson, & J Brito (2018) Notas sobre la dieta, desarrollo de jóvenes y distribución del Búho Estigio *Asio stygius* (Strigiformes: Strigidae) en Ecuador. *Revista Ecuatoriana de Ornitología* 3: 20–31.

Cadena-Ortíz, H, MF Solórzano, M Noboa & J Brito (2019) Diet of the Short-Eared Owl (*Asio fammeus*) in the Antisana highlands, Ecuador. *Huitzil, Revista Mexicana de Ornitología* 20: e-535.

Chaparro-Herrera, S & D Ochoa (2015) *Aves de los humedales de Bogotá: Aportes para su conservación.* Asociación Bogotana de Ornitología, Bogotá, Colombia.

Colwell, RK & DJ Futuyma (1971) On the measurement of niche breadth and overlap. *Ecology* 52: 567–576.

Delgado-V, CA, PC Pulgarín-R & D Calderón-F (2005) Análisis de egagrópilas del Búho Rayado (*Asio clamator*) en la ciudad de Medellín. *Ornitología Colombiana* 3: 100–103.

Delgado-V, CA (2007) Dieta del Currucutú *Megascops choliba* (Strigidae) en la ciudad de Medellín, Colombia. *Boletín SAO* 17: 114–117.

Diaz, LA, M Occelli, F Ludueña, WR Almirón & MS Contigiani (2008) Eared Dove (*Zenaida auriculata*, Columbidae) as host for St. Louis Encephalitis Virus (Flaviviridae, *Flavivirus*). *Vector-Borne and Zoonotic Diseases* 8: 277–282.

Dunning, J B (2008) *CRC Handbook of Avian Body Masses. Second edition.* CRR Press, Boca Raton, Florida, USA.

Figueroa, RA, JR Rau, S Mayorga, DR Martínez, ER Corales, A Mansilla & R Figueroa (2009) Rodent prey of the Barn Owl *Tyto alba* and Short-eared Owl *Asio flammeus* during winter in agricultural lands in southern Chile. *Wildlife Biology* 15: 129–136.

Hilty, SL & WL Brown (2001) *A Guide to the Birds of Colombia*. Princeton University Press, Princeton, New Jersey, USA.

Jaksic, FM & L Marone (2006) *Ecología de comunidades.* 2ª ed. Ediciones Universidad Católica de Chile, Santiago, Chile.

König, C, F Weick & J Becking (2008) *Owls of the World.* Christopher Helm, London, UK.

Krebs, CJ (1999) *Ecological methodology*. 2nd ed. Benjamin Cummings, Menlo Park, California, USA.

Leguizamón, N (2008) *Aves rapaces de Bogotá. Diversidad en medio de la urbe.* Dirección de Control y Seguimiento Ambiental. Oficina de Control de Flora y Fauna, Bogotá, Colombia.

Levins, R (1968) *Evolution in changing environments.* Princeton Univ. Press, Princeton, New Jersey, USA.

Marks, JS, DJ Cannings, & H Mikkola (1999) Family Strigidae (Typical Owls). Pp. 76–242 *in* del Hoyo, J, A Elliott & J Sargatal (eds.). *Handbook of the birds of the world. Volume 5: Barn Owls to hummingbirds*. Lynx Edicions, Barcelona, Spain.

Marti, CD (1987) Raptor food habits studies. Pp. 67-80 *in* Pendleton, BA, KW Millsap, Cline & DM Bird (eds.). *Raptor research and management techniques.* National Wildlife Federation, Washington, USA.

Marti, CD, M Bechard & JM Jaksic (2007) Food habits. Pp. 129-151 *in* DM Bird, & KL Bildstein (eds.). *Raptor research and management techniques.* Hancock House, Blaine, Washington, USA.

Molina-Prieto, L & J Osorio-Olarte (1999) *Guía de aves de Santafé de Bogotá.* Departamento Técnico, Administración de Medio Ambiente. Alcaldía Mayor de Santafé de Bogotá, Bogotá, Colombia.

Motta-Junior, JC (2006) Relações tróficas entre cinco Strigiformes simpátricas na região central do Estado de São Paulo, Brasil. *Revista Brasileira de Ornitología* 14: 359–377.

Motta-Junior, JC & VA Taddei (1992) Bats as prey of Stygian Owls in Southeasthern Brazil. *Journal of Raptor Research* 26: 259–260.

Pérez-Méndez, N & A Rodríguez (2018) Raptors as Seed Dispersers. Pp. 139-160 *in* Sarasola, JH, JM Grande, & JJ Negro (eds.). *Birds of Prey: Biology and conservation in the XXI century*. Springer, Cham, Switzerland.

Phillips, R (2011) Investigaciones del poco conocido *Asio stygius robustus* en Mountain Pine Ridge, Belice. *Boletín Spizaetus* 12: 2–6*.*

Pozo-Zamora, GM, J Brito, J. García, I Alarcón & H Cadena-Ortiz (2017) Primer Reporte de la Dieta del Búho Orejicorto *Asio flammeus* (Strigiformes: Strigidae) en Pichincha, Ecuador. *Revista Ecuatoriana de Ornitología* 1: 1–7.

Ramírez-Chaves, HE, M Ortega-Rincón, WA Pérez & D Marín (2011) Historia de las especies de mamíferos exóticos en Colombia. *Boletín Científico Museo de Historia Natural* 15: 139–156.

Rau, JR, MC Villagra, L Mora, DR Martínez & MS Tilleríam (1992) Food habits of the Short-eared Owl (*Asio flammeus*) in southern South America. *Journal of Raptor Research* 26: 35–36.

R Core Team (2013) *R: A language and environment for statistical computing*. Vienna: R Foundation for Statistical Computing.

Restrepo-Cardona, JS, D Marín-C, DM Sánchez-Bellaizá, DR Rodríguez-Villamil, S Berrío, L Vargas' & H Mikkola (2018) Diet of Barn Owl (*Tyto alba*), Spectacled Owl (*Pulsatrix perspicillata*) and Rufous-banded Owl (*Strix albitarsis*) in the western Andes in Colombia. *Ornitología Neotropical* 29: 193–198.

Restrepo-Cardona, JS, F Sáenz-Jiménez, MA Echeverry-Galvis, D Marín-C & J Poveda (2019) Diet of the Great Horned Owl (*Bubo virginianus*) during the breeding season in the páramo of La guna Corazón, Tolima, Colombia. *Ornitología Colombiana* 17: eNB02.

Rosselli, L, FG Stiles & PA Camargo-Martínez (2017) Changes in the avifauna in a high Andean cloud forest in Colombia over a 24-year period. *Journal of Field Ornithology* (early view).

Sergio, F, I Newton & L Marchesi (2005) Top predators and biodiversity. *Nature* 236: 192.

Stiles, FG, L Rosselli & S De la Zerda (2017) Changes over 26 years in the avifauna of the Bogotá region, Colombia: has climate change become important? *Frontiers in Ecology and Evolution* 5: 58.

Torres, JC, P Teta & NU de la Sancha (2014) Presas del Búho Campestre (*Asio flammeus*) en un Agroecosistema Subtropical de Paraguay. *Nuestras Aves* 59: 24–27.

Trejo, A, M Kun, M Sahores & S Seijas (2005) Diet overlap and prey size of two owls in the forest-steppe ecotone of southern Argentina. *Ornitología Neotropical* 16: 539–546.

Velásquez-Tibatá, JI, E Gutiérrez & E Carrillo (2000) Primer registro de parasitismo reproductivo en el Cucarachero de Pantano *Cistothorus apolinari* por el Chamón Maicero *Molothrus bonariensis*. *Cotinga* 14: 102–103.